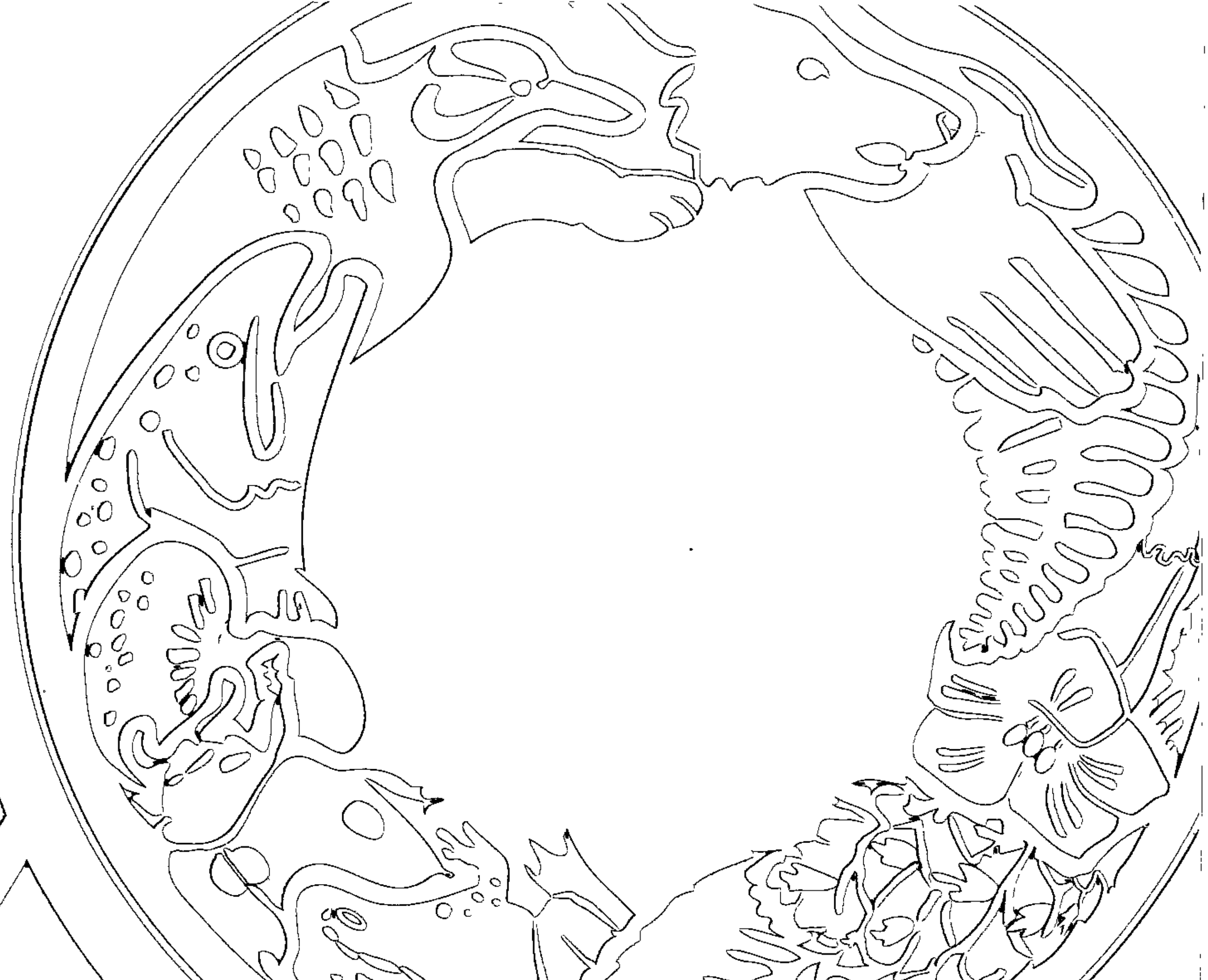

Forest Ecosystem Management:

An Ecological, Economic, and Social Assessment

Report of the Forest Ecosystem Management Assessment Team

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An Ecological, Economic, and Social Assessment

Report of the Forest Ecosystem Management Assessment Team
July 1993

United States Department of Agriculture
Forest Service

United States Department of the Interior
Fish and Wildlife Service

United States Department of Commerce
National Oceanic and Atmospheric Administration
National Marine Fisheries Service

United States Department of the Interior
National Park Service

United States Department of the Interior
Bureau of Land Management

Environmental Protection Agency

Errata

In figures and tables that show acreages for Option 3, some acres that should have been classified as managed Late-Successional Areas were instead classified as Late-Successional Reserves. This error affects figure II-3 and tables III-5, IV-9, IV-10, IV-11, IV-14, IV-29, and IV-36. The error occurs only in the eastern Washington Cascades, eastern Oregon Cascades, and California Cascades. New information is being generated for these figures and tables.

The map for Option 3 that accompanies this document reflects the same error. Some areas in the eastern Oregon and Washington Cascades and the California Cascades that should have been mapped as Managed Late-Successional Areas were instead mapped as Late-Successional Reserves.

The Hayfork Adaptive Management Area was not included in the map of Option 9. This 400,000 acre area, located in northern California, is described in the text of Chapter III.

Preface

Following the April 2, 1993, Forest Conference in Portland, Oregon, President Clinton created three interagency working groups: the Forest Ecosystem Management Assessment Team, the Labor and Community Assessment Team, and the Agency Coordination Team. Direction for the Teams came in a Statement of Mission letter. The following excerpts from that letter outline the mission for the Forest Ecosystem Management Team.

TO: **FOREST CONFERENCE INTER-AGENCY WORKING GROUPS**
Ecosystem Management Assessment
Labor and Community Assistance
Agency Coordination

FROM: **FOREST CONFERENCE EXECUTIVE COMMITTEE**
Department of Agriculture
Department of Interior
Department of Labor
Department of Commerce
Environmental Protection Agency
Office on Environmental Policy
Office of Science and Technology
National Economic Council
Council of Economic Advisors
Office of Management and Budget

RE: **STATEMENT OF MISSION**

Together, we are working to fulfill President Clinton's mandate to produce a plan to break the gridlock over federal forest management that has created so much confusion and controversy in the Pacific Northwest and northern California. As well, that mandate means providing for economic diversification and new economic opportunities in the region. As you enter into the critical phase of your work reviewing options and policy, this mission statement should be used to focus and coordinate your efforts. It includes overall guidance and specific guidance for each team.

BACKGROUND

President Clinton posed the fundamental question we face when he opened the Forest Conference in Portland.

"How can we achieve a balanced and comprehensive policy that recognizes the importance of the forests and timber to the economy and jobs in this region, and how can we preserve our precious old-growth forests, which are part of our national heritage and that, once destroyed, can never be replaced?"

And he said, "The most important thing we can do is to admit, all of us to each other, that there are no simple or easy answers. This is not about choosing between jobs and the environment, but about recognizing the importance of both and recognizing that virtually everyone here and everyone in this region cares about both."

The President said five principles should guide our work:

"First, we must never forget the human and the economic dimensions of these problems. Where sound management policies can preserve the health of forest lands, sales should go forward. Where this requirement cannot be met, we need to do our best to offer new economic opportunities for year-round, high-wage, high-skill jobs.

"Second, as we craft a plan, we need to protect the long-term health of our forests, our wildlife, and our waterways. They are a... gift from God; and we hold them in trust for future generations."

"Third, our efforts must be, insofar as we are wise enough to know it. scientifically sound, ecologically credible, and legally responsible."

"Fourth, the plan should produce a predictable and sustainable level of timber sales and nontimber resources that will not degrade or destroy the environment."

"Fifth, to achieve these goals, we will do our best, as I said, to make the federal government work together and work for you. We may make mistakes but we will try to end the gridlock within the federal government and we will insist on collaboration not confrontation."

ECOSYSTEM MANAGEMENT ASSESSMENT

Our objectives based on the President's mandate and principles are to identify management alternatives that attain the greatest economic and social contribution from the forests of the region and meet the requirements of the applicable laws and regulations, including the Endangered Species Act, the National Forest Management Act, the Federal Land Policy Management Act, and the National Environmental Policy Act. The Ecosystem Management Assessment working group should explore adaptive management and silvicultural techniques and base its work on the best technical and scientific information currently available.

Your assessment should take an ecosystem approach to forest management and should particularly address maintenance and restoration of biological diversity, particularly that of the late-successional and old-growth forest ecosystems; maintenance of long-term site productivity of forest ecosystems; maintenance of sustainable levels of renewable natural resources, including timber, other forest products, and other facets of forest values; and maintenance of rural economies and communities.

Given the biological requirements of each alternative, you should suggest the patterns of protection, investment, and use that will provide the greatest possible economic and social contributions from the region's forests. In particular, we encourage you to suggest innovative ways federal forests can contribute to economic and social well-being.

You should address a range of alternatives in a way that allows us to distinguish the different costs and benefits of various approaches (including marginal cost/benefit assessments), and in doing so, at least the following should be considered:

- timber sales, short and long term;
- production of other commodities;

- effects on public uses and values, including scenic quality, recreation, subsistence, and tourism;

- effect on environmental and ecological values, including air and water quality, habitat conservation, sustainability, threatened and endangered species, biodiversity and long-term productivity;

- jobs attributable to timber harvest and timber processing; and, to the extent feasible, jobs attributable to other commodity production, fish habitat protection, and public uses of forests; as well as jobs attributable to investment and restoration associated with each alternative;

- economic and social effects on local communities, and effects on revenues to counties and the national treasury,

- economic and social policies associated with the protection and use of forest resources that might aid in the transitions of the region's industries and communities;

- economic and social benefits from the ecological services you consider;

- regional, national, and international effects as they relate to timber supply, wood product prices, and other key economic and social variables.

As well, when locating reserves, your assessment also should consider both the benefits to the whole array of forest values and the potential cost to rural communities.

The impact of protection and recovery of threatened and endangered species on nonfederal lands within the region of concern should be minimized. However, you should note specific nonfederal contributions that are essential to or could significantly help accomplish the conservation and timber supply objectives of your assessment.

In addition, your assessment should include suggestions for adaptive management that would identify high priority inventory, research, and monitoring needed to assess success over time, and essential or allowable modifications in approach as new information becomes available. You should also suggest a mechanism for a coordinated interagency approach to the needed assessments, monitoring, and research as well as any changes needed in decisionmaking procedures required to support adaptive management.

You should carefully examine silvicultural management of forest stands -- particularly young stands -- especially in the context of adaptive management. The use of silviculture to achieve those ends, or tests of silviculture, should be judged in an ecosystem context and not solely on the basis of single species or several species response.

Your conservation and management assessment should cover those lands managed by the Forest Service, the Bureau of Land Management, and the National Park Service that are within the current range of the northern spotted owl, drawing as you have on personnel from those agencies and assistance from the Fish and Wildlife Service, the National Marine Fisheries Service, and the Environmental Protection Agency. To achieve similar treatment on all federal lands involved here, you should apply the "viability standard" to the Bureau of Land Management lands.

In addressing biological diversity you should not limit your consideration to any one species and, to the extent possible, you should develop alternatives for long-term management that meet the following objectives:

- maintenance and/or restoration of habitat conditions for the northern spotted owl and the marbled murrelet that will provide for viability of each species -- for the owl, well distributed along its current range on federal lands, and for the murrelet so far as nesting habitat is concerned;

- maintenance and/or restoration of habitat conditions to support viable populations, well-distributed across their current ranges, of species known (or reasonably expected) to be associated with old-growth forest conditions;

- maintenance and/or restoration of spawning and rearing habitat on Forest Service, Bureau of Land Management, and National Park Service lands to support recovery and maintenance of viable populations of anadromous fish species and stocks and other fish species and stocks considered "sensitive" or "at risk" by land management agencies, or listed under the Endangered Species Act; and,

- maintenance and/or creation of a connected or interactive old-growth forest ecosystem on the federal lands within the region under consideration.

Your assessment should include alternatives that range from a medium to a very high probability of ensuring the viability of species. The analysis should include an assessment of current agency programs based on Forest Service plans (including the Final Draft Recovery Plan for the Northern Spotted Owl) for the National Forests and the Bureau of Land Management's revised preferred alternative for its lands.

In your assessment, you should also carefully consider the suggestions for forest management from the recent Forest Conference in Portland. Although we know that it will be difficult to move beyond the possibility considered in recent analysis, you should apply your most creative abilities to suggest policies that might move us forward on these difficult issues. You also should address shot-term timber sale possibilities as well as longer term options.

Finally, your assessment should be subject to peer review by appropriately credentialed reviewers.

CONCLUSION

We appreciate your efforts and recognize, as President Clinton did, that these are difficult issues with difficult choices. And, we'll remind you of something else the President said at the Forest Conference, talking to the people of the Pacific Northwest and northern California: "We're here to begin a process that will help ensure that you will be able to work together in your communities for the good of your businesses, your jobs, and your natural environment. The process we (have begun) will not be easy. Its outcome cannot possibly make everyone happy. Perhaps it won't make anyone completely happy. But the worst thing we can do is nothing."

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Forest Ecosystem Management:

An Ecological, Economic, and Social Assessment

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I

Executive Summary

Chapter I

EXECUTIVE SUMMARY

Timber cutting and other operations on lands managed by the Forest Service and the Bureau of Land Management within the range of the northern spotted owl have been brought virtually to a halt by federal court orders. As a result, the Administration commissioned the Forest Ecosystem Management Assessment Team to formulate and assess the consequences of an array of management options that might form the basis of a solution to the crisis. The Team was told that the objectives were to produce management alternatives that would comply with existing laws and produce the highest contribution to economic and social well being.

The effort reported here is conceived as Phase I of a multiphased approach to ecosystem management. In this first phase, the "backbone" for ecosystem management for the federal forests within the range of the northern spotted owl is, in varying combinations, constructed of a network of late-successional forests and an interim and long-term scheme for protection of aquatic and associated riparian habitats adequate to provide for threatened species and "at risk" species associated with such habitats. In subsequent phases it is expected that planning will be carried out that extends ecosystem management concepts to multiple federal ownerships and, perhaps, to state and private lands (at the discretion of those landholders).

The Team was comprised of scientists and technical experts of a variety of disciplines from the Forest Service, Bureau of Land Management, Environmental Protection Agency, U.S. Fish and Wildlife Service, National Park Service, National Marine Fisheries Service, and from several universities. Over 600 scientists, technicians, and support personnel contributed in some fashion to this effort.

Some 48 previously prepared options addressing the issues of conservation of threatened species (spotted owls and marbled murrelets), anadromous fish, and the late-successional/old-growth ecosystems were examined and evaluated. Using the principles put forward in these previous exercises, 10 additional options were developed and analyzed. These options encompassed various mixtures of Late-Successional Reserves, Riparian Reserves, and prescriptions for the management of the forest both inside and outside of reserves. Most management would occur in areas outside of reserves, called the Matrix. The sizing, spacing, and silvicultural activities allowed in reserves varied between options. The size of the reserves varied from 4.2 to 11.5 million acres.

In one option, there is provision for 10 Adaptive Management Areas arrayed across the landscape and ranging from 84,000 to 400,000 acres. Their purpose is to provide areas where managers can use innovative approaches, perhaps at a landscape scale, to achieve management objectives. These areas will also provide a laboratory for innovative social mechanisms for managing federal lands and areas of mixed ownerships in a more cooperative and interactive fashion. These Adaptive Management Areas could be incorporated into any option presented, with some modification and additional assessment.

For each of the 10 options, the Team evaluated the likelihood of maintaining well-distributed habitat conditions on the federal lands for threatened marbled murrelets and northern spotted owls. In addition, for seven of the options, similar assessments were done for over 1,000 plant and animal species thought to be closely associated with late-successional forests. The likelihood of maintaining a connected viable late-successional ecosystem was also evaluated. These likelihoods varied across options but, in general, were found to be directly related to the amount of late-successional forest in reserve status. These results were reported without comment as to whether they met the statutory requirements of the Endangered Species Act or the regulations issued pursuant to the National Forest Management Act.

At-risk fish species and stocks were similarly assessed, and the ratings seemed most sensitive to the degree of stream side/watershed protection afforded. Such assessments for the northern spotted owl and marbled murrelet resulted in eight of 10 options having a likelihood of achieving habitat conditions suitable to maintain viable populations well distributed on the federal lands. Of the 10 options for at-risk fish species or stocks, eight would result in a reversal of the trend of habitat degradation on federal lands and begin a process of recovery of the aquatic ecosystems on those lands. The Team conducted the most thorough assessment to date of the "viability" of the broad array of species associated with late-successional forest conditions. There were numerous problems in trying to evaluate "real world" biological conditions against the language in the regulations issued pursuant to the National Forest Management Act.

Probable annual sale quantity estimates were completed for each option and compared to harvest levels for the period 1980 through 1989 (4.6 billion board feet per year) and 1990 through 1992 (2.4 billion board feet per year). The anticipated sale level, including cull and salvage volume, ranged from 0.2 billion board feet per year to 1.8 billion board feet per year across the options.

Nonfederal timber harvests have historically accounted for two-thirds of the harvest in the region. Nonfederal timber harvests seem likely to respond to higher prices in the 1990's, resulting in cutting above the sustained yield levels at a rate of 9.4 billion to 9.8 billion board feet per year. In aggregate, timber harvested and processed from all owners is projected to be some 0.8 billion to 2.1 billion board feet (7 to 17 percent) less than the 1990 through 1992 level and 3.5 billion to 4.7 billion board feet (24 to 32 percent) less than the levels of the 1980's, depending on the option.

Direct timber industry employment was as high as 152,000 as recently as 1988. It was approximately 144,900 in 1990 and dropped to an estimated 125,400 in 1992. The employment level anticipated for the next decade varies from 112,900 to 125,000 across the options.

State level forecasts for Oregon and Washington indicate that the aggregate economy will continue to grow regardless of the option chosen. The Washington outlook is rather stable while Oregon's economy is poised to expand 7.4 to 8.7 percent in the aggregate, between 1992 and 1995.

Large-scale reductions are expected in federal receipts and shares to local counties. Unless Congress continues to provide a "safety net," local government revenues could decline by $147 million to $277 million from the 1990 through 1992 level of $294 million, depending on the option.

Consequences to communities vary by option and by rural community. Community capacity to accommodate to change seems to be the most important factor in a community's anticipated ability to adjust to lowered federal timber harvest levels. Those communities that are dependent for federal timber supply and have low capacity to adjust are those communities most at risk. Some communities have already suffered severe impact from reduced timber supply and will suffer even more under most -- probably all -- of the options developed. Suggestions are made as to how help may be provided to those communities during a period of transition.

We describe a possible and detailed scenario for carrying out a phased coordinated and collaborative movement to achievement of ecosystem management for the federal lands within the range of the northern spotted owl. It is obvious that a new approach to coordinated and collaborative government (i.e., interagency) activities is essential if there is to be speedy recovery from the current impasse. Suggestions are made as to how that might be achieved so that momentum may not be lost as the implementation of a preferred option for ecosystem management proceeds.

We have done our best to fulfill the charge given to us in the time allotted. We believe the assessments of the current situation, the previous assessments of the situation, and the options presented herein are adequate to support an informed decision as to a course of action. Our work as scientists, economists, analysts, and technicians is complete. Whatever decisions that may emerge from this work are now, most appropriately, in the hands of elected leaders.

II

Overview and Summary of Options and their Evaluation

Chapter II

Overview and Summary

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Contributors

Spatial Analysis Support

John Steffenson and Duane Dippon shared the coordination role for this large group of over 80 individuals. The Spatial Analysis Group was charged with assembling and analyzing a wide variety of spatially explicit information for the other groups. The Spatial Analysis Group compiled the largest database of resource information regarding forests and related resources ever built for the Northwest. This was an extremely large task and the following people, divided out by sub-group, deserve recognition of the effort they put forth to support this project.

John Vosburgh coordinated the development of seral maps. Lisa Lackey, Alex Morton and Mike Golden assisted in this effort with the image processing. Lois Doyle kept track of the hundreds of maps developed, acting as our Map Librarian. The printed maps prepared with the report were developed in a wholly digital process and were developed by Jeff Nighbert with assistance from Margo Blosser, Cliff McClellan, Dave Lang, Andy Wilson, and A. Paul Newman. Cathy Askren provided information and edited portions of the report.

Andy Wilson supervised the group of analysts and managed the overall operations of the computer systems and analysis process. Tony Bacon, Anita Bailey, Mitchel Barton, Margo Blosser, Ted Falkner, Beth Galleher, Eric Gillette, Matt Gilson, Pat Green, Rick Griffen, Becky Gravenmeier Julie Johnson, Mary Hamilton, Aimee Lesieutre, George Lienkaemper, Virginia Lutz, Jan McCormick, Carol Murdock, Charlene Neihardt, A. Paul Newman, Steve Salas, Fred Seavey, Doug Taylor, Richard Vandewater, Bill Wettengel, Dan Wickwire, Michele Widener, and John Young constituted the Analyst sub-group assisting Andy.

Along with the primary analysts, a large number of people provided miscellaneous analytical support including the scanning and digitizing of maps, drafting, data conversion, analysis, process tracking, etc. These people include Mitra Akbari, David Akbari, Jim Archer, Don Arct, Dave Barbour, James Blatt, De Bui, Mark Christianson, Phung Dang, Kathleen Dinh, Tieu Doan, Jeffery Fields, Khoa Ha, Harvey Holien, Kenneth Horvath, Faramarz Jaihouni, Jeffery Johnson, William Lavely, Mervin Leigh, Bron MacDougal, Dave Mandel, James Moore, Hoa Nguyendang, Myle Phan, Scott Rollo, Karl Rosenberger, Bonnearin Sin, Debbie Smith, Timothy Spear, Tuyen Ta, Sirous Tanzadeh, Thong (Tom) Tran, Joseph Tyner, Isabel Villar, Hoang Vu, and Steve Wheeler.

The Database Administrator was Peg Watry who received documentation support from Mike Moscoe, Gina Williams, and Myle Phan. Database design was accomplished by Ernie Bergan, Tony Bacon, Andy Wilson, Dale Guenther, and Peg Watry. The primary Database Analysts were Ernie Bergan and Bob Varner with additional support from Loc Hoang, Terry Locke, Arther Miller, Mike Whetter, and Rick Griffen.

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Chapter II

OVERVIEW AND SUMMARY

Background

Timber cutting and other operations on lands managed by the U.S. Department of Agriculture, Forest Service and the U.S. Department of the Interior, Bureau of Land Management, have been brought virtually to a halt by federal court orders for several reasons. Foremost has been the failure of the agencies to produce plans that satisfy the requirements of several laws including the National Forest Management Act of 1976, the Endangered Species Act of 1979, and the National Environmental Policy Act of 1969. Shortcomings have included delays in meeting court-imposed time schedules, inadequate environmental impact statements, and numerous proposed management actions (e.g., timber sale proposals) that resulted in "jeopardy opinions" from the U.S. Department of the Interior, Fish and Wildlife Service.

This series of events (Thomas et al. 1993: 32-45) can be dated back at least to 1972 when scientists first suspected that at least one sub-species (the northern spotted owl) might be closely associated with the habitat conditions most frequently found in old-growth forests.

Over the period 1972 to 1993, the issue evolved from a question of dealing with a single species, now considered by the Fish and Wildlife Service to be threatened, to dealing with several such species simultaneously within the same ecosystem, to considering the effects of broadscale management plans on *all* species associated with old-growth or late-successional forests. This latter consideration -- and the evolving concerns with "sustainable forestry," "multiple-use," "threatened and endangered species," "retention of biodiversity," "landscape ecology," and other concepts -- led the Bureau of Land Management, the Forest Service, and political leaders to embrace the concept of ecosystem management. In addition, these land managers and political leaders have reached the obvious conclusion that ecosystem management must exist in the context of human needs and desires that are most commonly measured in economics: the production of goods and services from those lands. Considering these factors, political decisions concerning ecosystem management must be made.

Brief History of Forest Management in the Pacific Northwest

Cutting of forests in the Pacific Northwest began in the 1800's when the first non-Indian immigrants began to settle and farm in the interior valleys of western Oregon and the Puget Sound region. Initially, the extensive forests that covered much of the landscape were viewed as an impediment to progress and were systematically cleared and burned to make way for agriculture.

In the late 1800's and early 1900's, extraction of timber for commercial purposes began to increase. Lumber camps sprang up around the region, especially in areas accessible by river or steam locomotive. Lowland areas close to human population centers were logged first, followed eventually by less accessible areas in more mountainous terrain. Logging in these early years frequently consisted of a clearcut and burn approach in which noncommercial species and many small diameter trees were left following logging, with little or no attention to replanting after harvest. Because of the seemingly inexhaustible supply of trees and the considerable labor required to fell them with hand saws and axes, trees with low commercial value were frequently left standing.

Shortly after World War II and subsequent to the invention of the gas-powered chain saw and improvements in transportation, logging began in earnest on federal lands in the Pacific Northwest. European methods of forest management were gradually adopted on most federal and private lands, including techniques such as clearcutting, removal of logs and snags, slash burning, thinning, and planting of single species stands on cutover areas. The assumption was that forests managed in this manner could be cut and regrown at relatively short intervals (e.g., 40-80 years) without negatively affecting other resources such as water quality, fish, soils, or terrestrial animals.

As a result of over a century of logging and fire control, the forests of the Pacific Northwest presently consist of a highly fragmented mosaic of recent clearcuts, thinned stands and young plantations interspersed with uncut natural stands. The natural stands that remain range from 1,000-year-old or older forests of large trees to relatively young, even-aged stands that have regenerated following wildfires. Because wildfires and windstorms often killed only part of the trees in a stand, natural stands are frequently characterized by uneven-aged mixtures of trees that survived a catastrophic event and younger trees that filled in the understory after the event. Where many large old trees remain in the overstory, these stands are usually referred to as "old growth" or "ancient forests." Where only scattered individuals or patches of large old trees remain and the majority of the stand consists of young or mature trees, stands are referred to as "mixed age" or even "young." Mixed-age stands are particularly common in some areas, such as the Oregon Coast Range, where extensive fires occurred in the 1800's. Mixed-age stands defy categorization -- they are not "old growth" in the classical sense (Franklin and Spies

1991; Spies and Franklin 1991), and they are certainly not young even-aged stands. It is these mixed-age stands that have led to much of the debate over how much "old growth" or "ancient forest" is left in the Pacific Northwest.

As studies on the ecology of late-successional forests began to proliferate in the 1970's and 1980's, it gradually became apparent that a simplistic approach to forest management based on high-yield, short-rotation forestry was not going to adequately protect the considerable biodiversity that was present in late-successional forests and their associated aquatic ecosystems. The northern spotted owl was the first species to receive recognition in this regard followed closely by the marbled murrelet, anadromous fish, and the recognition that a wide variety of species are closely associated with old forests (Thomas et al. 1993). More recently, ecologists, foresters, and the public have begun to recognize that the old forests that remain in the Pacific Northwest may be unique ecosystems that developed under climatic and disturbance regimes that may never be duplicated.

Changes in public perceptions and expectations concerning management on federal lands in the Pacific Northwest and elsewhere have led to a gradual increase in protection of unique ecosystems and species, increased concern with riparian areas, and experimentation with methods of "new forestry" designed to retain some of the structural features found in old forests and thereby more closely imitate natural disturbance regimes. As these changes have occurred, harvest rates of timber on federal lands have declined, and considerable controversy has ensued. The Forest Ecosystem Management Assessment Team was formed to develop and evaluate possible management options for resolving this issue.

Approach

It took a century and a half to arrive at the current crisis in the Pacific Northwest. From the beginning of their assignment, Forest Ecosystem Management Assessment Team members knew that 3 months was not enough time to develop a full-scale ecosystem management plan. Therefore, the team concluded that the shift to an ecosystem management approach could best be achieved through a continuing three-phase process. The first phase is development and assessment of management options for establishment of a network of late-successional/old-growth forest reserves and a prescription for the management of the intervening forested land (i.e., the Matrix). The first phase also included selection of an option and the completion of the procedures required by the National Environmental Policy Act (i.e., the environmental impact statement). The options developed were to attempt to meet the Administration's directives of achieving biological diversity while attaining economic and social goals including compliance with law. The second phase in the shift to ecosystem management is reinstituted forest planning -- a process that must include federal, state, local government, and private interests if ecosystem management is to be achieved. The third phase is implementation, monitoring, and adaptive management.

There are several key biological objectives. First is assuring adequate habitat on the federal lands to aid in "recovery" of late-successional forest habitat-associated species listed as threatened under the Endangered Species Act (e.g., northern spotted owls and marbled murrelets). In addition, in keeping with agency responsibilities to prevent species from being listed under the Endangered Species Act and with the regulations issued pursuant to the National Forest Management Act, the Team assessed the risk of "viability" to all identified species of plants and animals under each suggested management option.

Then, considering that aquatic and riparian habitats and wetlands on federal lands are key to numerous aquatic organisms including some 13 species and approximately 260 runs (fish stocks) of anadromous fishes considered to be "at risk" of extinction, riparian management options for habitat adjacent to streams were developed. Without such appropriate management options, many aquatic and riparian associated species may become candidates for listing as threatened or endangered under the Endangered Species Act within the near future, indeed many of these species may well be listed as threatened in any case.

Development of management options for protection of stream corridors to enhance habitat conditions for associated aquatic and terrestrial species also established "connectors" between patches of forested habitats. Such connections are one way to permit individuals to move between habitat patches over both short and longer term thereby increasing the species' viability. Facilitated movement between habitat patches reduces the risk of both demographic and genetic isolations of plants and animals.

The selected option will provide the "backbone" of an ecosystem management approach. Full development and implementation of an ecosystem approach to management will be recognized through a renewed federal land management planning process that might occur over 3 to 5 years. The planning will be in two stages. The first is the short term with emphasis, of necessity, on assurance against losses in biological diversity (with emphasis on threatened species) and ecological processes. The second is the longer term, which will be aimed at achievement of restoration and more spatially appropriate conditions at landscape scale. Next in achieving ecosystem management is the implementation of the management approach described in the selected option in conjunction with monitoring and adaptive management.

Compliance with Law and Regulations

The instructions given to the Forest Ecosystem Management Assessment Team by the Forest Conference Executive Committee are set forth in the Preface to this volume. The Executive Committee stated that its objectives were "to identify management alternatives" that attain the greatest economic and social contributions from the forests and also "meet the requirements of the applicable laws and regulations, including the Endangered Species Act, the National Forest Management Act, the Federal Land Policy Management Act, and the National Environmental Policy Act."

The Team was not asked to interpret the applicable laws and regulations or to indicate whether a particular alternative satisfied those regulations or requirements. However, "in addressing biological diversity" the Team was instructed to:

> ...develop alternatives for long-term management that meet the following objectives:
>
> - maintenance and/or restoration of habitat conditions for the northern spotted owl and the marbled murrelet that will provide for viability of each species – for the owl, well distributed along its current range on

federal lands, and for the murrelet so far as nesting habitat is concerned;

- maintenance and/or restoration of habitat conditions to support viable populations, well distributed across their current range, of species known (or reasonably expected) to be associated with old-growth forest conditions;

- maintenance and/or restoration of spawning and rearing habitat on Forest Service, Bureau of Land Management, National Park Service, and other federal lands to support recovery and maintenance of viable populations of anadromous fish species and stocks and other fish species and stocks considered "sensitive" or "at risk" by land management agencies, or listed under the Endangered Species Act;

- maintenance and/or creation of a connected or interactive old-growth forest ecosystem on the federal lands within the region under consideration...

The Team was instructed to "include alternatives that range from a medium to a very high probability of ensuring the viability of species" and that the analysis "should include an assessment of current agency programs..."

The use of the term "viability" is an obvious reference to the regulations issued under the National Forest Management Act requiring that "fish and wildlife habitat shall be managed to maintain viable populations of existing native and desired nonnative vertebrate species in the planning area" (36 CFR Ch. II; 7-1-91 Edition, 219.19). The regulations also require provision "for diversity of plant and animal communities and tree species" (id., 219.26 and 27).

The provisions of the Endangered Species Act are not limited to vertebrates but extend to any species of plant or animal that is endangered or threatened. The principal provisions come to bear when a species is formally listed as endangered or threatened. The threatened species mentioned specifically in our instructions were the northern spotted owl and the marbled murrelet. The Team also paid particular attention to "at-risk" species and stocks of anadromous fishes.

Although the "viability regulation" is applicable only to lands managed by the Forest Service, the Team was told that "to achieve similar treatment on all federal lands involved here, you should apply the 'viability standard' to the Bureau of Land Management lands." As a practical matter, this instruction made little difference to the final results. In all of the options developed by the Team, potential harvest levels were affected primarily by the need for protecting the northern spotted owl, the marbled murrelet, at-risk fish species, and late-successional forest considerations. Consideration of the first two of these is required by the Endangered Species Act, which is equally applicable to both land management agencies. In addition, the Bureau of Land Management's preferred alternative from their Draft Resource Management Plans considered at-risk fish and other species that could be listed in the near future as species of special status. Moreover, the Team recognized that if the plan failed to consider at-risk species, the Bureau of Land Management could have been in a position of having to revise its planning as soon as those species become listed. The impact on Bureau of

Land Management lands of considering the viability of other species (that is, other than the northern spotted owl, the marbled murrelet, and at-risk fish) was minimal.

Overview: Option Development and Description

As a first step in development of an ecosystem management plan with options that provided for varying levels of likelihood of "viability" for species of concern we considered 48 previously described plans (see chapter III). These plans represented the full range of options that existed prior to our assignment (Preface). These plans were evaluated using criteria pertaining to the likelihood that such plans would provide habitat to maintain the viability of (1) northern spotted owls, (2) marbled murrelets, (3) at-risk fish species and stocks, and (4) other species closely associated with old-growth forests. The likelihood the plans would provide an interacting late-successional forest ecosystem was also evaluated. Such evaluations were used to select a set of options that were analyzed more thoroughly and then refined to better meet the Team's mission (see Preface). A total of 10 options were eventually developed. A general discussion of the options follows. For a more complete description of each option, see chapter III. See also the maps of the options that accompany the report.

Components of the Options

This section summarizes information found in chapter III, Option Development and Description. For more detailed information refer to that chapter. Each of the options included consideration of late-successional forests found in National Parks, Wilderness Areas, and Research Natural Areas. Such areas are referred to as Congressionally Withdrawn Areas. They are the same for all options. Other areas have been withdrawn from timber harvest by the federal agencies for varying reasons such as protection of unstable soil, trees retained along roadsides, wild and scenic river corridors, etc. These areas are called Administratively Withdrawn Areas.

The options vary in four principal respects: the quantity and location of land placed in some form of reserve; the activities permitted within those reserve areas; the delineation of areas outside the reserves; and the activities allowed within areas outside reserves.

Designation of Reserves

The Team found that to assure the viability of threatened and at-risk species (and thereby satisfy the requirements of current law) some system of reserves was required. Consequently, each of the options contains reserve areas in which timber harvests are either not allowed at all or are limited, and areas outside of reserves (referred to as the **Matrix**) where most timber cutting occurs.

The reserves are of two types: **Late-Successional Reserves**, encompassing older forest stands, and **Riparian Reserves**, consisting of protected strips along the banks of rivers, streams, lakes, and wetlands, which act as a buffer zone between the water and areas where cutting is allowed.

Late-Successional Reserves were developed in three ways. In some options, the starting point was the habitat needs of individual species, particularly the northern spotted owl. Most of these incorporate the features of the Final Draft Recovery Plan for the

Northern Spotted Owl (USDI 1992) that was developed by the Interior Department as required by the Endangered Species Act. The primary owl protection areas under that plan are known as **Designated Conservation Areas.** These are relatively large areas, both sized and spaced across the landscape in a manner that meets the habitat needs for multiple pairs of owls. Other smaller areas for the protection of individual pairs of owls (or single owls) are known as **managed pair areas, reserved pair areas,** and **residual habitat areas.** In developing options based on this approach, the Team generally started with owl habitat and then designated additional habitat to contribute to meeting the habitat needs of other species.

- Options 4, 5, and 7 take this approach. Of these, the Reserves are largest under Option 4 and smallest under Option 7.

Other options develop Late-Successional Reserves by starting with remaining old growth. In an earlier study, the old growth remaining on federal land in the region was classified in three categories of **late-successional/old-growth (LS/OG)** forests.

The first category, **LS/OG1,** includes relatively large areas containing old growth that was deemed to be the most ecologically significant. (These areas also contain some younger forest stands that have been previously cut or burned.) The second category, **LS/OG2,** contains old growth areas that tend to be somewhat smaller and more fragmented but still ecologically significant. The third category, **LS/OG3,** comprises isolated patches or highly fragmented parcels of old growth that have ecological importance to some species.

Both the northern spotted owl and the marbled murrelet are associated with habitat conditions found in old-growth areas. LS/OG-based reserves provide much of the necessary protection for northern spotted owls on federal lands. However, some additional designations (referred to as **owl additions**) are required to provide the habitat conditions needed for the recovery of the spotted owl. Options 1, 2, 3, 4, 6, 8, and 10 take an approach that includes some combination of LS/OG areas and owl additions:

- Option 1 protects LS/OGs 1, 2, and 3 and owl additions. It has the largest Late-Successional Reserves of any option and the most restrictive rules about entry into the Reserves.

- Options 2 and 3 protect LS/OGs 1 and 2 plus owl additions. However, under Option 3, LS/OG2s outside a zone of primary marbled murrelet use are treated as Managed Late-Successional Areas (see below).

- Options 6, 8, and 10 protect LS/OG1s plus owl additions and in the primary marbled murrelet zone, LS/OG2s. Total acres in Late-Successional Reserves under these options are less than under Options 1, 2, and 3.

Option 4, which starts with Late-Successional Reserves based on spotted owl protection, adds all LS/OG1s and in the primary marbled murrelet zone LS/OG2s.

Option 9 is an integration of the other approaches because it starts with the Reserves developed under other options, both species-based and old-growth based, and attempts to provide an integrated Reserve system based on the protection of Key Watersheds (see below) that serve multiple purposes.

Under all options except Option 7, LS/OG1s and LS/OG2s, are established as Late-Successional Reserves within a zone of primary use by marbled murrelets to provide for that species' nesting habitat needs until a required recovery plan, being prepared under the auspices of the Fish and Wildlife Service, is complete. Option 7, based on the current land management plans of the agencies, includes no special protection for marbled murrelets and as a result has a relatively low likelihood of providing for murrelets. All options but Options 7 and 8 provide for surveys for and the protection of sites occupied by marbled murrelets found outside Reserves.

All options contain some form of **Riparian Reserves.** Riparian Reserves are intended to address the habitat requirements for fish and other aquatic and riparian species. They also protect water quality, maintain appropriate water temperatures, and reduce siltation and other degradation of aquatic habitat that results from timber cutting on adjacent land. This degradation has been an especially serious product of past road building and cutting practices and is a contributing reason why some fish species are now at risk of extinction. Riparian Reserves also serve as "connectors" that may help species to move among Reserve areas.

Under different options, Riparian Reserves along rivers, streams, lakes, and reservoirs vary in width depending on the size of the body of water and the ecological importance of the **watershed** (literally the area that drains into a particular river or stream). Some options involve the designation of **Key Watersheds,** where riparian protection may be greater than in other locations. Options 1 and 4 provide the greatest amount of riparian protection. Options 7 and 8 provide the least. The rest are in the middle of the range of protection.

The options recognize three categories of water: (1) permanently flowing fish-bearing rivers, streams, lakes, and reservoirs; (2) permanently flowing nonfish-bearing streams, ponds, and wetlands larger than 1 acre; and (3) intermittent streams and wetlands smaller than 1 acre.

All options except Options 7 and 8 incorporate buffer widths that are a minimum of 300 feet on each side of the water for the first category of streams, and a minimum of 150 feet for permanently flowing streams of the second category. Option 7 uses buffers established by Forest Service and Bureau of Land Management plans, which are generally narrower. Option 8 uses 75-foot buffers for the second category.

In addition, all options except Option 7 prescribe minimum buffer widths for intermittent streams and for small wetlands:

- Options 1 and 4 use a buffer width of at least 100 feet for these areas.
- Options 2, 3, 5, 6, 9, and 10 use a 100-foot minimum width for intermittent streams in certain Key Watersheds and 50 foot minimum elsewhere. In Option 9 an effort was made to delineate the Late-Successional Reserves in Key Watersheds.
- Option 8 uses a 25-foot minimum for all intermittent streams and small wetlands.

- Option 7 is based on the plans of the Forest Service and Bureau of Land Management. Those plans do not generally prescribe a minimum buffer for intermittent steams; where they do, the buffer width is usually 25 feet.

Activities Within the Reserves

Late-Successional Reserves. Under Option 1, no timber harvest or salvage operations would be allowed in the Late-Successional Reserves. Under all other options (except Option 8 -- see below), some thinning of younger stands would be allowed in the portion of the Reserve that does not currently meet the definition of late-successional forest. The objective of thinning in these options is to accelerate the development of late-successional forest conditions and provide timber volume. However, Option 9 also allows thinning that has a neutral effect on attainment of late-successional forest conditions. Some salvage would be allowed in Late-Successional Reserves in all options but Option 1. All silvicultural treatment and salvage must be approved by an interagency oversight team.

- Options 2, 3, 6, and 10: cutting in Reserves limited to thinning of stands no older than 50 years that have regenerated after timber harvest, and salvage of areas greater than 100 acres where trees have been killed by catastrophic events.

- Options 4, 5, and 7: thinning allowed in stands with tree sizes less than 11 inches diameter at breast height; salvage of areas larger than 10 acres where trees have been killed by catastrophic events.

- Option 8: thinning of stands up to 180 years old and unlimited salvage.

- Option 9: thinnings are allowed in any stand regardless of origin up to 80 years; salvage of areas larger than 10 acres where trees have been killed by catastrophic events.

Riparian Reserves. Initially, under all options but 7, no harvest would be allowed in Riparian Reserves, and agencies would be required to minimize the impact of roads, cattle grazing, and mining activities. Prescriptions under Option 7 are less restrictive. The options that prescribe buffers allow for the adjustment of buffer widths and may allow some timber cutting after completion of watershed assessments.

Activities Outside of Reserves (the Matrix)

Under all options, timber harvesting outside of Reserve areas (i.e., within the Matrix) will meet, at a minimum, the specifications in current plans of the Forest Service and the Bureau of Land Management. However, most of the options incorporate additional guidelines that would apply to timber harvests in the Matrix.

The 50-11-40 Rule. One such guideline, applicable under Options 1 through 7, is the 50-11-40 rule. This guideline was developed to provide habitat conditions to facilitate movement of juvenile and adult spotted owls across the landscape. The rule calls for 50 percent of the federal forested land within each quarter township to be in a forested condition with trees averaging at least 11 inches in diameter at breast height and with a canopy closure of at least 40 percent. "Canopy closure" refers to the degree to which the crowns of trees obscure the sky when viewed from below.

Options 8 through 10 do not apply the 50-11-40 rule. The rationale for not applying it under Options 9 and 10 is that the other features of the options (primarily the size of the Late-Successional Reserves, the connectivity provided by Riparian Reserves, and the requirements in some options for leaving a number of trees in cut areas) lessen the need for the rule. In addition, under Option 7, the rule is not applied on Bureau of Land Management lands.

Retention and rotation. The options call for varying degrees of retention of live or green trees following logging within the Matrix. Retention of green trees is important for the establishment of micro-habitats for various species, to provide connectivity, and to facilitate the future development of diverse landscapes. Some options also prescribe long timber harvest rotations.

- Options 1, 2, 6, and 10 require retention of at least six large green trees per acre that exceed the average stand diameter, two large snags per acre, and two large down logs per acre. In addition, Option 1 requires 180-year timber harvest rotations. It further requires that 10 percent of the trees in the Matrix be over 180 years old.

- Option 3 requires that 10 percent of harvested areas be retained in small well-distributed forest stands. On the remainder of the harvested areas, retention requirements are four large green trees per acre, retention of snags to support a percentage of the population of cavity nesting species, and retention of 12 logs per acre in the western region and 2-10 logs per acre in the eastern part of the range.

- Options 4, 5, 7, and 8 require only the retention of numbers of snags and logs as currently prescribed for each National Forest and Bureau of Land Management District. Generally, this means retention of less than two green trees per acre in National Forests in region 6 and six to nine per acre on lands administered by the Bureau of Land Management. Options 4 and 5 call for retention of additional snags in the eastern Cascades and Klamath Provinces based on Thomas et al. (1993).

- The requirements for the Matrix under Option 9 vary by area:

    - For most National Forests in Washington, Oregon, and California, 15 percent of trees would be retained following harvest; half of that volume would be left in small intact patches of late-successional forest and the rest dispersed throughout the harvest unit.

    - For National Forests in the Oregon Coast Range, and the Olympic and Mt. Baker-Snoqualmie National Forests, retention requirements would be reduced because of the extent of Riparian Reserves and marbled murrelet protection in those areas.

- For Bureau of Land Management districts in Oregon, retention varies from 6 to 25 large green trees per acre depending on location, with 150-year rotations prescribed for some areas.

- For federal forests in northern California, long rotations are prescribed for conifer and mixed conifer/hardwood (180 years) and hardwood (100 years) forests.

Five options (1, 3, 4, 5, and 9) specifically require **protection of specified rare and locally endemic species** associated with late-successional forests within the Matrix. All options except 7 and 8 require surveys and protection of occupied marbled murrelet nesting sites. Other protective measures may be added to provide for at-risk species under each option.

Managed Late-Successional Areas

Under some options, there are areas that fall between Late-Successional Reserves and the Matrix in terms of permitted management activities. In these **Managed Late-Successional Areas**, cutting of trees can occur with less constraint than in Late-Successional Reserve Areas, but the primary objective remains the maintenance of late-successional forests on a landscape scale.

There are generally only small Managed Late-Successional Areas under Options 1, 2, and 9.

Under Options 4, 5, and 7, Managed Late-Successional Areas are **managed pair areas** (for spotted owls) where timber cutting is allowed as long as a specified amount of spotted owl nesting, roosting and foraging habitat is retained. A range of management techniques may be used to attain this goal and to reduce the risk of fire and insect infestation.

Option 3 involves the most extensive Managed Late-Successional Areas. These include LS/OG2 areas outside of marbled murrelet zone 1 and spotted owl additions in the eastern Cascades and California Cascades. Fifty percent of the area of each must be retained as late-successional forest with only special silviculture allowed. Within the portion of the spotted owl range west of the crest of the Cascades, timber harvests on the remaining 50 percent would be based on 250-year harvest rotations and contingent upon 40 percent of the forest stands being over 100 years old. Within the portion of the range east of the crest of the Cascades, the rotation would be between 100 and 350 years (depending on the species of tree), contingent upon 40 percent of the area being made up of stands greater than 80 years old. In the eastern portion, uneven-aged timber management could also be employed. Salvage would be allowed in part of the Managed Late-Successional Areas.

Adaptive Management Areas

Option 9 includes the concept of **Adaptive Management Areas**. Ten relatively large areas (84,000 to 400,000 acres) would be used for the development and testing of technical and social approaches to integration and achievement of desired ecological, economic, and other social objectives. The overarching objective is to improve knowledge of how to do ecosystem management, and in those areas, the agencies would be expected to pursue a variety of approaches to achieving the conservation objectives of Option 9. There would be more reliance on the experience and ingenuity of resource managers and communities, rather than traditional prescriptive approaches that are applied in many other areas. A full-scale monitoring program will be particularly important in these areas to assure adherence to plans that will clearly spell out the goals (e.g., desired future conditions to be achieved through management).

The concept of Adaptive Management Areas could be applied in any of the options presented. However, it only appears in connection with Option 9. If the concept is applied in other options it will be necessary to reconfigure arrangement on the landscape and reevaluate risk to species, particularly those listed as threatened.

Watershed Analysis

In planning for ecosystem management and establishing Riparian Reserves to protect and restore riparian and aquatic habitat, the overall watershed condition and the suite of processes operating there need to be considered. Watershed condition includes not only the state of the channel and riparian zone, but also the condition of the uplands, distribution and type of seral classes of vegetation, land use history, effects of previous natural and land-use related disturbances, and distribution and abundance of species and populations throughout the watershed. Watershed analysis is a systematic procedure for characterizing watershed and ecological processes to meet specific management and social objectives. This information then guides management prescriptions, including setting and refining boundaries of Riparian Reserves and other Reserves, sets restoration strategies and priorities, and reveals the most useful indicators for monitoring environmental changes. Watershed analysis is a stratum of ecosystem planning applied to watersheds of approximately 20-200 square miles. It provides a process for melding social expectations with the biophysical capabilities of specific landscapes. Watershed analysis is required in Key Watersheds before moving forward with all options except Option 7.

Silvicultural Manipulations Within Late-Successional Reserves

All of the options developed and presented in this report contain Reserves of late-successional forest. The treatment of Late-Successional Reserves varies between options in terms of size, location, arrangement, amount, and the management activities (primarily thinnings and salvage) allowed within such Reserves. All Late-Successional Reserves contain both stands of late-successional forest and stands of younger forest that are expected to achieve appropriate late-successional stand characteristics over time.

Thinning of Young Forest Stands Within Late-Successional Reserves

Some of the younger stands included within the Reserves have developed naturally following fires or blowdown or other stand-replacing disturbances while other such stands have been regenerated following cutting of the previous stand. Some of these stands, particularly those that had been cut, have been planted with seedlings with the intention that they be managed as plantations through intensive forestry to maximize wood production. The presence of these younger stands within Late-Successional Reserves raises the question of if and how they should be managed. Should these younger stands be silviculturally treated to accelerate their attainment of a condition that mimics late-successional forest conditions? Or should there be no silvicultural treatment of these younger stands under the assumption that such stands will evolve, given enough time, into the desired habitat conditions? It should be noted that no empirical evidence exists to support either conclusion as a blanket solution to the question of how to achieve desired future habitat conditions.

The Interagency Scientific Committee to Address the Conservation of the Northern Spotted Owl (Thomas et al. 1990) concluded that as no evidence existed that such treatment of younger stands would produce desired habitat conditions, it was best to leave those stands in unmanaged condition. That committee assumed that this prohibition against management within the designated reserves would continue until such time that clear empirical evidence existed to justify silvicultural treatment. The Interagency Scientific Committee's mission was to deal strictly with the management of the northern spotted owl. There was no consideration of the late-successional forest ecosystem per se.

After two additional years of consideration and intensified consultation with silviculturists and fire ecologists, a totally different team of scientists, technicians, attorneys, and political appointees was designated to prepare a recovery plan for the northern spotted owl (USDI 1992). That team concluded that some limited amount of silvicultural treatment of younger stands within "designated conservation areas" was warranted both to accelerate achievement of desired habitat conditions across the range of the northern spotted owl, to reduce fire danger in such reserves east of the Cascade crest and in the Klamath Province, and to provide some level of timber harvest compatible with those objectives. This group too was dealing strictly with the provision of a management strategy for the northern spotted owl and not with the late-successional forest ecosystem as such.

Biologists and foresters agree that, as a generality, thinning of forests stands, when appropriately prescribed and executed, produces larger trees at a rate significantly faster than would otherwise occur. However, there is more confidence that habitat attributes for the northern spotted owl could be produced through silviculture than that those treatments would likewise provide habitat for the myriad species (such as those listed by Thomas et al. 1993) associated with late-successional forest conditions. Conversely, some experts have reservations as to whether younger stands, particularly plantations of planted trees, would achieve desired habitat conditions in the future if left unmanaged.

Ecological attributes of the reserves designated for the northern spotted owl (Thomas et al. 1990 and USDI 1992c) vary across the range of the northern spotted owl (the area addressed in this report). The most marked difference is between the reserves west of the Cascade crest (which occur in more mesic circumstances) than those east of the cascade crest and in the Klamath Province (which exist in more xeric conditions and are much more prone to large-scale fire). Present conditions in the reserves east of the Cascade crest developed from many decades of selective logging (some would say "high grading") and determined efforts at fire exclusion. As a result, two fire-sensitive species (white-fir and/or grand fir) have come to be a major component of forest stands that make up these proposed reserves. A prolonged drought coupled with outbreaks of defoliating insects has caused extensive tree mortality in Douglas-fir and white fir.

There has also been marked mortality in lodgepole and ponderosa pine due to mountain pine beetle outbreaks over the past decade. This extensive tree mortality has produced a build up of fuels (dead trees) in many of the proposed reserve areas that is unprecedented -- at least within this century. Two recent reviews of the situation by respected biologists and ecologists (Everett et al. 1993; USDI 1992c) have concluded that management action inside Late-Successional Reserves in any areas east of the Cascade crest is advisable. This results from considering the risk of loss of significant portions of the proposed reserve system to fire versus the risk to the retention of the structure and function of such reserves from some level of silvicultural manipulation to reduce the risk from fire. The situation concerning the fire danger to late-successional forest reserves on the Eastern Cascades and the Klamath Provinces was extensively examined by Agee (1992) in the Final Draft Recovery Plan for the Northern Spotted Owl (USDI 1992c).

The debate over the advisability of silvicultural activities within late-successional forest reserves has philosophical attributes as well as technical ones. On one side of the debate there are those who, cognizant of past successes, believe that management can and will produce desired results. On the other side are those who, cognizant of past failures, are more cautious. They believe that proof should precede any silvicultural activities in reserves.

Closely related to differences in philosophical position is the matter of trust as to whether agencies will perform consistent with the selected management option. It is critical to separate matters of technical feasibility from matters of trust so that discussions are appropriately focused and appropriate solutions derived. The debate over whether to allow silvicultural treatment in late-successional forest reserves may revolve even more closely around the issue of trust than around technical feasibility. The focus of that distrust is that the desire to provide timber from the thinnings will override the overriding objective of the reserves -- production and maintenance of late-successional forest conditions.

Fortunately, means at hand can be used to address some of the barriers to problem solutions created by this lack of trust. Foremost among those approaches are development or review of prescriptions for silvicultural treatment by appropriately composed multidisciplinary teams and the monitoring of both implementation of and response to management activities. The problem of lack of trust cannot be ignored and must be addressed head-on if any solution is to emerge. Too often the seemingly endless debate over technical points is, in reality, an issue of trust.

The options for management strategies present an array of approaches for the management of younger stands within Late-Successional Reserves. Younger stands subject to silvicultural treatment are defined differently among the options as less than 50, 80, and 180 years of age. Further, availability of younger stands for treatment is differentiated in some options between stands regenerated (often by planting) following logging and natural stands that evolved after fires or blowdown.

These varying prescriptions are described below.

In all the management options presented herein, save two, young stands older than a prescribed age (50 or 80 years) or a prescribed condition (11 inches or less diameter) are reserved from any manipulation. In other words, the late-successional stands within Late-Successional Reserves are not subject to thinning or harvest of any kind in eight options. The exceptions are Option 8, where stands up to 180 years could be thinned, and Option 7 where the Late-Successional Reserves on Bureau of Land Management lands could be subject to management in the future.

The various options include one of the four general prescriptions for treatment of younger stands in the Late-Successional Reserves.:

1. No silvicultural treatment of any kind.

2. Thinning of younger stands that were established after logging. There is no thinning of younger stands that resulted from naturally occurring events such as fire or blowdown.

3. Thinning of younger stands regardless of how those stands were established.

4. Within Managed Late-Successional Areas (as opposed to Late-Successional Reserves) a portion of the area (usually about 50 percent) is reserved from harvest and the remainder is managed through 250-year or longer rotations or under uneven-aged management to maintain a portion (40-50 percent) in late-successional condition. In some cases, particularly on eastside forests, there is no cutting of large (more than 21 inches diameter at breast height) ponderosa pine or larch within Reserves.

There are advantages and disadvantages to each approach.

Prescription 1 - No thinning allowed.

Advantages - There is maximum protection against the risk that silvicultural techniques applied in other options will fail or be inappropriately applied. Options are retained for later application of such techniques once those techniques are demonstrated to achieve desired results. Watershed values are give the highest level of protection. There is no need to deal with issues evolving from lack of trust. If it is assumed that there would be reduced need to maintain or build roads in such an area, recreational activities to which roads would be a detriment would be enhanced, costs associated with road maintenance may be reduced, and human-related disturbance associated with roads would be lowered.

Disadvantages - There is no wood volume made available from within Reserves with the attendant economic and social opportunity costs. Management flexibility to deal with forest health problems and potential fire problems is absent or much reduced, leading to an increased risk of loss of significant portions of such Reserves to fire. Opportunities for achievement of desired late-successional forest conditions at a significantly accelerated rate is foregone. If it is assumed that there would be no need to maintain roads or construct new ones under the circumstances described, then there would be decreased access to such areas that would, in turn, impinge on harvest of other forest products, types of recreational use associated with vehicular access, and fire control activities.

Prescription 2 - Thinning in plantations only.

Advantages - It is assumed that naturally regenerated stands that are established from seed after naturally occurring stand-replacing events are more likely to achieve late-successional forest conditions over time than are stands that are established after logging. These natural stands, therefore, are not disturbed. However, thinning of stands that have become established after logging will provide jobs and timber. It is assumed stands so treated will achieve at least some attributes of late-successional forests more rapidly than would otherwise occur. Roads associated with such activities will provide access for harvest of other forest products, enhance recreational activities that are dependent on road access, and facilitate management activities including fire suppression. Management flexibility to deal with problems caused by disease, insects, and fuels buildup is increased.

Disadvantages - Prescribed thinnings may fail to produce the anticipated results and foreclose the alternate course of action to achieve late-successional forest conditions -- letting young stands grow, age, and mature without human intervention. Thinning opportunities in natural stands is foregone. If there is no difference between treated and untreated stands in meeting late-successional forest conditions, the jobs and wood production associated with thinning of natural stands are lost. Further, the opportunity for those stands to achieve desired conditions at a earlier time is likewise foregone. Economic feasibility of such thinning may be problematic. Thinning may reduce natural stand mortality leading to a shortage of dead trees in such stands to support cavity nesters and species requiring dead wood on the forest floor. Safety regulations may require felling of standing dead trees during thinning operations, exacerbating this problem. Roads and soil disturbance associated with such thinning activities may cause adverse watershed effects, introduce additional human disturbance, and adversely affect some types of recreational use.

Prescription 3 - Thinning permitted in all younger stands.

Advantages - All younger stands are candidates for thinning. More wood volume is therefore available with attendant associated benefits in jobs and economic activity than would occur under prescriptions 1 or 2. If successful, more habitat in late-successional structural condition would be more quickly provided. Economic feasibility of thinning activities would likely be enhanced due to economies of scale -- particularly as related to establishment and maintenance of access roads. These roads will provide the same advantages as described for prescription 2. Management flexibility to deal with problems caused by insects, disease, and fuels buildup is enhanced.

Disadvantages - If it is demonstrated that naturally regenerated stands will provide for a wider array of species of plants and animals and ecological functions once they reach late-successional state as compared to stands that are thinned, there would be a loss in the ability of the Reserves to achieve the objectives for which they were intended. There will be problems with trust of the agencies to carry out the prescription. Economic feasibility of such activities is problematic. There may be a paucity of standing and down dead trees with the consequences described under prescription 2 above. Disadvantages related to the associated road system are as described for prescription 2.

Prescription 4 - Managed Late-Successional Reserves.

Advantages - Extensive flexibility is provided to deal with the situation that exists in the late-successional forest reserves on the eastside and in the Klamath Province that was described earlier. The thinning and salvage in the 50 percent of the area designated for preservation will improve the chances of retaining desired conditions over time by reductions of fire danger and, perhaps, by protecting the stands from insect damage. These activities will provide jobs and some wood to wood processors. The 50 percent of the Reserve that will be managed provides additional capability to produce wood and deal with forest health problems. Timber volume produced as a byproduct of such management to sustain late-successional forest conditions would provide economic benefits as well as jobs. The advantages to the associated road system are as described under prescription 2.

Disadvantages - It is not certain that such management activities will result, over the long term, in the retention of late-successional forest conditions suitable for the northern spotted owl and other species associated with late-successional forest conditions in eastside and Klamath Province forests. Distrust of agency motives can be expected to be high. There may be problems with retention of standing and down dead trees as described under prescription 2 above. The economic practicality of such a management strategy is problematic. The disadvantages of the associated road system are as described under prescription 2.

Salvage Within Late-Successional Reserves

The questions of whether salvage should be allowed inside late-successional forest reserves is contentious. The standards and guidelines developed in the Interagency Scientific Committee report (Thomas et al. 1990) allowed for salvage in habitat conservation areas set aside for northern spotted owls, provided that a review by an interagency team (Forest Service, Bureau of Land Management, and Fish and Wildlife Service) composed of foresters and wildlife biologists determined that such salvage was beneficial to maintaining habitat conditions, over time, for the owl. Experience with these review procedures revealed that most situations reviewed do not meet that criterion. Conversely, the interagency team did not think, at least in some cases, that such salvage would be detrimental to achieving maintenance of habitat conditions for the northern spotted owl over the long term.

The question about whether or not to salvage in late-successional forest reserves is complicated by three factors. First, the value of the mature and old-growth timber involved is relatively great. Second, many of the public concerned about the ecological and other value of the late-successional forest are deeply distrustful of the motives of the land management agencies and logging operators when such salvage is contemplated. Third, there are no definitive data nor universal agreement among natural resource management professionals as to the effect of such salvage or the conditions that will impinge on stand development over the long term.

For those management strategy options that contain Late-Successional Reserves, two approaches to the salvage question are taken. These approaches and their comparative advantages and disadvantages are described below. Where salvage is allowed, it can occur only after an evaluation by an interagency interdisciplinary team that will evaluate whether the proposed salvage is neutral or beneficial to achievement of the purposes of the Reserve in both the short and long term. If the proposed salvage does not meet those criteria, the salvage will not take place. The exception is Option 8 where salvage can occur with only minimal guidelines outside of zone 1 for marbled murrelets. Salvage is limited to circumstances where there are patches of dead trees resulting from fire or blowdown or some other factor.

Prescription 1 - No salvage allowed in Late-Successional Reserves.

Advantages - Risk of disturbance to the Reserve (Late-Successional and Watershed) is minimized both from the salvage activity and the construction of roads and landings. The trust issue is negated. All standing dead trees are retained for cavity nesting wildlife as are logs that contribute to ecosystem function and provide habitat for associated wildlife species. This avoids making evaluations concerning the pros and cons of individual salvage opportunities and contentious decisions concerning if and how to salvage.

Disadvantages - The salvage of increasingly rare and increasingly valuable old growth or other large trees is foregone with the jobs and social and economic benefits that would result from such salvage. Unsalvaged areas may be particularly prone to hot fires. There may be risks to adjacent stands from fire or insects and disease that originate in patches of dead trees. There may be severe public criticism concerning the economic opportunities foregone.

Prescription 2 - Limited salvage is allowed in Late-Successional Reserves.

Advantages - Valuable trees that are dead can be used for commercial purposes with the attendant employment and economic benefits. These logs cannot be exported and so must be processed within the region. Increased fire danger or risk to insect and disease resulting from large accumulations of dead trees can be reduced in an economically feasible fashion. Avoided are the perceptions of economic waste if patches of dead trees are not salvaged.

Disadvantages - There is potential risk to watersheds from roads and soil disturbance associated with salvage operations. If hypotheses about effects of management prove incorrect, salvaged areas may be adversely affected in terms of their short and long-term contributions to the achievement of Late-Successional Reserves. Certain segments of the public will be distrustful of agency motives whenever salvage is allowed inside a Reserve, particularly when such salvage occurs in portions of the Reserve that contain (or contained) trees considered to be true "old growth" or "ancient forest."

Prescription 3 - Salvage with minimal guidelines is allowed in Late-Successional Reserves.

Advantages - The advantages are the same as under prescription 2, except that more wood volume could be utilized with greater economic benefit. Opportunities to control fire, insect, and disease risk would also be greater.

Disadvantages - The short- and long-term contributions of salvaged areas to Late-Successional Reserves would be decreased. There would be greater risks to watersheds than in prescription 2. There would be high levels of distrust of agency motives.

Discussion

No empirical evidence or unanimity of expert opinion exists on the question of whether silvicultural treatment of younger forest stands or salvage of dead trees will achieve the objective of the Reserves -- production and maintenance of late-successional forest conditions. The advantages and disadvantages and the inherent uncertainties in biological/ecological responses and interactions must be considered. Ultimately, however, the decision must be made in a circumstance of uncertainty.

Overview: Ecological Assessment - Terrestrial Ecosystems

Forest Conditions Within Options

The range of the northern spotted owl encompasses about 57 million acres (including both forested and nonforested) within Washington, Oregon, and northern California (table II-1). Of this total, 24.3 million acres (42 percent) are federally administered (fig. II-1), of which 3.6 million acres are nonforested (table II-2). Of the 7.0 million total acres of federal land within Congressionally Withdrawn Areas (e.g., National Parks, Wilderness), 5.7 million acres are forested (table II-2).

Forest stands with trees averaging greater than 9 inches in diameter cover about 14.3 million acres of the 20.7 million acres federally administered forested lands within the range of the northern spotted owl (table II-3). Late-successional forests -- stands in mature (80+ years) and old-growth seral stages -- compose a large percentage of this total. Seral stage inventory and classification differ among the federal land managing agencies. To achieve a common denominator that captured the full array of stands with late-successional forest characteristics, we adopted a three-category classification based on satellite imagery:

1. The youngest seral category includes stands of trees generally less than 21 inches in diameter, ranging down to 9 inches. A minority of the stands in this seral category have scattered large overstory trees that provide old-forest characteristics. From a functional view, this seral category provides suitable dispersal and some foraging habitat for northern spotted owls. We termed this category **small single-storied conifer.**

2. Stands with trees generally greater than 21 inches in diameter, including some trees greater than 32 inches in diameter, usually with only a single canopy layer, we termed **medium/large single-storied conifer.** These stands qualify as late-successional forest.

3. Stands with trees greater than 21 inches in diameter and with two or more canopy layers we termed **medium /large multistoried conifer.** This category is generally similar to old-growth forest as defined by the Forest Service. Such stands cover about 4.5 million acres of which 2.2 million acres occur outside of Congressionally and Administratively Withdrawn Areas and are subject to harvest under current land management plans (fig. II-2).

Collectively these three categories capture the extent of late-successional forest. However, most small, single-storied stands would not be considered late successional; for the remainder of this section we discuss only the latter two categories.

All options contain the same amount of Congressionally Withdrawn Areas (7.0 million total acres). The total for Administratively Withdrawn Areas is currently 4.1 million

Table II-1. Estimated total land acres within the range of the northern spotted owl by agency or ownership and physiographic province.

State/ Physiographic province	Acres by ownership				
	U.S. Forest Service	Bureau of Land Management *	National Park Service	Other federal	Non-federal
Washington					
Eastern Cascades	3,329,000	0	137,200	6,000	2,210,000
Western Cascades	2,957,000	0	760,200	4,400	2,428,300
Western Lowlands	0	0	1,700	124,700	6,343,900
Olympic Peninsula	628,000	0	889,400	1,500	1,512,200
Total:	**6,914,000**	**0**	**1,788,500**	**136,600**	**12,494,900**
Oregon					
Klamath	1,284,800	821,200	200	0	1,894,200
Eastern Cascades	1,431,800	48,400	77,200	100	767,500
Western Cascades	3,724,600	666,300	86,800	500	2,161,700
Coast Range	618,600	776,300	100	1,700	4,374,400
Willamette Valley	0	16,800	0	8,700	2,632,600
Total:	**7,059,800**	**2,329,000**	**164,300**	**11,000**	**11,830,400**
California					
Coast Range	70,100	219,900	77,500	20,600	5,302,300
Klamath	4,358,200	101,600	0	0	1,621,100
Cascades	998,500	10,400	0	0	1,493,300
Total:	**5,426,800**	**331,900**	**77,500**	**20,600**	**8,416,700**
Three-State Total:	**19,400,600**	**2,660,900**	**2,030,300**	**168,200**	**32,742,000**

* No acres tallied for Bureau of Land Management in Washington due to the dispersed nature of the ownership

Table II-2. Estimated total federal acres and federal forest acres in Congressionally Withdrawn Areas and Administratively Withdrawn Areas in the range of the northern spotted owl, by state and by physiographic province.

State/ Physiographic province	Federal land acres			Federal forest acres *		
	Total	Congressionally Withdrawn areas	Administratively Withdrawn areas	Total	Congressionally Withdrawn areas	Administratively Withdrawn areas
Washington						
Eastern Cascades	3,472,400	1,473,800	586,100	2,498,100	986,800	409,400
Western Cascades	3,721,700	1,749,400	630,300	3,083,200	1,377,900	531,500
Western Lowlands	126,300	1,700	0	1,700	1,700	0
Olympic Peninsula	1,518,800	976,700	45,400	1,440,200	960,100	43,200
Total:	8,839,200	4,201,600	1,261,800	7,023,200	3,326,500	984,100
Oregon						
Klamath	2,106,200	259,100	333,500	1,939,300	223,300	300,500
Eastern Cascades	1,557,400	425,200	320,400	1,444,500	379,300	288,200
Western Cascades	4,478,200	721,800	545,300	4,219,200	661,100	516,200
Coast Range	1,396,800	22,100	73,600	1,331,500	22,100	47,100
Willamette Valley	25,600	0	200	16,000	0	200
Total:	9,564,200	1,428,200	1,273,000	8,950,500	1,285,800	1,152,200
California						
Coast Range	388,200	94,700	96,500	198,500	90,200	45,400
Klamath	4,459,900	1,214,300	1,203,100	3,553,600	955,800	957,700
Cascades	1,009,200	44,300	211,000	732,200	18,200	144,600
Total:	5,857,300	1,353,300	1,510,600	4,484,300	1,064,200	1,147,700
Three-State Total:	24,260,700	6,983,100	4,045,400	20,458,000	5,676,500	3,284,000

* Acre values for Forest Service, Bureau of Land Management , and National Park Service administered lands only.

Table II-3. Current estimated late-successional conifer forest on federal lands in the range of the northern spotted owl by total acres, acres in Congressionally Withdrawn Areas, and acres in Administratively Withdrawn Areas by state and physiographic province.

State/ Physiographic province	Total: Small conifer single story *	Total: Medium/large conifer ** Single story	Total: Medium/large conifer ** Multi-story	Portion in Congressionally Withdrawn Areas: Small conifer single story *	Portion in Congressionally Withdrawn Areas: Medium/large conifer ** Single story	Portion in Congressionally Withdrawn Areas: Medium/large conifer ** Multi-story	Portion in Administratively Withdrawn Areas: Small conifer single story *	Portion in Administratively Withdrawn Areas: Medium/large conifer ** Single story	Portion in Administratively Withdrawn Areas: Medium/large conifer ** Multi-story
Washington									
Eastern Cascades	830,100	515,500	432,200	286,000	183,700	217,700	164,400	74,600	68,600
Western Cascades	1,009,000	676,000	515,700	373,000	309,600	209,000	175,500	112,800	143,900
Western Lowlands	0	0	0	0	0	0	0	0	0
Olympic Peninsula	485,800	47,400	446,700	274,300	23,000	327,700	17,800	3,000	16,600
Total:	**2,324,900**	**1,238,900**	**1,394,600**	**933,300**	**516,300**	**754,400**	**357,700**	**190,400**	**229,100**
Oregon									
Klamath	596,200	207,500	489,500	98,100	19,400	50,900	104,400	30,500	75,700
Eastern Cascades	968,900	207,000	81,100	250,700	68,400	22,200	203,100	49,100	16,900
Western Cascades	1,165,100	997,900	921,200	279,400	231,900	102,200	189,900	125,200	122,600
Coast Range	526,100	209,300	140,500	18,900	2,600	400	19,400	9,700	10,900
Willamette Valley	4,300	1,300	800	0	0	0	0	0	100
Total:	**3,260,600**	**1,623,000**	**1,633,100**	**647,100**	**322,300**	**175,700**	**516,800**	**214,500**	**226,200**
California									
Coast range	4,700	25,800	9,800	300	2,700	2,200	2,100	9,600	3,800
Klamath	140,300	963,200	1,303,900	37,100	304,500	368,000	28,800	214,500	462,600
Cascades	38,500	181,500	157,100	1,800	4,700	0	1,400	40,100	34,400
Total:	**183,500**	**1,170,500**	**1,470,800**	**39,200**	**311,900**	**370,200**	**32,300**	**264,200**	**500,800**
Three-State Total:	**5,769,000**	**4,032,400**	**4,498,500**	**1,619,600**	**1,150,500**	**1,300,300**	**906,800**	**669,100**	**956,100**

* Stands generally characterized by trees 9.0 - 20.9 inches in diameter at breast height (dbh) - only a portion of these acres are late-successional forest.

** Stands generally characterized by trees 21.0 inches in diameter at breast height (dbh) or larger

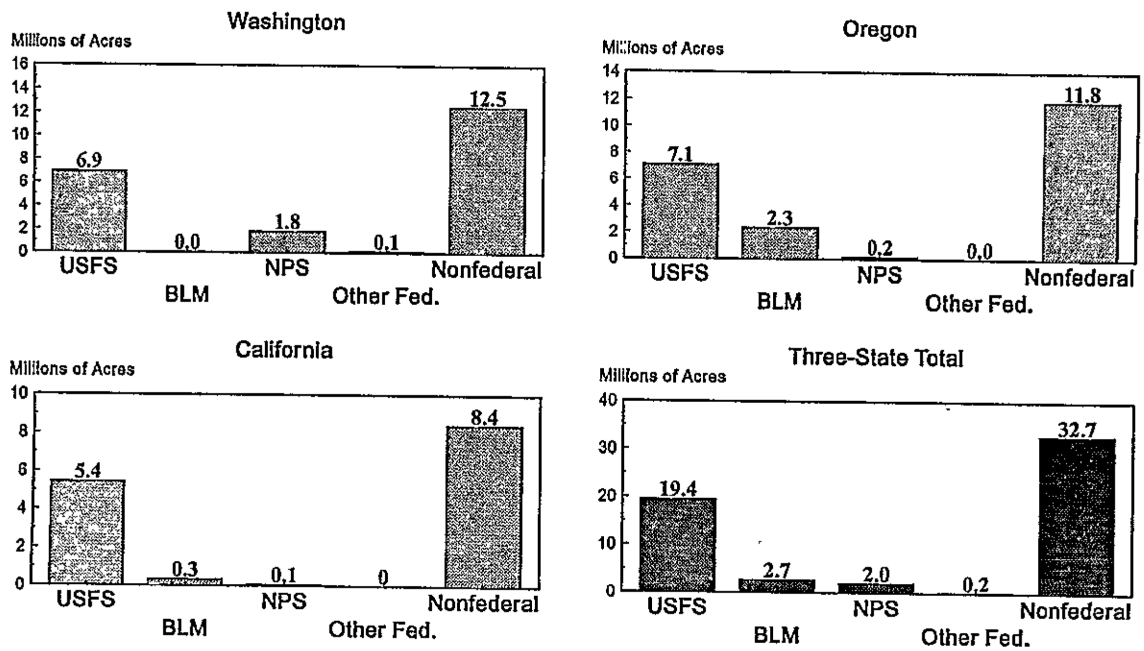


Figure II-1. Gross area of lands administered by different agencies within the range of the northern spotted owl by state.

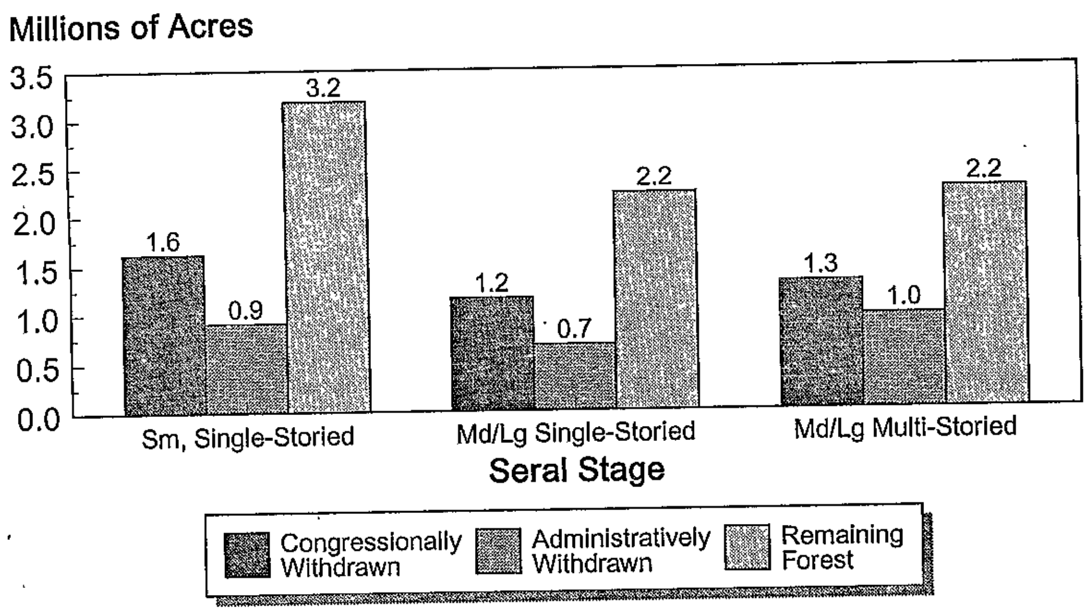
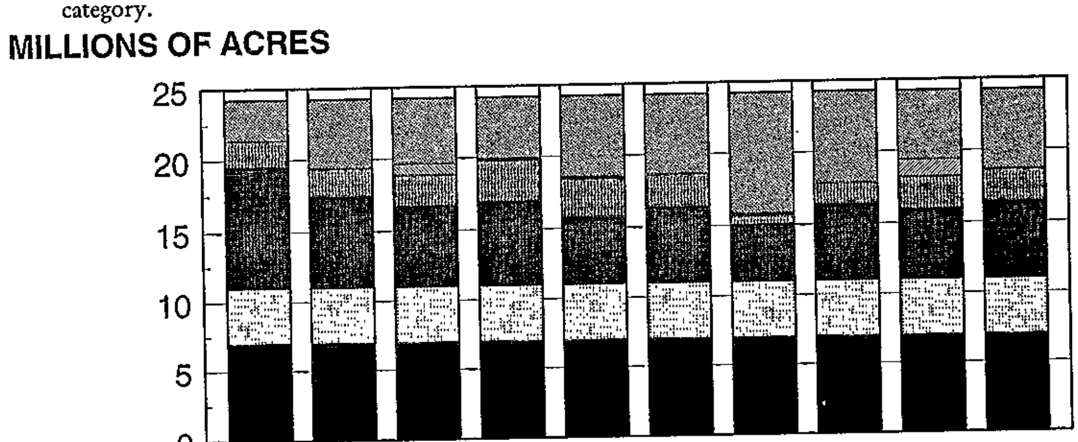


Figure II-2. Current acreage of late-successional forest seral stages under different land allocations. See text for description of each seral-stage category.



OPTIONS	Option 1	Option 2	Option 3	Option 4	Option 5	Option 6	Option 7	Option 8	Option 9	Option 10
Congressionally Withdrawn	6.98	6.98	6.98	6.98	6.98	6.98	6.98	6.98	6.98	6.98
Administratively Withdrawn	4.05	4.05	4.05	4.05	4.05	4.05	4.05	4.05	4.05	4.05
Late-Successional Reserves	8.53	6.39	5.69	5.87	4.75	5.31	4.00	5.31	4.89	5.31
Riparian Reserves	1.87	1.99	2.12	2.88	2.65	2.29	0.62	1.50	2.23	2.29
Managed L.S. Reserves	0.00	0.00	0.85	0.15	0.15	0.00	0.15	0.00	0.00	0.00
Adaptive Mgmt. Areas	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.26	0.00
Matrix	2.83	4.85	4.58	4.33	5.69	5.64	8.46	6.43	4.85	5.64
Total	24 26	24.26	24.26	24.26	24.26	24.26	24.26	24.26	24.26	24.26

Figure II-3. Allocation of federal lands by option. Administratively Withdrawn acres calculated before Late-Successional Reserves.

acres. There is considerable overlap between existing Administrative Withdrawals and the Late-Successional Reserves developed under the options. As a result, there are two ways to compute the acreage involved in Late-Successional Reserves. The first is to consider Late-Successional Reserves as an addition to existing Administrative Reserves. This approach focuses on the cumulative impact of the reserves (in addition to land that has already been withdrawn Congressionally or Administratively from the timber base). In that case, the total area of such Late-Successional Reserves varies between 8.5 million acres in Option 1 to 4.2 million acres in Option 7. Other options have intermediate amounts, as shown in figure II-3.

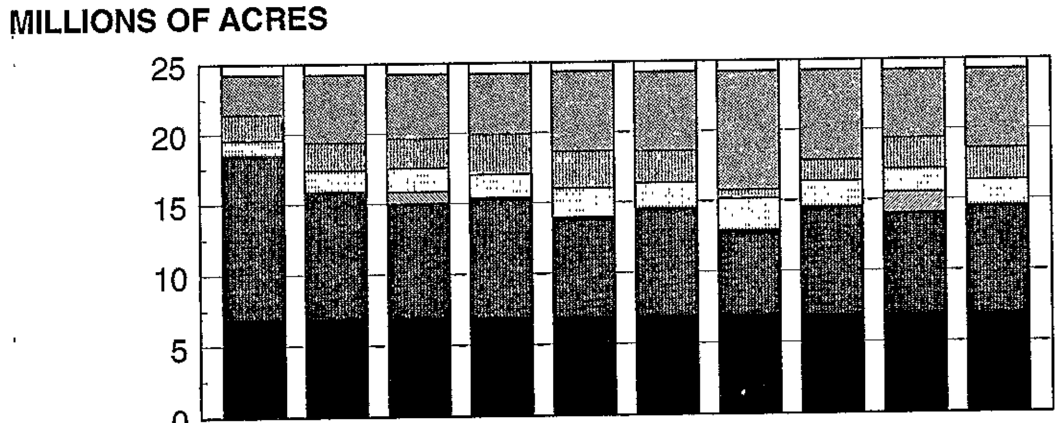
The other way to calculate acreage of Late-Successional Reserves is to consider them as superseding the existing Administrative Reserves and including as Late-Successional Reserves the acreage that overlaps the two categories. In that case, the total area of Late-Successional Reserves varies from 11.5 million acres in Option 1 to 5.9 million acres in Option 7 (fig. II-3a); other options have intermediate amounts. It should be recognized that the fate of Administrative Reserves outside of Late-Successional and Riparian Reserves will be determined in the phase II planning effort – i.e., the continued status as Administrative Reserves is not certain.

Conversely, Matrix lands are greatest in Option 7 (8.5 million acres) and lowest in Option 1 (2.8 million acres). The extent of Riparian Reserves (calculated to include only those lands outside of Late-Successional Reserves) is subject to change over time under any of the options based on results of watershed analysis. Under interim estimates, the total area within Riparian Reserves varies from 2.9 million total acres (forested and unforested) under Option 4 to 1.5 million total acres (forested and unforested) under Option 8 (fig. II-3).

The area of current late-successional and old-growth forest (medium/large single-storied and multistoried conifer) that is contained within Late-Successional Reserves and Riparian Reserves, and outside of Congressionally or Administratively Withdrawn Areas totals from 6.1 million acres under Option 1 to 2.8 million acres under Option 7 (fig. II-4). It should be remembered that these Reserves contain a mix of late-successional and younger forests. Totals vary considerably among physiographic provinces (table II-3, fig. II-5). Conversely, the percentage of the total current late-successional and old-growth forest acres that is in the Matrix and available for harvest (subject to the standards and guidelines of each option) is nil in Option 1 and varies from 13 percent in Option 3 to 30 percent in Option 7 (fig. II-6).

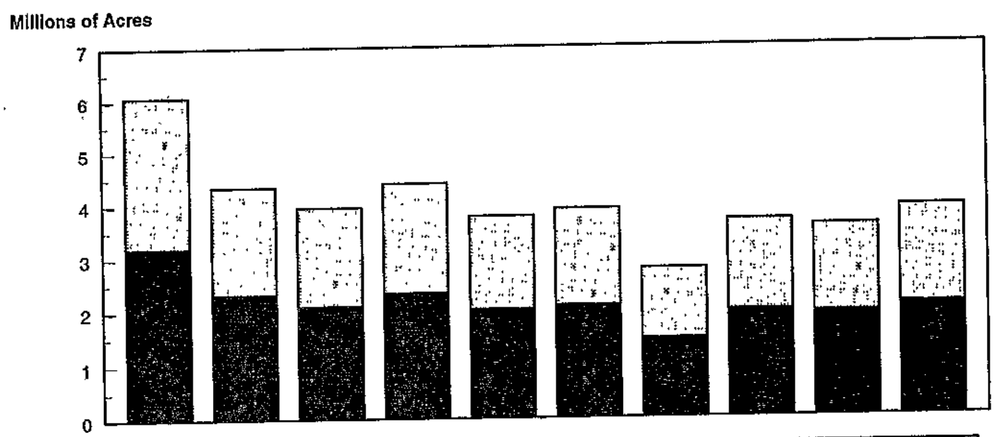
Biological Assessment

For the ten options we evaluated the likelihood of maintaining sufficient habitat, well distributed on federal lands to provide for the continued existence of viable populations of northern spotted owls and marbled murrelets. For seven of the ten options we performed similar assessments for over 1000 plant and animal species closely associated with old-growth forests. The geographic bounds were the range of the northern spotted owl; the time frame was 100 years. We likewise assessed the likelihood of maintaining a functional, interacting late-successional and old-growth forest ecosystem on federal lands. A series of panels of experts provided the primary information for these assessments. Leading experts, well-versed on the ecology of respective groups of organisms, were recruited from state and federal agencies, universities, and research organizations. The



OPTIONS	Option 1	Option 2	Option 3	Option 4	Option 5	Option 6	Option 7	Option 8	Option 9	Option 10
Congressionally Withdrawn	6.98	6.98	6.98	6.98	6.98	6.98	6.98	6.98	6.98	6.98
Late-Successional Reserves	11.50	8.92	8.04	8.26	6.81	7.52	5.76	7.52	7.05	7 52
Managed L.S. Areas	0.00	0.00	0.85	0.15	0.15	0.00	0.15	0.00	0.00	0.00
Adaptive Management Areas	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1.49	0 00
Administratively Withdrawn	1.08	1.52	1.68	1.66	2.08	1.83	2.29	1.83	1.65	1.83
Riparian Reserves	1.87	1.99	2.12	2.88	2.65	2 29	0.62	1.50	2.23	2.29
Matrix	2.83	4.85	4.59	4.33	5.69	5.64	8.46	6.43	4 85	5.64
Total	24.26	24.26	24.26	24.26	24.26	24.26	24.26	24.26	24.26	24 26

Figure II-3a. Allocation of federal lands by option. Administratively Withdrawn acres calculated after Late-Successional Reserves.



Option	1	2	3	4	5	6	7	8	9	10
Multi-Story	3.187	2.313	2.089	2.333	2.024	2.086	1.458	1.977	1.929	2.086
Single Story	2.881	2.026	1.856	2.072	1.745	1.817	1.315	1.695	1.633	1.818
Total	6.068	4.339	3.945	4.405	3.769	3.903	2.773	3.672	3.562	3.904

Figure II-4. Amount of medium and large (>21 inches dbh) single-storied or multi-storied conifer stands located in Late-Successional or Riparian Reserves outside of Congressionally or Administratively Withdrawn Areas. Collectively these two categories comprise the bulk of the late successional and old-growth forest stands.

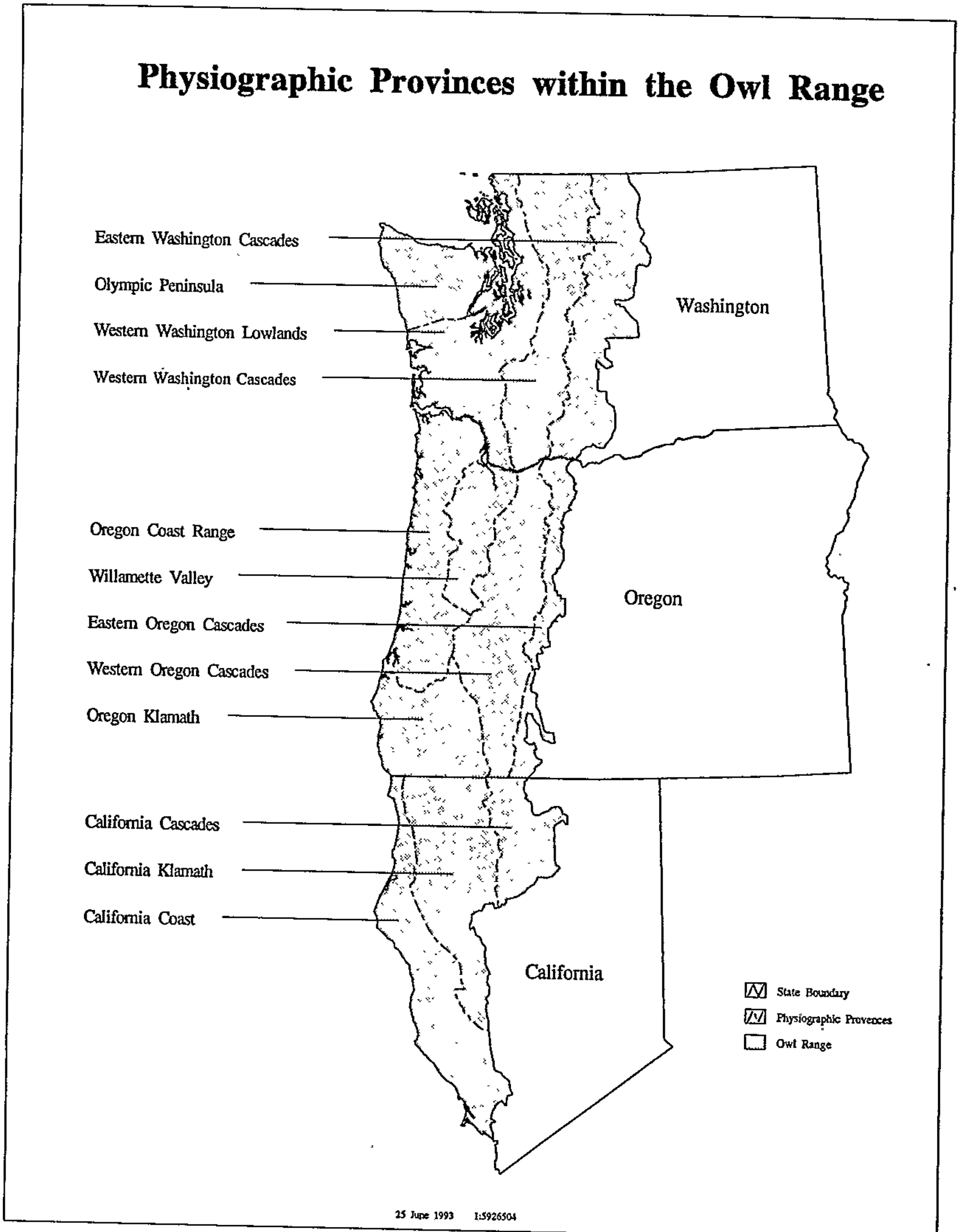


Figure II-5. Physiographic provinces within the range of the northern spotted owl. Provinces as depicted in the Final Draft Recovery Plan for the Northern Spotted Owl (USDI 1992c).

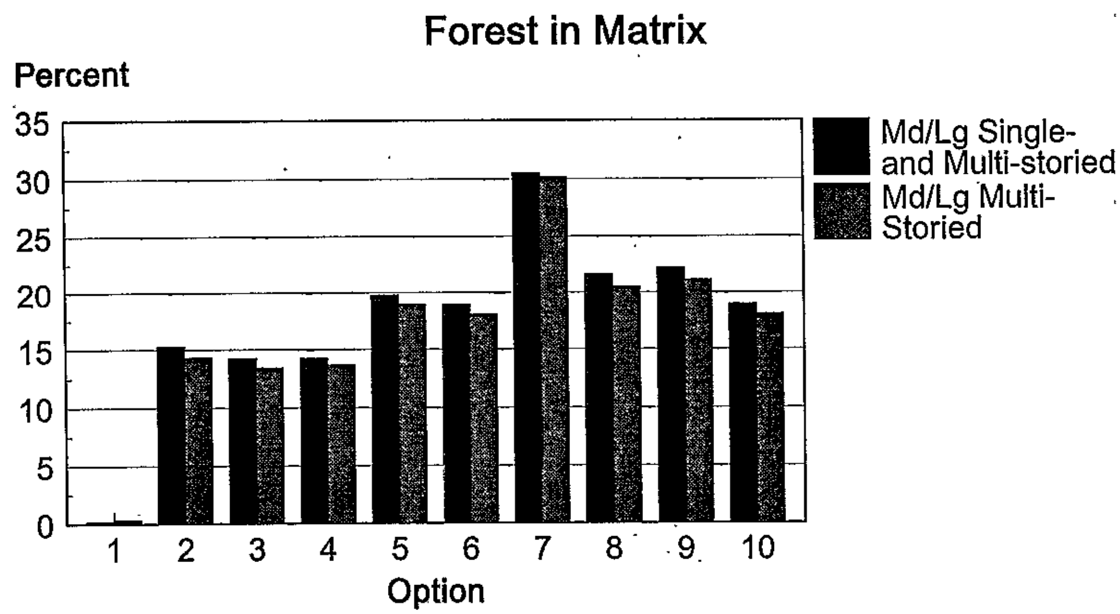


Figure II-6. Percent of the total late-successional and old-growth forest (medium/large single and multi-storied conifer--8.5 million acres) and old growth only (medium/large multi-storied conifer--4.5 million acres) acres which are in the Matrix and are available for harvest subject to the standards and guidelines of each option.

panel process was designed to elicit the expert opinion and professional judgment of the panelists. We used the advice from the panel, other information, and our own expertise to make the final assessment of habitat sufficiency for species or groups of species under each option. Each panel was asked to determine the likelihood of achieving four possible outcomes as it related to habitat conditions on federal lands for each species presented to them for evaluation: Outcome A - Viable populations well-distributed; Outcome B - Viable populations with gaps in distribution; Outcome C - Populations relegated to refugia; and Outcome D - Extirpation(s) likely. We compared outcomes of options by assessing whether a species (or group) attained an 80 percent or greater likelihood of achieving outcome A: Habitat is of sufficient quality, distribution, and abundance to allow the species population to stabilize, well distributed across federal lands (see table IV-7 additional description). This basis of comparison represents a relatively secure level of habitat and thus provides a stringent criterion for comparison. The same process was used to assess the likelihood of maintaining a functional, interacting late-successional and old-growth forest ecosystem.

In focusing on the attainment of 80 percent likelihood of achieving outcome A, we are not suggesting that only options attaining that likelihood satisfy the viability regulation. We think it likely that options attaining such a percentage would be viewed as meeting the requirement, but a score of less than 80 should not automatically be regarded as a failing grade. Similarly, in some instances it may be appropriate to look at categories A and B (that is, A plus B) as the benchmark. Indeed, in situations where a species is already restricted to refugia, it may be appropriate to look at A plus B plus C.

We conducted 14 separate assessment panels for the status of species associated with late-successional forests during late April and again in June 1993. Evaluations were conducted for 82 species of vertebrates and 21 groups of fish, 102 species of mollusks, 124 vascular plant species, 157 species of lichens, 527 species of fungi, and 106 species of bryophytes. In addition, 15 functional groups of arthropods that may include 10,000 species were evaluated. More than 70 experts served on the panels. The assessments for terrestrial life forms are discussed below. Assessments for fish are discussed in the subsequent section on aquatic ecosystems.

The rating process was a subjective evaluation of the sufficiency of the amount and distribution of late-successional and old-growth habitat on federal lands under each option to support the species or group of species over the next 100 years. For most species, the information necessary to precisely quantify the response to changes in the quality and pattern of their environments simply does not exist. Our evaluations, therefore, should not be viewed as precise analyses of likelihoods of persistence or extinction; they represent the Forest Ecosystem Management Assessment Team's judgment as to the sufficiency of habitat on federal lands to support viable populations of the species examined. With additional data and studies, the ability to predict response of species to habitat change will improve.

The spectrum of options provides an array of protection for late-successional and old-growth forests and associated organisms. We predicted that increased levels of protection of old forests provided by larger reserve systems should foster increased likelihood of successful persistence of organisms associated with late-successional and old-growth forest. That was in fact the case (fig. II-7). Both numbers of species as well as individuals within a species respond favorably to increased protection of late-successional forest. If a species did not fare well under a particular option its response generally improved under a more conservative option.

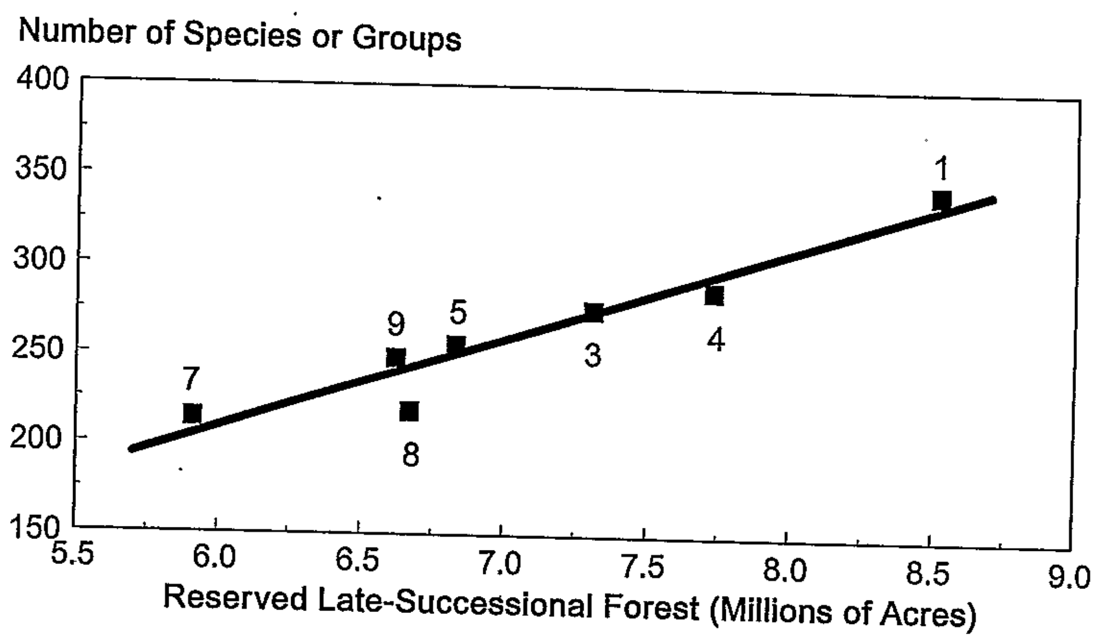


Figure II-7. Numbers of species or groups of species which were rated as having a greater than 60 percent likelihood of having habitat sufficient to maintain populations well distributed on federal lands within the range of the northern spotted owl for the next 100 years versus acreage of reserved late-successional forest in Options 1, 3, 4, 5, 7, 8, and 9.

However, we identified species and situations where particular organisms or groups did not respond to the level of habitat protection provided. Other species did not fare well under any option. Such species may simply be so rare, so sparsely distributed, that even under the most conservative options we cannot be assured of the continued persistence of sufficient habitat given the vagaries of natural processes, especially given human intervention. Some species occur within extremely limited geographic ranges or occur in relatively isolated pockets in association with specific microhabitats (e.g., seeps or springs, rock outcrops). For these species, mitigation measures to protect specific habitats on federal lands must be implemented to ensure viability. Without such mitigation measures in place, none of the options may provide habitat sufficient to assure viability of an assortment of species or groups.

Our analysis of the options was limited to assessing the sufficiency of habitat on federal lands to provide for the persistence of the species. We did not assess population viability per se. We noted, however, that some species are influenced so strongly by habitat on nonfederal lands or other conditions (i.e., air pollution) that their continued persistence is in question regardless of federal land management. In many of the above situations the fate of the species is not principally a function of the management of federal forest lands and must be addressed via other venues.

Viability of Life Forms

Listed Species

Eight federally listed threatened or endangered species are found in the area considered by this assessment (forests within the range of the northern spotted owl). In addition to the marbled murrelet and the northern spotted owl (addressed below), the six listed species include the gray wolf, grizzly bear, peregrine falcon, bald eagle, Sacramento River winter chinook salmon, and an endangered plant, MacDonald's rock cress. Recovery plans exist for four of the six (all but the wolf and grizzly bear); all options considered in this assessment incorporate appropriate measures from the respective recovery plans. Recovery plans for both the grizzly bear and gray wolf in the Cascade Mountains of Washington are currently under development; neither species is closely associated with late-successional and old-growth forests, and the options considered should not conflict with recovery actions. Thus, for six of the eight federally listed threatened or endangered species, the 10 options for federal forest management either incorporate or should not conflict with proposed recovery measures, although this was not evaluated.

Both the northern spotted owl and the marbled murrelet are closely associated with late-successional and old-growth forests and are responsive to changes in management of federal forests within their range. The options evaluated were crafted to incorporate conservation measures providing a spectrum of protection levels for these two species.

Northern spotted owl. In comparison to other species, the northern spotted owl has been intensively studied and there is much information available that is pertinent to developing a conservation strategy. The elements of a conservation strategy appropriate for the northern spotted owl were proposed by the Interagency Scientific Committee (Thomas et al. 1990); the strategy was confirmed and refined during the preparation of the Final Draft Recovery Plan for the Northern Spotted Owl (USDI 1992). That conservation strategy employs a network of reasonably large (generally 30,000 to 100,000 of forest adequate to provide for dispersal of owls among reserves. The Forest Ecosystem Management Assessment Team accepted the refined conservation strategy as presented in the Final Draft Recovery Plan as the appropriate basis for spotted owl management. The elements of the Recovery Plan are incorporated in most of the options considered; thus most options provided greater than 80 percent likelihood of providing habitat sufficient to maintain well distributed, viable populations of northern spotted owls on federal lands for 100 years (fig. II-8).

All options except Option 7 incorporate the Scientific Analysis Team (Thomas et al. 1993) approach to late-successional and riparian forest management (which enhances both the connectivity between reserve areas and increases the acreage of late-successional and old-growth forest available to northern spotted owls). Some options include additional large blocks of late-successional and old-growth habitat, beyond that called for in the Recovery Plan; these options (1, 2, 3, 4, and 5) provide additional confidence that viability of spotted owls will be assured, especially in the long term. Options 7, 8, and 10 provide conservation measures for spotted owls significantly less than those specified in the Recovery Plan (fig. II-8a; page II-42).

Option 9 incorporates a reserve design different from that specified in the Recovery Plan but tailored to meet owl population objectives; it also substitutes Riparian Reserves and 15 percent green tree retention in the Matrix for the dispersal habitat provisions of the Recovery Plan. The reserved pair areas (which occurred primarily in the marbled murrelet range) were dropped. The rationale was that enhanced retention of marbled murrelet habitat would meet or exceed this requirement. In all options, we recognize

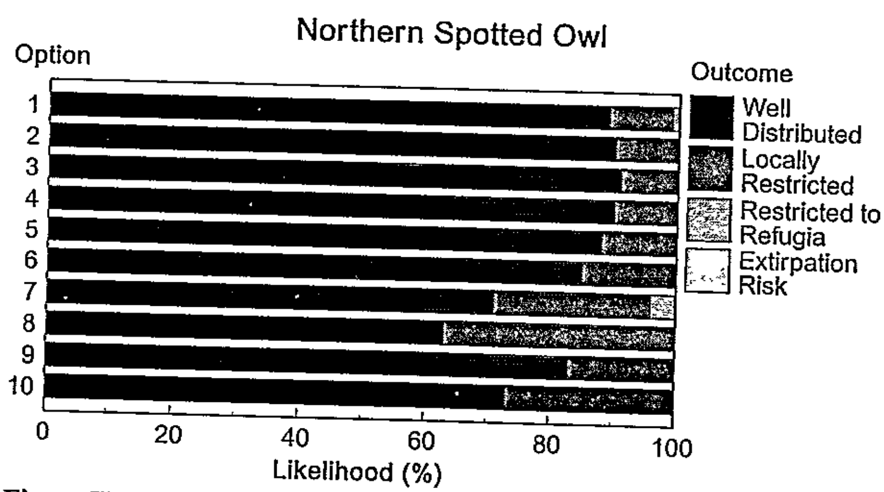


Figure II-8. Outcomes for the northern spotted owl under each of ten land management options. Values shown are the likelihood of the species achieving the indicated outcome based on the habitat conditions provided on federal lands over the next 100 years.

areas of special concern where current habitat conditions on federal lands are deficient in portions of the owl's range, or where private, state, and federal lands are intermingled or federal lands are absent. In these areas of special concern, contributions by nonfederal lands remain important to recovery of the species and should be addressed in the final recovery plan for the northern spotted owl. These contributions can be negotiated by the Fish and Wildlife Service under the Habitat Conservation Plans or "4d" rules of the Endangered Species Act.

Marbled murrelets. The marbled murrelet, a sea-bird, nests in old-growth forests as far as 40 or more miles inland. Yet provision of abundant suitable federal forest nesting habitat is not sufficient, of itself, to ensure viability of the species. At sea, the murrelet remains vulnerable to such hazards as oil spills and net fishing. In addition, broad gaps exist within its nesting range where there are no federal forests to provide secure nesting habitat. Thus, the Team recognizes that the efforts to supply nesting habitat on federal forest land within the range of the northern spotted owl, however substantial and appropriate, will not alone suffice to ensure viability of the marbled murrelet.

We recruited a working team of biologists with marbled murrelet research and management experience to devise a strategy to provide sufficient nesting habitat within the range of the northern spotted owl on federal lands to accommodate a viable population. This initiative does not supplant the effort to fashion a marbled murrelet recovery plan that is already under way. The working team devised a strategy based on Late-Successional Reserves within the nesting range of the murrelet in the three state area. In addition, the strategy calls for surveys for murrelets and reservation of all occupied sites. The murrelet working team strategy is in place in Options 1, 2, 3, 4, 5, 6, and 10 and is exceeded in Options 1, 4, and 5; it is modified somewhat in Option 9 as related to retention of habitat and planning of management activities in adaptive management areas. Options with the murrelet working team strategy in place should provide sufficient protection for nesting habitat to support well-distributed populations of marbled murrelets on federal lands within the range of the northern spotted owl over the next 100 years (fig. II-9). These actions alone, however, are not sufficient to provide adequate viability for the species because of its other life history requisites. The task of fashioning a comprehensive strategy to provide for viable populations remains for the marbled murrelet recovery team.

Other Vertebrates (Other than Fish)

We believe we understand the life history requisites of vertebrates better than those of invertebrates and many other organisms and are therefore relatively confident in the outcomes predicted (fig. II-10). For birds, all options but 7 and 8 provide at least 80 percent likelihood of habitat sufficient to maintain a well distributed population for all but one species; mitigation measures can raise that species to the 80 percent likelihood level. Among 26 mammal species, 11 fell below an 80 percent likelihood that habitat would be maintained adequate to assure a viable population well distributed within the planning areas in some options. Application of recommended mitigation measures suffices to bring four of the 11 species up to the 80 percent likelihood of habitat sufficient to maintain a well distributed population in all options. For the other seven mammal species, selection of a more conservative option is necessary; Options 1 and 3 provide an 80 percent likelihood for 6 species and Option 1 alone does so for the American marten. Under all the remaining options, except Option 7, the marten

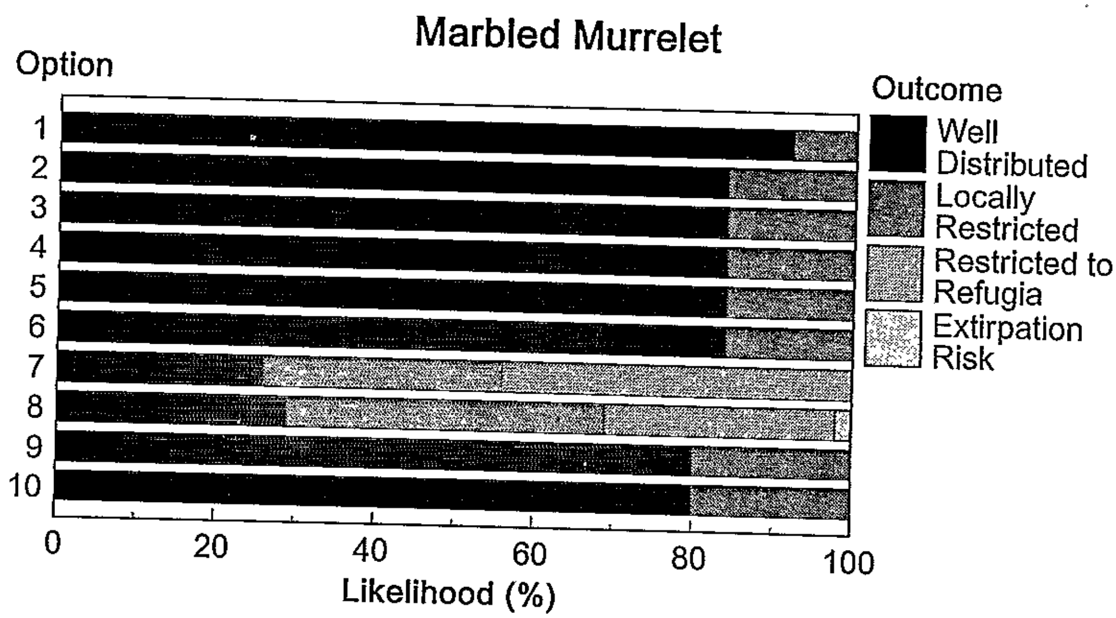


Figure II-9. Outcomes for the marbled murrelet under each of ten land management options. Values shown are the likelihood of the species achieving the indicated outcome based on the habitat conditions provided on federal lands over the next 100 years within the range of the northern spotted owl.

exceeds a 60 percent likelihood of habitat sufficient to maintain a well distributed population on federal lands.

For the amphibians, six of the ten species that did not achieve a rating of 80 percent likelihood of habitat sufficient to maintain a well distributed population can have mitigation measures applied that raise the likelihood to 80 percent or better under all options. The other species are local endemics and mitigation measures must involve both federal and other lands.

Other Species Associated with Late-Successional Reserves.

The Forest Ecosystem Management Assessment Team considered six taxonomic groups of species in addition to the vertebrates: lichens, fungi, mosses and liverworts, vascular plants, mollusks, and arthropods. While there is in-depth knowledge for some of the species in these taxa, in general, we know less than for most vertebrate species. An exception is the vascular plants. Considerable in-depth information is available for this group and we were able to examine, species by species, how the vascular plants fare across the options. For the other taxa, except mollusks, both because there are so many species closely associated with old-growth forests (i.e., 10,000 estimated arthropod species -- insects and spiders), and because we know less about them than about vertebrate species, we found it both convenient and necessary to combine species to form groups based on their ecological and taxonomic relationships.

The array of options provides a spectrum of Late-Successional Reserves and management opportunities on federal forest land to maintain habitat sufficient to support most common vascular plant species (fig. II-11). Those vascular plants not rating 80 percent likelihood of habitat sufficient to maintain well distributed populations are rare or locally endemic species. As such they are amenable to mitigation that will raise them to the 80 percent likelihood level.

The lichens, bryophytes, fungi, arthropods, and mollusks are maintained as functionally effective groups or species at least within the Late-Successional Reserves where they occur. But many species of mollusks, for instance, are locally endemic and/or rare and do not rate well under any of the options; this situation extends to other taxa as well, and the taxa fare poorly under all options in comparison to the vertebrates and vascular plants (fig. II-12). Even under the most conservative options (i.e., Options 1 and 3) only about a quarter of the species or groups rated an 80 percent likelihood of habitat sufficient to maintain well distributed populations. The lack of information on the species and their responses to habitat manipulations coupled with the large proportion that are inherently rare and/or locally endemic and likely sensitive to habitat disturbance gave the expert panels and our Team little confidence to predict many species/groups would find habitat well distributed within the range of the northern spotted owl for the next 100 years. These results are troubling. Investigations of these taxa should receive priority attention because it is widely accepted that the vascular plants, fungi, and lichens, along with the invertebrates, are critically important for the maintenance of ecosystem function and productivity.

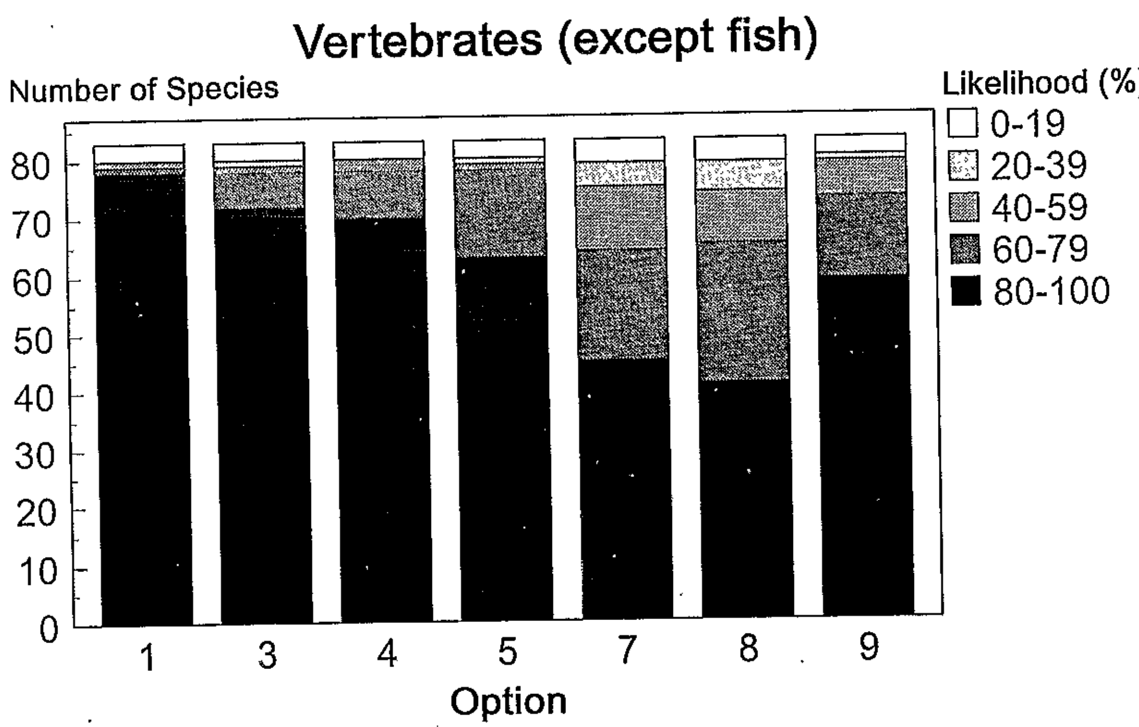


Figure II-10. Numbers of vertebrate species (except fish) that are expected to achieve various likelihoods of attaining stable, well distributed populations in response to habitat conditions provided under land management options on federal lands within the range of the northern spotted owl over the next 100 years.

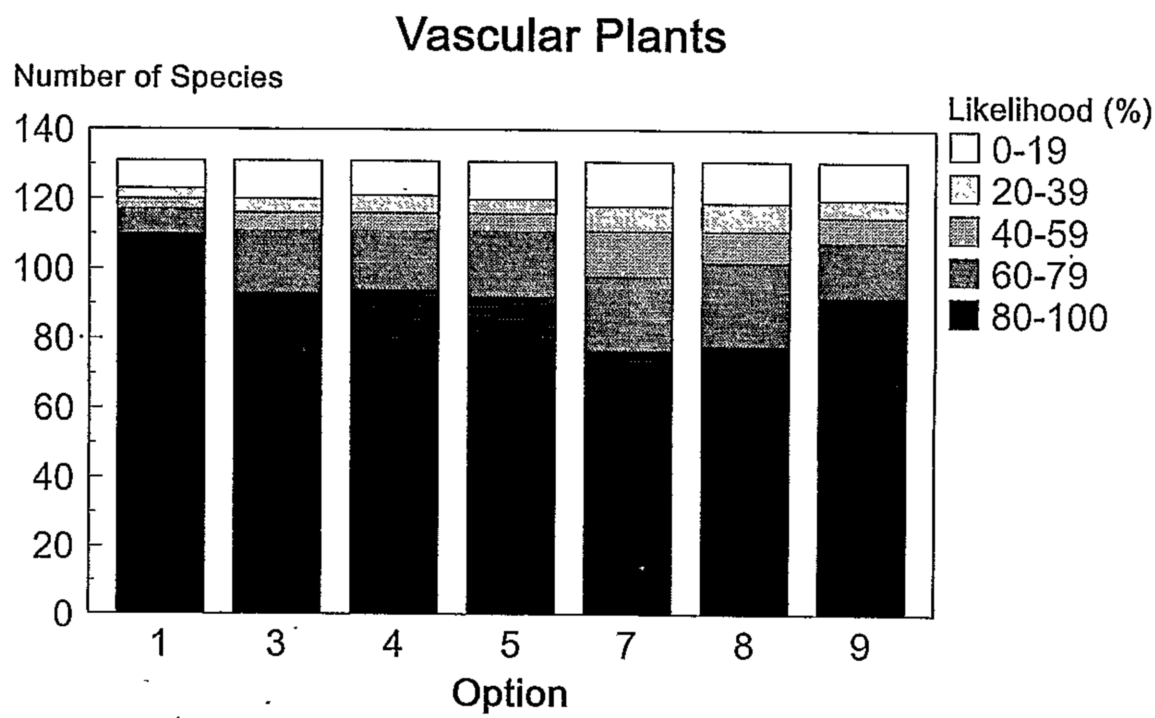


Figure II-11. Numbers of vascular plant species that are expected to achieve various likelihoods of attaining stable, well distributed populations in response to habitat conditions provided under land management options on federal lands within the range of the northern spotted owl over the next 100 years.

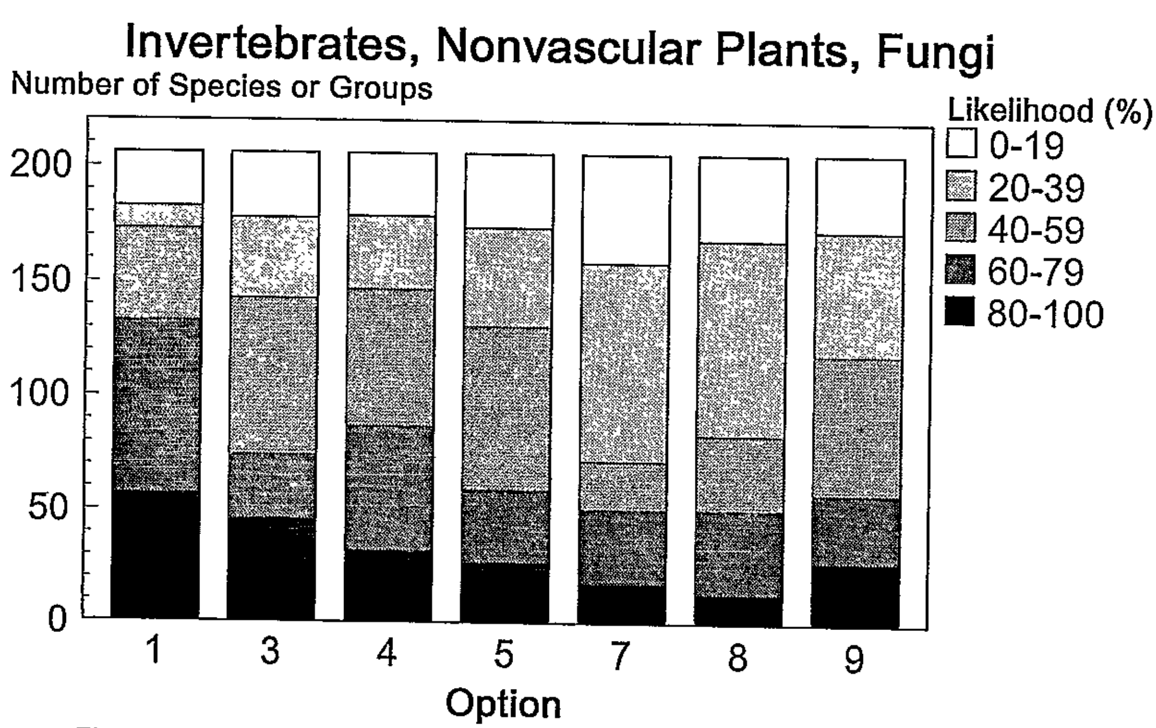


Figure II-12. Numbers of invertebrates, nonvascular plants and fungi that are expected to achieve various likelihoods of attaining stable, well distributed populations in response to habitat conditions provided under land management options on federal lands within the range of the northern spotted owl over the next 100 years.

Functional Late-Successional and Old-Growth Forest Ecosystems

In many respects the test of providing a functional, interacting late-successional and old-growth forest ecosystem subsumes the test of viability for the system's component species and groups of organisms. But an ecosystem will likely continue to function in some fashion, even in the absence of some component and perhaps even important species. Such a system is, however, no longer providing the same array of processes and functions once present. An impoverished ecosystem is not likely to be as productive and sustainable as one in which all the functions are provided. Clearly, the goal is to maintain functional interacting ecosystems and their complement of component species to maintain biodiversity.

The Team assessed the likelihood of maintaining a functional interacting late-successional and old-growth forest ecosystem with the following characteristics:

1. A relatively high abundance and diversity of old-growth communities and subregional ecosystem types that are well distributed across the region.

2. The occurrence of ecological processes and functions that are characteristic of old forests and lead to the development and maintenance of these ecosystems.

3. An interacting system in which the distribution of patches, and the landscapes in which they occur, provide for biotic flow to maintain distributions of viable species.

Two major geographic areas are considered based on dramatic differences in the influence of fire: the "dry provinces" -- Eastern Cascades of Washington, Oregon and California together with the Klamath Province; and the "moist provinces" -- the more moist northern and western provinces. The stability of a functional interacting old-growth forest ecosystem is less in the Eastern Cascades and Klamath Provinces than in the moister provinces due to the likelihood of large-scale disturbance (especially fire), current stand conditions and the portent of global climate change within the 100-year evaluation period. The effects of human disturbance and land ownership patterns further weigh against maintenance of the old-growth forest ecosystems that were once present. Nevertheless, our evaluation of the moist provinces identified Options 1, 3, 4, 5, and 9 as having a greater than 70 percent likelihood of maintaining characteristics of late-successional ecosystems within the range of variation of conditions experienced in the presettlement period. For the dry provinces, Options 1, 3, 4, 5, and 9 had at least about 60 percent likelihood of maintaining ecosystem characteristics within the range of variation of presettlement conditions.

Overview: Aquatic Ecosystems

Critical issues in management of aquatic resources include: (1) at-risk fish stocks and species; (2) stream, riparian, and wetlands habitat; (3) water quality; and (4) nonfish species of aquatic and riparian-dependent organisms. An estimated 314 stocks of anadromous salmonid stocks have been identified as at risk, because of low or declining population numbers based on assessments by the American Fisheries Society and Oregon, Washington, and California fish management agencies. Of these, only 55 stocks occur solely on nonfederal land. Thus, federal agencies share in the responsibility for managing habitat for 259 at-risk stocks.

The decline of these fish stocks is indicative of a historic and continuing trend of aquatic resource degradation. Although several factors are responsible for declines of anadromous salmonid populations, habitat loss and modification are major determinants of their current status. Aquatic systems in the range of the northern spotted owl exhibit signs of degradation and ecological stress. Approximately 55 percent of the 27,000 stream miles examined in Oregon are either severely or moderately impacted by nonpoint source pollution (Edwards et al. 1992). Over a third of Washington state's wetlands have been lost (Dahl 1990), and 90 percent of those remaining are considered degraded (Washington Department of Wildlife 1992).

Over the last century, federal land within the range of the northern spotted owl has become increasingly important for ensuring the existence of high quality aquatic resources. Privately held forest lands have been developed into farms, urban areas, transportation corridors, and industrial forests. Conversion of native forest to tree farms and agriculture decreases the capacity of these lands to supply high quality aquatic resources. Thus, society's reliance on federal forest lands to sustain aquatic resources continues to grow.

We developed a set of options for management of aquatic and riparian ecosystems based on scientific understanding of the functional links between stream and wetland ecosystems and adjacent terrestrial vegetation. Streamside forests, for example, profoundly influence habitat structure and food resources of stream systems for lateral distances exceeding a tree height for many functions. Tree height distance away from the stream is a meaningful indicator of an area that is crucial for providing aquatic habitat components, including wood recruitment and degree of shade. We defined a site-potential tree as the average maximum height of the tallest dominant trees (200 years or more) on a given site.

Another critical linkage within stream systems is the downstream movement of material and disturbances. Small, steep intermittently flowing channels are often sources of woody debris and debris flows that enter larger, fish-bearing streams. Intermittent channels are also sites of management-initiated debris flows originating from channel heads or road failures, which can severely degrade aquatic habitat. Intermittent streams have a defined channel that shows evidence of sediment transport and scour. In this exercise, we estimated the number of these by intermittent streams to be 90 percent greater than estimated in forest plans and Johnson et al. (1991).

Nine of the 10 options incorporate an aquatic conservation strategy and have the following elements:

- A network of 162 Key Watersheds to protect at-risk fish stocks or basins with outstanding water quality.

- Riparian Reserves to maintain ecological functions and protect stream and riparian habitat and water quality.

- Watershed analysis (which is also significant to welfare of terrestrial species) is a procedure for planning further protection or management, including restoration practices within a basin.

- Restoration to speed ecosystem recovery in areas of degraded habitat and to prevent further degradation.

- No new road construction in designated roadless areas in Key Watersheds to prevent further effects of roads as sources of sediment and flood flows.

Key Watersheds

A system of Key Watersheds that serve as refugia is critical for maintaining and recovering habitat for at-risk stocks of anadromous salmonids and resident fish species. These refugia include areas of good habitat as well as areas of degraded habitat. Areas in good condition would serve as anchors for the potential recovery of depressed stocks. Those of lower quality habitat have a high potential for restoration and will become future sources of good habitat with the implementation of a comprehensive restoration program. We identified a network of 162 Key Watersheds (fig. II-13) located on federal lands including both 139 Aquatic Conservation Emphasis Key Watersheds (Tier 1), selected specifically for directly contributing to anadromous salmonid and bull trout conservation, and 23 Water Quality Emphasis Key Watersheds (or Tier 2), which are important sources of high quality water.

Riparian Reserves

Riparian Reserves are portions of watersheds where riparian-dependent resources receive primary emphasis and where special standards and guidelines apply. Riparian Reserves include those portions of a watershed that are directly coupled to streams and rivers, that is, the portions of a watershed that directly affect streams, stream processes, and fish habitats. Every watershed in National Forests and Bureau of Land Management Districts within the range of the northern spotted owl will have Riparian Reserves. Land allocated to Riparian Reserve status varies between options from 0.62 to 2.88 million acres (see chapter III, table III-5).

All options recognize three categories of water: (1) fish-bearing streams and lakes; (2) permanently flowing nonfish-bearing streams and wetlands greater than 1 acre; and (3) intermittent streams and wetlands smaller than 1 acre. All options but two (Options 7 and 8) incorporate buffers that are a minimum 300 feet or two site potential tree heights on each side of the stream for the first category and 150 feet or one site potential tree height for streams and wetlands for the second category. Under all options, intermittent streams in Tier 1 Key Watersheds use a 100 feet or one site potential tree height and 50 feet or one-half tree height in watersheds elsewhere. Options 7 and 8 have little or no protection for these small but important channels. These scenarios are components of the set of 10 forest management options.

Restoration

Stream and riparian systems have been significantly degraded by past management actions, including selective or complete cutting of streamside forests, removal of woody debris from channels, and construction of roads that increase streamflow and sediment production. Therefore, watershed restoration should be an integral part of a program to aid recovery of fish habitat, riparian habitat, and water quality and will be a significant contribution to stream conservation in all options. The most important elements of a restoration program are (1) to control and prevent road-related runoff and sediment

Key Watersheds
(Tier 1 & 2)

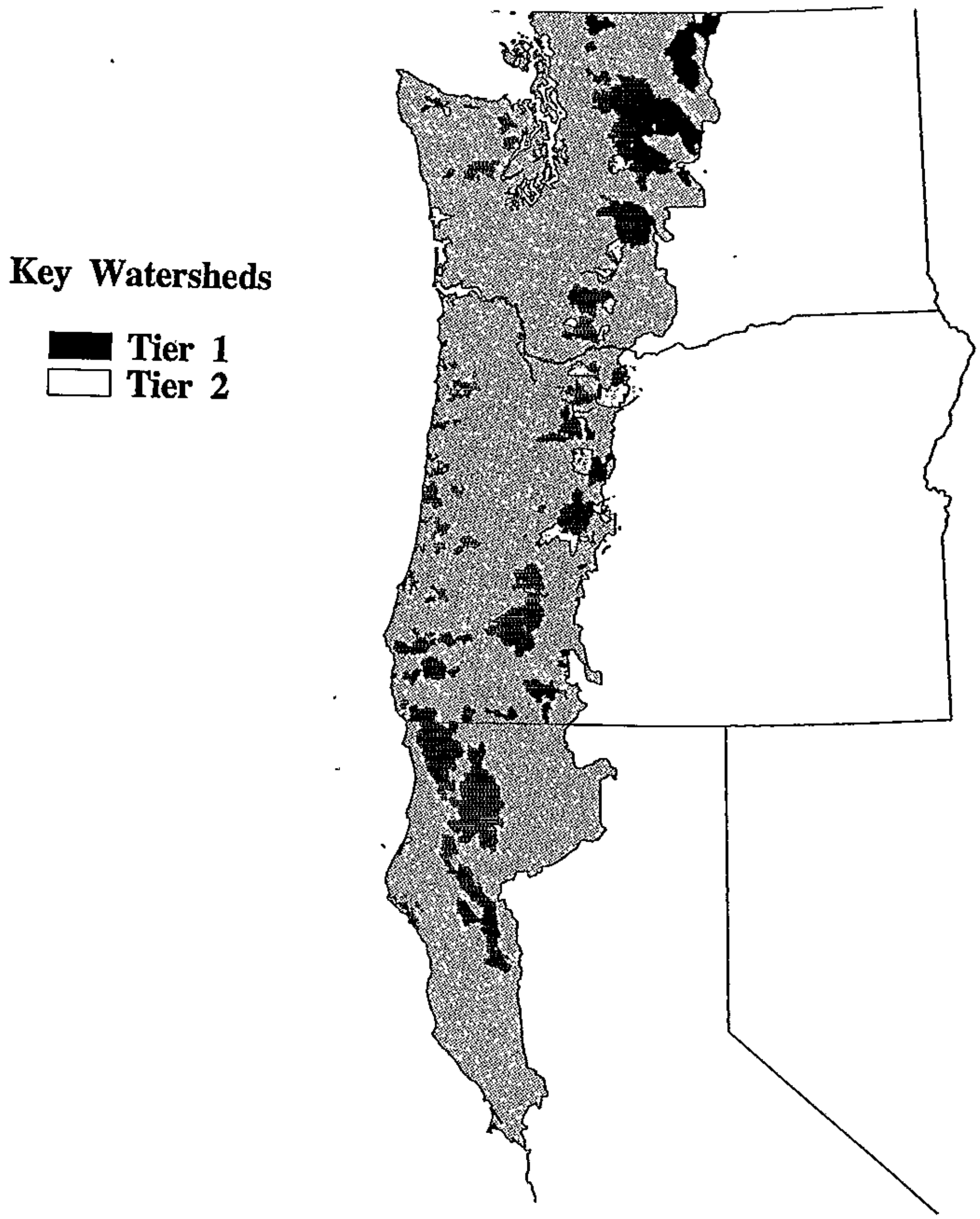


Figure II-13. Key Watersheds.

production, (2) to improve the condition of riparian vegetation, and (3) to improve habitat structure in stream channels.

Of particular concern is that the federal lands within the northern spotted owl's range contain approximately 110,000 miles of roads. Much of this network adversely affects water quality and peak flow levels. The capacity of the Forest Service and Bureau of Land Management to maintain roads has declined dramatically as both appropriated and traffic-generated funds for maintenance and timber purchaser-conducted maintenance have been reduced. Without an active program of identifying and correcting problems, habitat damage will continue for decades.

Roads and Roadless Areas

There are over 3 million acres of inventoried roadless areas within National Forests in the range of the northern spotted owl. Over 50 percent of this area is in identified Key (Watersheds, with about 48 percent contained in Tier 1 Key Watersheds. Roadless areas are often characterized by significant amounts of unstable land. Road networks are the most important sources of accelerated delivery of sediment to fish-bearing streams. Road-related landslides, surface erosion, and stream channel diversions often deliver large quantities of sediment to streams, both catastrophically during large storms and chronically during smaller runoff events. Older roads in poor locations and with inadequate drainage systems pose high risks of future sediment production. Road surfaces and ditches can also serve as extensions of the stream network, thereby increasing flood peaks and efficiently delivering road-derived sediments to streams.

Management activities in roadless areas would increase the risk of aquatic and riparian habitat damage and impair the capacity of Key Watersheds to function as intended and to contribute to achieving the objectives of the conservation strategy. To protect the best habitats in the identified Key Watersheds, no new roads should be constructed in roadless areas within Key Watersheds. This criterion was applied in all but Option 7.

Summary

In assessing the options, we considered five factors: (1) assessments for the individual races/species/groups made by the expert panel; (2) amount of Riparian Reserves and type and level of land-management activity allowed within in them; (3) extent of other reserves (e.g., Congressionally designated withdrawals, Late-Successional Reserves, etc.) and type and level of land management activity allowed within them; (4) presence of a watershed restoration program; and (5) prescriptions for management of Matrix lands. The expert panels also considered items 2-5.

This assessment of habitat on federal lands does not directly correspond to population viability of the affected species. This is due, in part, to impacts or cumulative effects from nonfederal habitat sectors where the species might spend a portion of their life cycles. Furthermore, with anadromous fish, there is limited science available to establish direct relationships between land management actions and population viability due in part to other impacts such as predation and artificial propagation and the difficulty of translating these impacts into population numbers.

The analysis rated the sufficiency, quality, distribution and abundance of habitat to allow the species populations to stabilize across federal lands. In this assessment, Options 1 and 4 had the greatest likelihood, 80 percent or greater, of attaining sufficient quality, distribution, and abundance of habitat to allow all races/species/groups to stabilize, well distributed across federal lands (outcome A, see chapter IV, table IV-7; fig. II-14). The positive outlook for these options resulted from the relatively larger amount of area in Late-Successional Reserves and the Riparian Reserves.

Options 2, 3, 5, 6, 9, and 10 generally had a 60-70 percent likelihood of attaining Outcome A -- habitat for the seven species/groups of anadromous fish sufficient to support quality spawning and rearing habitat well-distributed across federal lands. These options had a smaller likelihood of attaining this outcome than Options 1 and 4 because of less area in Late-Successional Reserves and the Riparian Reserves. Options 7 and 8 had the lowest likelihoods of attaining Outcome A for all races/species/groups. The likelihood of obtaining Outcome A for Option 7 ranged from 10-15 percent. Option 7 was ranked low primarily because of the relatively (compared to other options) small amount of Riparian Reserves and the amount of activity that was allowed within them in Bureau of Land Management land management plans and in many National Forest plans. Likelihood of obtaining Outcome A for Option 8 ranged from 20-25 percent for all groups. Again, the reduced likelihood was due to reduced size of Riparian Reserves, particularly along intermittent streams.

The likelihood of achieving Outcome A for fish habitat is lower for Options 2, 3, 5, 6, 9, and 10 than for Options 1 and 4. However, we think all options except Option 7 and 8 will reverse the trend of degradation and begin recovery of aquatic ecosystems and habitat on federal lands within the range of the northern spotted owl. Even if changes in land management practices and comprehensive restoration are initiated, it is possible that no option will completely recover all degraded aquatic systems within the next 100 years. The likelihood of attaining a functioning late-successional/old-growth ecosystem

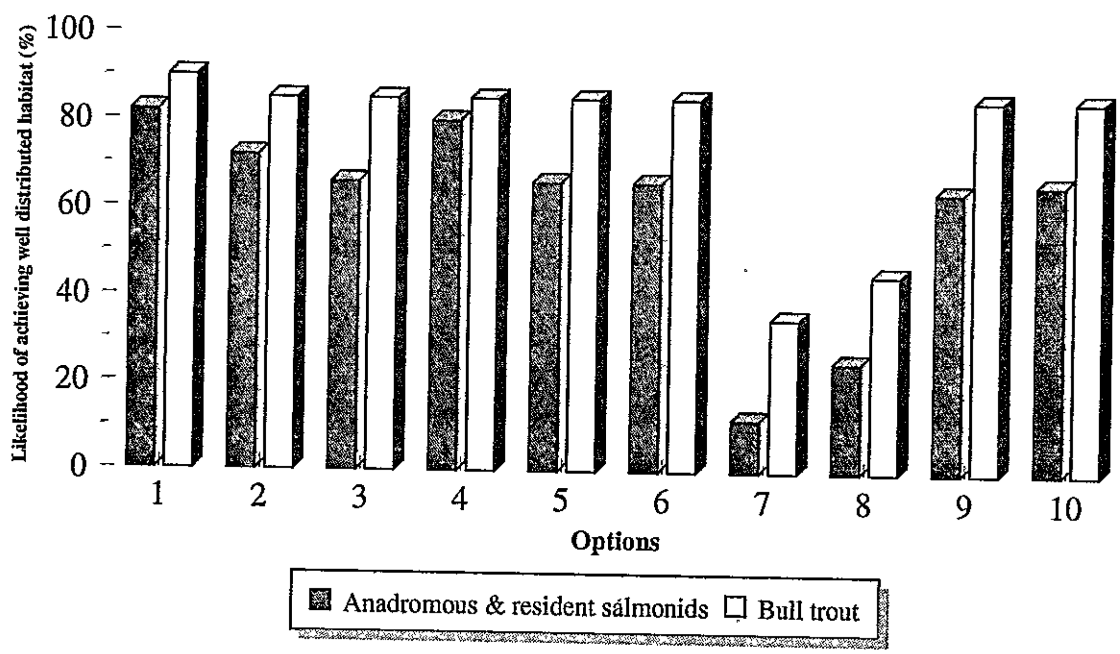


Figure II-14. Viability assessments for anadromous and resident salmonids and bull trout.

in the next 100 years is impaired because some characteristics of these terrestrial ecosystems will not be obtained for at least 200 years (see chapter IV). Similarly, we expect that degraded aquatic ecosystems will not be fully functional in 100 years. Faster recovery rates are probable for aquatic ecosystems under Options 1 and 4 due to reduced disturbance across the landscape that results from application of a larger Late-Successional Reserve network and the use of the Riparian Reserve 1 scenario which requires wider interim Riparian Reserves for intermittent streams in non-Key Watershed than in other scenarios.

Finally, in considering the effects of any federal land management option on aquatic resources, two points are key: overharvest, disease, artificial propagation practices, and habitat impacts such as urbanization and agricultural practices have degraded and may continue to degrade aquatic habitat; and a plan for managing federal lands alone will not solve these problems. Ecosystem management cannot be successful without participation of all federal and nonfederal landowners and agencies that affect a watershed. The federal agencies must foster a partnership for ecosystem management with these entities to ensure conservation and prevent further degradation of the region's aquatic resources.

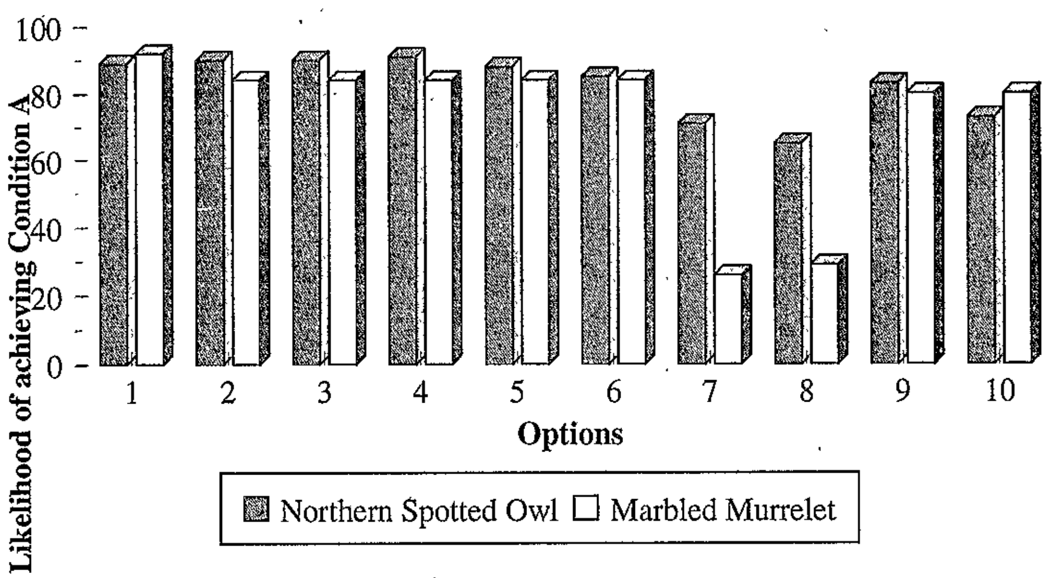


Figure II-8a. Likelihood of achieving habitat Condition A (Habitat suitable to maintain viable populations well-distributed on federal lands). Likelihood for Options 2, 6 , and 10 are internal assessments; these Options were not rated by expert panel.

Overview: Economic Assessment of the Options

The Forest Ecosystem Management Assessment Team was charged with addressing a broad range of forest resource outputs and their economic implications. The economic assessment of proposed forest ecosystem management options was designed to evaluate resource yields and values, local and regional economic conditions, National Forest product markets, and additional policy considerations. The economic analysis focused upon the management of the federal forests within the range of the northern spotted owl and the counties directly within their influence (fig. II-15).

Outlook for Federal Timber Harvests

Federal harvests must be viewed from two perspectives: (1) the implications of the land allocation and management guidelines on anticipated timber sales quantities per decade (i.e., the sustainable harvest level) and (2) the implications of these guidelines on the potential near-term sale levels.

Comparison of Forest Service Estimates of Annual Sale Quantity Levels Between Various Reports (1990-1993)

Prior to evaluating the probable sustainable harvest levels, a comprehensive assessment of Forest Service annual sale quantity estimates for the period 1990-1993 was conducted. The probable sale quantity estimates developed for Forest Service Region 6 forests under Option 7 (based on individual forest plans with the imposition of the Final Draft Recovery Plan for the Northern Spotted Owl; USDI 1992) were compared to estimates derived by Forest Service analysts for the Northern Spotted Owl Final Environmental Impact Statement (USDA 1992). Estimates of the probable sale quantity for the Region 6 National Forests within the range of the northern spotted owl were 1.01 billion board feet for Option 7. When this was compared to the estimates of annual sale quantity (with a similar owl management strategy Thomas et al. 1990) from the Northern Spotted Owl Environmental Impact Statement (USDA 1992), the estimate was 1.54 billion board feet. This represented a 34 percent reduction (table II-4). In the assessments made for the Forest Ecosystem Assessment Team, Forest Service and Bureau of Land Management analysts were asked to provide feasible harvest levels that might be achieved. This estimate was referred to as the probable sale quantity. This is a departure from the concept of annual sale quantity that was a ceiling that should not be exceeded during the decade.

Table II-4. National Forest annual sale quantity estimates for Region 6 (Oregon and Washington)

National Forest	Option 7 - Forest Plans with Recovery Plan - [a] (1993)	Forest Plans With ISC Strategy - Northern Spotted Owl FEIS (1992)	Forest Plans With ISC Strategy - Hamilton Report (1990)	Final Forest Plans (1988-1990)
	millions of board feet			
State of Oregon	781	1,214	1,362	1,846
State of Washington	234	328	419	752
Total of Forests Within Owl Range	1,015[b]	1,542	1,781	2,598
Forest Plan for Areas[c] Outside the Owl Range	989	843	843	843
R6 Total	2,004	2,385	2,624	3,441

[a]Option 7 estimates for the Northern Spotted Owl Recovery Plan give "probable sale quantities" as opposed to "allowable sale quantities" as done in the other three columns. The term "probable sale quantity" is used instead of "allowable sale quantity" because National Forests were asked for estimates of the likely harvest level rather than maximum harvest level (allowable sale quantity) as previously done.
[b]Total probable sale levels for forests within the range of the northern spotted owl should fall within 10 percent of this result.
[c]Forest Plan Nonowl - The annual sale quantity for those forests outside the range of the northern spotted owl and, for Option 7, the value plus harvest from the Deschutes, Winema, and Okanogan National Forests outside the range of the owl.

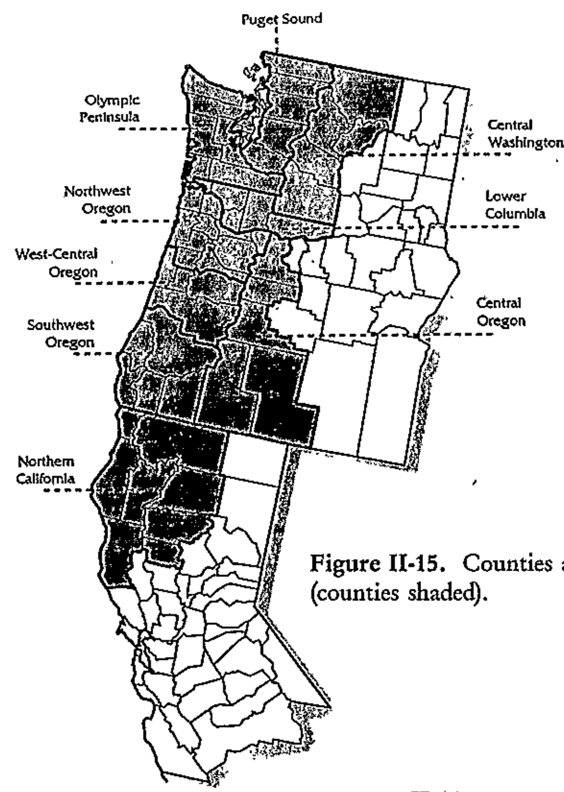


Figure II-15. Counties and sub-regions included in the impact region (counties shaded).

Three primary reasons for this reduction were detected:

1. The computations for the Deschutes, Okanogan, and Winema National Forests were based on a different land base. Computations for Option 7 included only those portions of the forests within the range of the northern spotted owl. Computations performed in connection with the Northern Spotted Owl Environmental Impact Statement included the entire forests. After compensating for differing land bases, the difference between the estimates decreased by 9 percent, leaving a difference of 25 percent.

2. The land area in the "habitat conservation areas" (Thomas et al. 1990) used in the Northern Spotted Owl Final Environmental Impact Statement (USDA 1992) differed from that reported for the "designated conservation areas" in the Recovery Plan (USDI 1992) used in Option 7. The areas designated in both plans were similar but 250,000 additional acres of designated conservation area were added in the Recovery Plan. In addition, a modified version of the 50-11-40 rule (which required 50 percent of each quarter township in the Matrix to be maintained in stands of trees averaging 11 inches diameter breast high with 40 percent canopy closure) was employed in Option 7. In this modification, 50 percent of a quarter township that does not meet the 50-11-40 requirement is released for timber harvest or silvicultural treatments while the remaining 50 percent is targeted to achieve the 11-40 part of the rule at a future date. Further, deciduous trees were removed from consideration in meeting the rule. The net effect of these factors was to reduce the difference between the two estimates by another 8 percentage points, leaving a difference of 16 percent.

3. Incorporation of new information and altered management practices into management planning reduced the annual sale quantity that was computed in preceding planning efforts. In calculating the annual sale quantity levels for Option 7 Forest Service analysts were asked to use their most up-to-date information. This information included insights field personnel had gained from experience in applying the standards and guidelines that were inherent in the forest plans, in developing the Northern Spotted Owl Environmental Impact Statement, and in the Interagency Scientific Committee's report (Thomas et al. 1990).

   Examples of the developing insights incorporated in these assessments were:

   - Implementation of standards and guides, such as retention of "wildlife trees" and logs following regeneration cuttings, had a greater impact on the timber volume achieved in harvests than had been originally anticipated.

   - The delineated habitat conservation areas, in many cases, included the more productive timber growing sites leaving somewhat less productive areas available for timber harvest resulting in lower estimates of harvest volumes.

   - Fires within the period between assessments resulted in stands that had been counted on for harvest in the near future being converted into the "young plantation" condition class, thereby reducing the present allowable sale quantity.

   - Decisions were made to significantly reduce the use of clearcutting as a silvicultural prescription and substitute various prescriptions in which significant numbers of green trees were left in place after harvest. This resulted in less timber volume being attained per unit area.

- Applications of standards and guidelines to protect special habitats, cultural resources, locations of threatened or rare plant species, etc. have reduced timber harvest per unit of area more than had been anticipated.

- Increasing awareness of the critical nature of watershed health to water quality and fish habitat has produced a management response in which more trees are being protected along stream courses. This, in turn, reduced annual sale quantity.

- Updated resource inventories (soils, stream condition, vegetation, etc.) have resulted in updated, and reduced, timber harvest estimates.

It seems likely that such factors in combination or in interaction account for all or most of the remainder of the difference between the two estimates.

The Northern Spotted Owl Final Environmental Impact Statement had already reduced the estimate of annual sale quantity from that in the Final Forest Plans for Region 6 (Oregon and Washington) and those in the so-called Hamilton Report (USDA 1990) in which the impacts of the Interagency Scientific Committee Report on annual sale quantity was estimated (table II-4). The Hamilton Report computed downward adjustments from the Final Forest Plans based primarily on the shift of forest areas that had been assumed to be available for timber production into habitat conservation areas reserved from cutting. A further assumption in that report has proven incorrect with accumulating experience. It was assumed in the Hamilton Report that meeting the 50-40-11 rule would cause only minor negative adjustments in the annual sale quantity. Experience has revealed the impacts of meeting the 50-11-40 rule to be much greater than originally thought.

The difference between the annual sale quantity estimates for the Forest Plans, including the owl conservation strategy put forward by the Interagency Scientific Committee, as represented in the Hamilton Report, differs from the estimates for Option 7 after adjustment for land base differences by 35 percent. This is derived from the data displayed in table II-4. The probable sale quantity in Option 7 for the area included within the range of the northern spotted owl (1.01 billion board feet) is adjusted to place it on a comparable land base used in the Hamilton Report by adding 0.15 billion board feet (the difference between the 0.99 billion board feet estimated in Option 7 and the 0.84 billion board feet estimated in the Hamilton Report or 0.15 billion board feet) to 1.01 billion board feet yielding an estimate of 1.16 billion board feet including eastside forests. The difference between the 1.78 billion board feet in the Hamilton Report and the adjusted figure for Option 7 of 1.16 billion board feet is 0.62 billion board feet (35 percent). Thus, over the past 3 years (1990-1993) the estimates of declines in the timber sale quantity required to attain the objective of protecting habitat for northern spotted owls (in conjunction with the objectives in the forest plans) have continually increased based on accumulating experience with "real world" conditions and refinements in the data.

Sustainable Harvest Levels

Probable sale levels for the first decade under the rules for each option are summarized in table II-5 and in figure II-16 along with recent harvest levels. Each of these options start with existing forest plans (Forest Service, Region 6) or proposed plans (Forest Service, Region 5 and Bureau of Land Management) as the base. The new allocations and management rules for each option are then overlayed on these plans and the more restrictive set of management rules are retained. Option 7, which has the highest harvest level, simulates the agencies' existing or proposed plans overlayed with the Draft Recovery Plan for the Northern Spotted Owl (USDI 1992). The remaining options contain various additional levels of protection for streamside habitat, marbled murrelet habitat, habitats of other species, and ecologically significant old growth. The additional protection measures impact harvest levels through precluding areas from harvest, distributing the harvest, extending rotations, and requiring more stringent green tree retention standards.

The probable sale quantity figures do not include removal of cull volume or small-scale salvage operations that would not have been calculated in annual sale quantity estimates. Historically, this "other wood" volume has averaged about 10 percent of the annual sale quantity (fig. II-17).

In addition, probable sale estimates do not include additional volume that might be obtained under some options from thinning, salvage, and other treatments within reserves. An additional volume of up to 150 million board feet per year might be obtained from these activities depending on the option.

It is difficult to determine fully the actual sale levels that will result from some of the management rules for the different options. As an example, 15-20 percent of the sale levels comes from Tier 1 Key Watersheds (those with potentially threatened fish stocks) in most options. These watersheds will need a watershed assessment before sales go forward. We do not know when this analysis will be finished nor what the outcome will be. The probable sale levels were based on a set of interim rules for these watersheds. Therefore it is problematic as to what level will be achieved after assessment. In addition, a portion of the sale levels in most options come from lands within the near and far zones of the marbled murrelet. This land could (in theory) be captured by marbled murrelet "activity centers." As marbled murrelets are found, creation of additional activity centers will further prohibit harvest levels. Also, Option 9 creates Adaptive Management Areas. The probable sale calculations are based on the assumption that harvest levels would not be reduced significantly in these adaptive management areas compared to the Matrix in which they exist. Depending on how the management rules are written for these areas, the availability of this volume could also be problematic. Finally, it is difficult to fully capture the impact of these new rules, especially a more extensive riparian protection network, on the area actually available for timber production. Much of this area is in fairly small pieces and slivers. While an operability assessment was conducted, and a reduction for inoperable acres was factored into the harvest numbers presented here, concern remains as to whether the full extent of this difficulty has been recognized.

All options yield probable timber sale levels that are substantially less than was historically sold and harvested from the federal forests in the region. This applies to both the period 1980-1989 (before the sales were enjoined by the federal courts) harvest

Table II-5. Historic federal harvests and probable annual average timber sales in the first decade by option.[a]

Administrative Unit	Average Harvest 1980-89	Average Harvest 1990-92	Option[c] 1	2	3	4	5	6	7	8	9	10
National Forests- Owl Forests			million board feet, scribner									
Region 6 - Owl Forests												
Western Washington	824	404	22	69	75	67	119	87	186	133	131	94
Eastern Washington	195	124	11	31	33	30	26	37	47	65	47	52
Western Oregon	1902	897	68	207	239	284	392	300	716	473	429	357
Eastern Oregon	127	100	15	45	45	37	49	47	65	53	59	52
Total	3048	1525	116	352	391	418	585	471	1015	723	666	555
Region 5 - Owl Forests												
Total	561	291	20	127	132	106	146	141	242	246	152	220
Bureau of Land Management - Owl Forests												
Western Oregon/Calif.	880	568	41	134	142	146	177	158	406	298	260	200
Eastern Oregon	35	5	0	3	3	3	6	4	7	6	6	4
Total	915	573	41	137	145	149	183	162	413	304	266	204
Total Owl Forests	4524	2389	177	616	668	673	915	774	1669	1274	1084	979
National Forests- NonOwl Forests[b]												
Region 6 - NonOwl Forests												
Eastern Washington	134	138	102	102	102	102	102	102	102	102	102	102
Eastern Oregon	942	831	422	422	422	422	422	422	422	422	422	422
Total NonOwl Forests	1076	969	524	524	524	524	524	524	524	524	524	524

[a]Probable sale levels should be within 10 percent of the final results and include no "other wood" estimates. Historic numbers are "gross" volumes and thus include historic levels of other wood. Historic numbers for 1990-92 are estimates.
[b]Nonowl forests have not been subjected to rigorous analysis for the various alternatives and appear only for regional price projections. Fate of the eastside forests is highly uncertain at the present time.
[c]Volumes for Options 1, 3, and 10 are approximated on the basis of analysis on the other seven options.

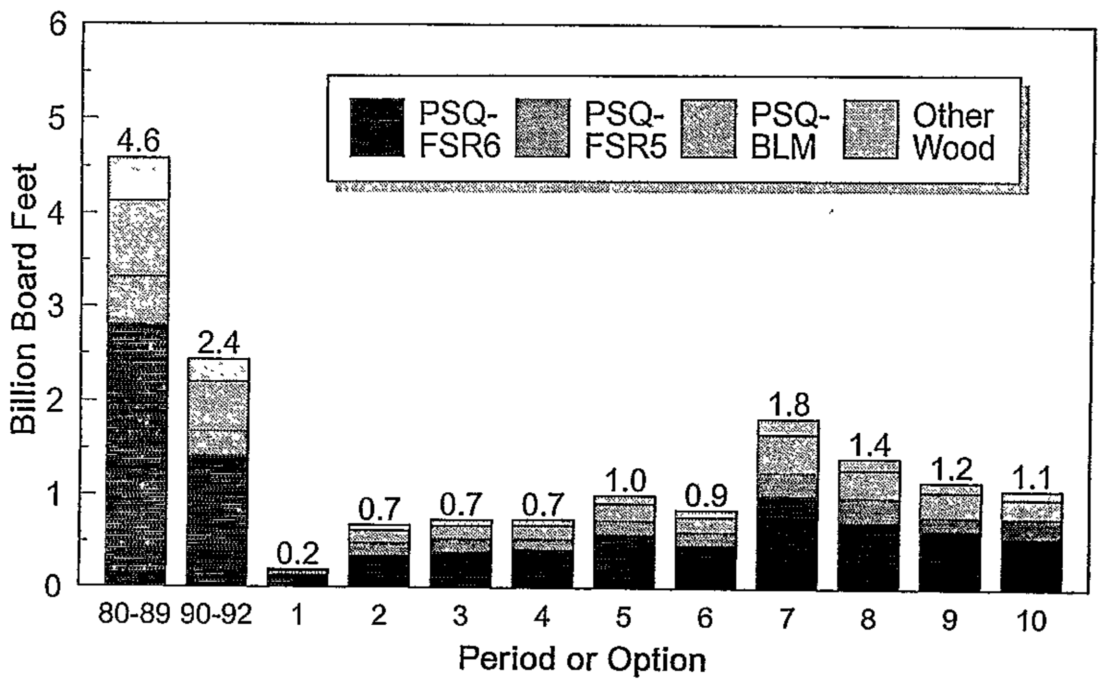


Figure II-16. Historic average for federal timber harvests and first decade's probable sale levels from federal forests within the impact region by agency ownership and option.

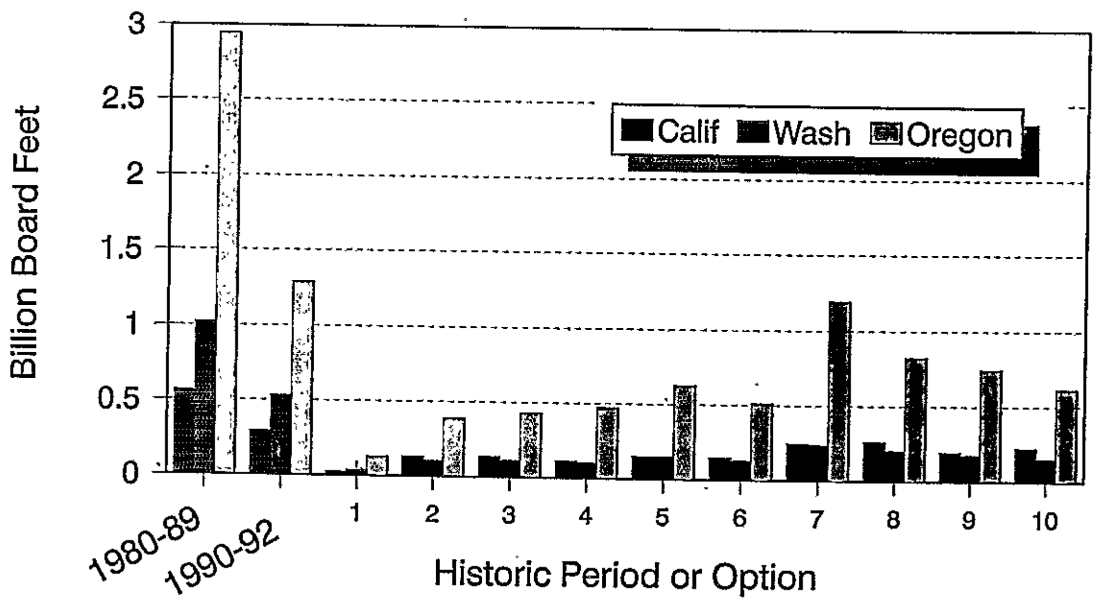


Figure II-17. Historic average federal timber harvests and first decade's probable sales levels from federal forests within the impact region by state and option.

of 4.6 billion board feet from the owl forests and the period 1990-1992 (after sales were enjoined by the federal courts) harvest of 2.4 billion board feet. The value of the 1990-1992 harvest exceeded $650 million per year in terms of stumpage and $1 billion per year in terms of logs.

The largest federal harvest reductions will be in Oregon, although the federal harvest in Washington is characterized by a larger percentage reduction (fig. II-17). Timber harvest in the coastal forests will be the most affected due to the combination of fisheries, marbled murrelet, and northern spotted owl protection.

Near-Term Outlook for Timber Sales

The near-term sale outlook from federal land is difficult to estimate and may differ from the sustainable harvest level due to required surveys and assessments prior to resumption of sales and due to time required to distill proposals into a new timber sales program.

Execution of timber sales that have already been prepared to provide short-term volume may prove difficult because of their location in Late-Successional Reserves, Key Watersheds containing potentially threatened fish stocks, Riparian Reserves, roadless areas, Fish and Wildlife Service critical habitat for the northern spotted owl, or in the "near zone" for the marbled murrelet. Only one of those options is described in detail. As an example, under Option 9, of the 1.7 billion board feet currently prepared for sale (or nearing completion in preparation) on Forest Service lands in the owl region, approximately 0.60 billion (slightly more than one-third) lies outside of these potentially controversial areas. Close to half of this 0.60 billion board feet would come from stands over 200 years of age. Even the offering of this volume for sale may be delayed for some time while sales are redesigned to come into compliance with the rules (especially the riparian rules) for the option that is selected. Similar results can be expected across most other options.

An analysis of Bureau of Land Management timber sales produces similar results, although less of its potential sale volume is over 200 years of age. On Bureau of Land Management land, there may be 0.1 billion board feet outside of these potentially controversial areas in sales nearing completion of preparation.

The agencies may be able to prepare some additional sales in fiscal year 1994 beyond those discussed above, but requirements for design surveys and consultation make it difficult to develop new sales to offer in fiscal year 1994. Recent new sale preparation has focused on sales in nonowl habitat or acceptable sales as determined by consultation with the Fish and Wildlife Service in owl habitat. Thus, more of these sales might be ready before the end of fiscal year 1994. It must be pointed out, though, that some of the sales listed above (nonowl habitat sales) will be sold before the end of fiscal year 1993. Thus, the new sales would replace, to some degree, the depletion of these sales. It seems unlikely that the total sales on Forest Service and Bureau of Land Management lands within the owl region outside of potentially controversial areas could rise much above 1 billion in fiscal year 1994 in most of the options.

Beyond fiscal year 1994, the picture brightens somewhat if it is assumed that the agency(s) develop clear rules for project design and an efficient process exists to evaluate sales within Late-Successional Reserves. Starting in 1993 with the preparation of the fiscal year 1995 program would provide enough lead time (almost 2 years) to prepare substantial amounts of new timber volume for sale. This timber sale volume is to be determined by the option chosen to guide management action. One specific concern, however, is the continuing reduction in force that is rapidly depleting the ranks of agency personnel required to prepare timber sales. Unless this reduction is slowed and (in some cases) reversed, the agency work force may not be in place to prepare a future sales program of the desired amount.

Outlook for Other Commodity Production

The four other resource commodities produced on federal lands in the region are "special forest products", livestock grazing (range), commercial fisheries, and minerals.

In the near-term, significant growth is expected to continue in the special forest products sector (e.g., mushrooms, boughs, ferns). Current annual harvest values are in excess of $50 million.

Near-term reductions in livestock grazing levels are likely, although this is a minor segment of the economy of the region.

Proposals are also apt to have little near-term impact upon the commercial fisheries whose fate is more strongly tied to "groundfish" and other ocean species. Longer term commercial fisheries yields may be enhanced over present conditions through all the options considered in this report (except Option 7).

In the long-term, potential limitations on mineral development could have significant economic implications, because the forests in the region are situated on some potentially valuable mineral terrains.

Outlook for Noncommodity Production

In addition to commodity products (i.e., those that are marketed), a number of noncommodity outputs from the forest are influenced by forest management. While market prices may not exist for these outputs, they do have economic value.

Recreation

Recreational visits to the federal forests in the region in 1990 exceeded 134 million people. These visitors spent $2.8 billion and expressed a willingness-to-pay an additional $1.6 billion beyond their expenditures for access to the recreational areas.

Increasing the availability of primitive and semiprimitive nonmotorized recreation opportunities may spur more visits as these are the only forest-based recreation activities viewed as being in deficit supply in the region.

Scenic Quality, Water Quality, Air Quality, and Other Public Goods

All of these are elements of the region's quality of life. Many in the region contend that these quality of life considerations may have helped spur the region's greater than

U.S. average employment growth since 1985 and may be prime considerations in the future attractiveness of the region for economic development.

Outlook for Nonfederal Timber Harvests

Nonfederal timber historically accounted for two-thirds of the harvest in the region in the 1980's (fig. II-18). State-to-state variations are large, with Oregon harvests being about half from nonfederal sources. The outlook for nonfederal timber harvests will be a vital component of the outlook for the timber industry in the region. In addition, the future marketing of this nonfederal timber will be important, as it dictates whether domestic or foreign buyers will receive the raw materials.

Timber Prices

Market pressures are anticipated to result in regional stumpage prices in 1995 being 33 percent higher than in 1990 (in real terms). By the year 2000, stumpage prices are projected to be 25 percent higher than 1990. The options considered contribute to these projected price increases, but are not the sole source of the rise.

Rate of Harvests

In the 1990's, private and state timber growers in the impact region seem likely to respond to higher prices and cut at levels greater than is sustainable over the long-term. In the decade ahead, the nonfederal harvests processed in the impact region are anticipated to rise from the 1980-1989 level of 9.5 billion board feet and the 1990-1992 level of 9.1 billion board feet to 9.4-9.8 billion board feet (fig. II-18). In the following decade, nonfederal harvests are projected to decline slightly as a result of that accelerated rate of harvest.

The outlook differs geographically as California appears poised for decreases in nonfederal harvests, while Washington and Oregon will likely see some increases.

These projections are based upon the current operating conditions for nonfederal owners. Additional restrictions on operations would likely reduce the harvests forthcoming from these nonfederal lands.

Aggregate Timber Harvests

In aggregate, timber harvested and processed from all owners will be approximately 0.8-2.1 billion board feet (7-17 percent) less than the level of 1990-1992 and 3.5-4.7 billion board feet (24-32 percent) less than the levels of the 1980's (fig. II-18). Thus, the nonfederal landowners mitigate only a part of the federal harvest reductions. Because Oregon is the most federally timber-dependent state, and it incurs the largest federal timber harvest reductions, it will clearly be the most impacted state (fig. II-19). The state of Washington is buffered by its large nonfederal forest land base which has, historically, provided over 80 percent of the state's timber harvest. This situation has potential to off-set some of the short-term effect of reductions in timber harvest on federal lands.

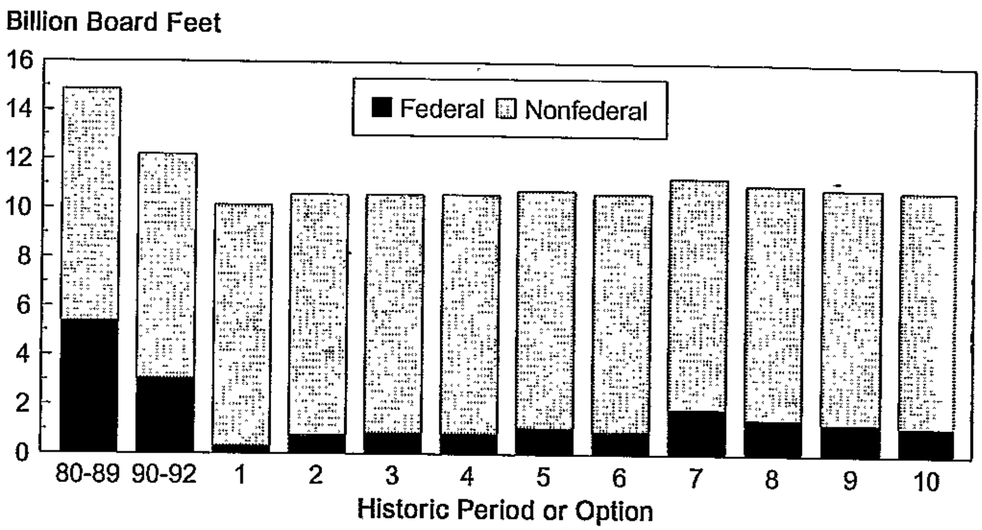


Figure II-18. Historic average and first decade's projected annual average wood volume processed in the impact region from all owners by option.

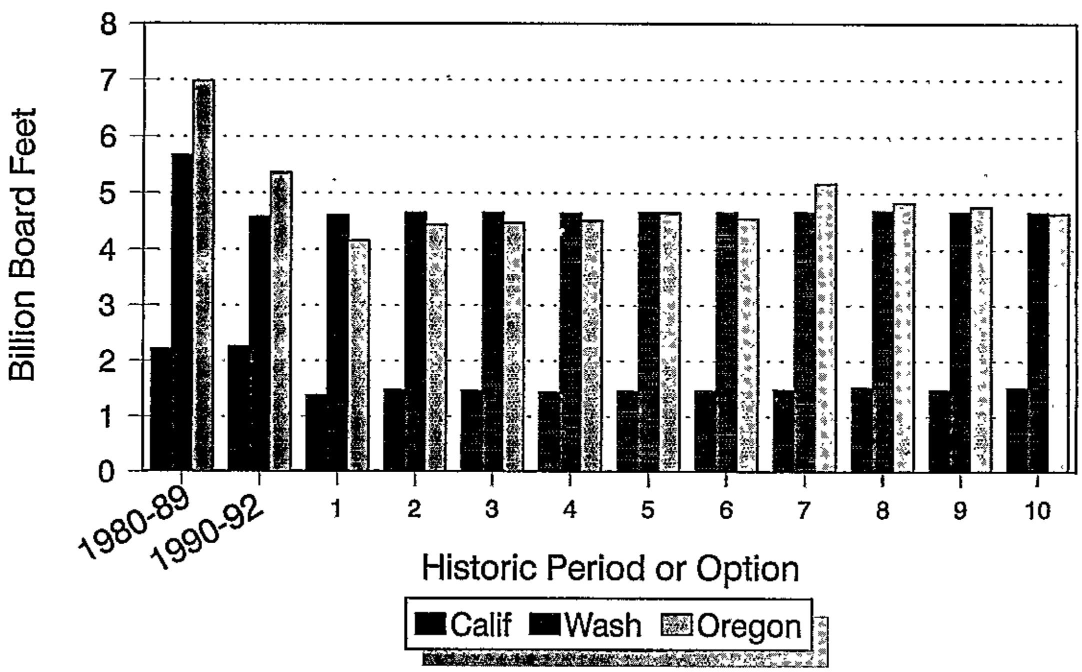


Figure II-19. Historic and first decade projected annual average volume processed for all ownerships in the impact region by state and option - totals.

Export Levels

Traditionally, regional log exports accounted for 2.9 billion board feet per year in the 1980's (20 percent of total harvests). These exports represented the second highest valued product from the region, but they also represented a reduction in supply to domestic mills. The outlook for future exports is a reduction in quantities.

Domestic competition for logs and changing quality will likely reduce historic exports by a third to a half of their level in the late 1980's (3.7 billion board feet per year in 1988-1989). Much of this decrease has already occurred since 1990, and in the absence of trade restrictions (or tax law changes) log exports will likely stay about at their current level of 2.5 billion board feet per year.

Outlook for Regional Employment

A major concern in the region is the relationship between resource management and future employment, particularly in the rural areas.

Timber-Based Employment

Timber industry employment (including self-employed individuals) was approximately 144,900 in 1990. By 1992 this level had dropped to an estimated 125,400. Employment in this industry had been as high as 152,000 as recently as 1988.

Most of the options addressed here will likely result in a further drop in employment (table II-6, fig. II-20). Option 7 maintains employment close to its 1992 level of 125,400 but at 85 percent of the 1990 level of 144,900. Options 2 through 5 reduce employment to approximately 117,000, while Option 1 reduces employment to 112,900. Options 6, 8, 9, and 10 reduce employment to approximately 118,600 to 120,900.

Job reductions are heavily concentrated (one-third) in southwestern Oregon (Coos, Curry, Douglas, Jackson, and Josephine counties) -- an area that is among the most dependent on federal timber in the region (fig. II-21).

Other Natural Resource-Based Employment

A large recreation and tourism industry exists within the region. Currently between 50,000 and 80,000 full-time equivalent jobs can be directly attributed to forest-based recreation opportunities. Tourism employment surpasses 20,000 employees in the coastal counties alone. A large portion of this employment is tied to the recreational fisheries industry.

Federal forest fishing opportunities support about 4,000 to 5,000 recreation/tourism jobs, while ocean catch of salmon supports approximately an additional 1,000 recreation/tourism jobs to the 20,000 mentioned for the coastal counties.

Commercial fisheries employment stands at 5,000 employees and is tied primarily to groundfish, crab, and shrimp (less than 10 percent is currently associated with commercial salmon catch). Future reductions are likely in the fishing industry due to concerns with these other species, particularly groundfish.

Table II-6. Historic and projected employment in timber industries in next decade, by subregion and option.

State/Region	Actual 1990	Estimated 1992	Option 1	2	3	4	5	6	7	8	9	10
	thousand jobs											
Washington - Owl Region												
Olympic Peninsula	13.9		12.0	12.1	12.1	12.0	12.1	12.0	12.0	12.0	12.1	12.0
Puget Sound	25.7		20.9	21.0	21.0	21.0	20.9	21.0	20.9	21.1	21.0	21.0
Lower Columbia	14.1		12.7	12.8	12.8	12.8	12.9	12.8	12.9	12.9	12.9	12.8
Central	4.2		4.0	4.2	4.3	4.2	4.3	4.3	4.4	4.5	4.3	4.4
Total	57.9	51.3	49.7	50.1	50.1	50.0	50.2	50.1	50.3	50.5	50.2	50.2
Oregon - Owl Region												
Northwest	21.9		20.4	20.8	20.9	21.0	21.3	21.0	22.3	21.4	21.3	21.1
West-Central	20.9		14.3	14.8	14.9	15.0	15.4	15.1	16.4	16.0	15.9	15.5
Southwest	21.4		11.0	12.3	12.5	12.6	13.1	12.8	15.7	14.2	13.9	13.2
Central	8.9		7.5	8.0	8.0	7.9	8.1	8.0	8.4	8.0	8.2	8.0
Total	73.1	62.8	53.2	56.0	56.3	56.6	57.9	56.9	62.8	59.5	59.3	57.7
California - Owl Region												
Total	13.9	11.3	10.0	10.5	10.5	10.4	10.5	10.5	10.6	10.9	10.3	10.8
All States - Owl Region												
Total	144.9	125.4	112.9	116.6	116.9	117.0	118.6	117.5	123.7	120.9	119.8	118.7

[a]Includes self employed in all solid wood products and pulp and paper sectors (SIC24 and SIC26).
Wage and salary employment is approximately 7.5 percent less than total employment.

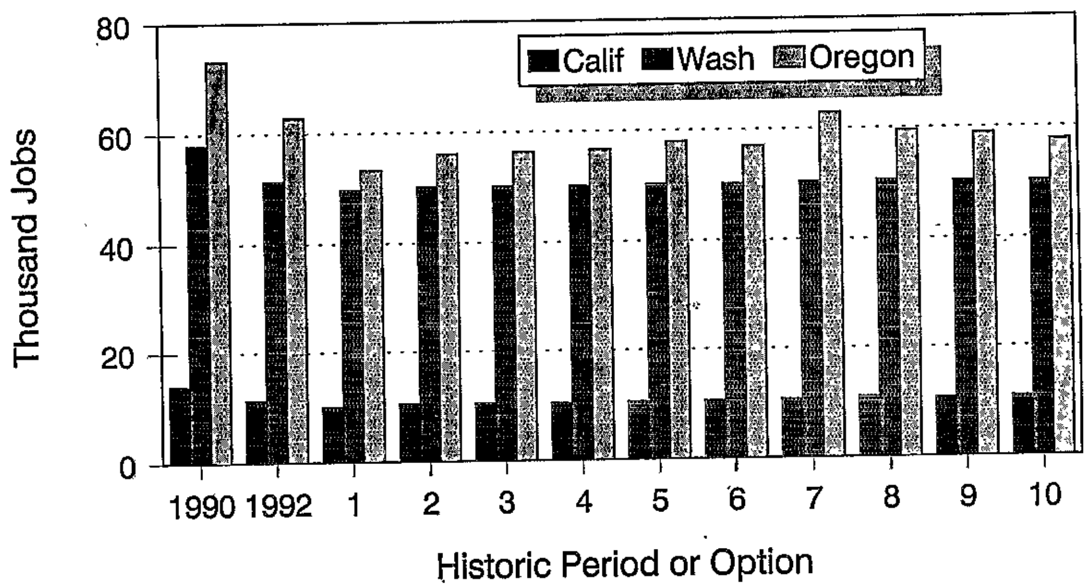


Figure II-20. Historic and first decade annual average projected timber industry employment by state and option in the impact region.

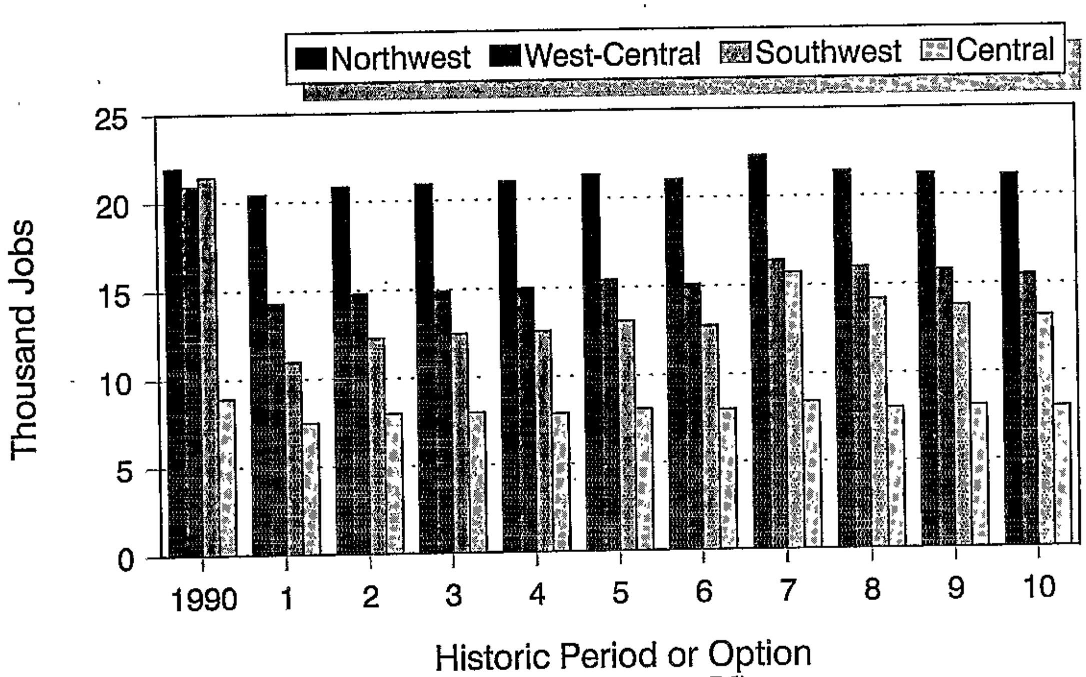


Figure II-21. Historic and projected first decade annual average timber industry employment in Oregon by sub-region and option.

Almost 30,000 individuals are engaged in the harvesting and marketing of special forest products. However, many of these jobs are part-time and seasonal in nature. Significant growth may still be possible in this sector, but detailed assessments of potential sustainable yields of special forest products are required before such growth can be calculated.

Forestry Services Sector

Timber industry job numbers do not include tree planting, timber stand improvement, or other forestry labor. The reductions in commercial forest activities in the region will likely displace many of these workers as well, if there are not changes in the level of silvicultural intensity on remaining timber acres. If such changes are made, then opportunities for more intensive silviculture, monitoring, inventory, and restoration may maintain or improve employment in this sector.

Preliminary assessments indicate the potential for up to 6,000 additional jobs in these activities. But many of these are seasonal and the costs per job may be quite high (total program costs of $250 million to $300 million). In addition, startup time of at least 1 year is likely to be required for conducting assessments for designing needed projects. The near-term needs will thus be for highly trained resource professionals as opposed to traditional woods labor. Many of the options assessed by this Team, however, require the restoration and monitoring activities as critical components.

Overall Economic Outlook

In a static view of the Pacific Northwest economy, every job in the forest sector supports approximately one job in other sectors of the economy (induced and indirect effects). Thus, in a static sense, job impacts may be double the level suggested by direct jobs alone.

In a dynamic view of the economy, other industries are growing and/or entering the region and may render many of the indirect and induced effects equivalent to lost opportunities as opposed to actual job losses. The proportions of indirect and induced effects that are actual job losses are hard to deduce.

State-level forecasts for Washington and Oregon do indicate that the aggregate economy will continue to grow, regardless of which of the federal forest management options is selected. Between 1992 and 1995 aggregate employment in Oregon and Washington is anticipated to expand by 4 to 4.5 percent (total, as opposed to annual). Washington's outlook is rather stable, while the Oregon economy is viewed as poised for 7.4 to 8.7 percent aggregate growth between 1992 and 1995. Much of the growth is apt to be in the metropolitan areas, and job gainers may not be the same individuals as job losers.

Outlook for Government Revenues

Large-scale reductions will occur in federal receipts and the shares to local governments. Without legislation that mitigates these losses, local government shares in revenues are anticipated to decline by $147 million to $277 million from the 1990-1992 level of $294 million (depending upon the option) (fig. II-22).

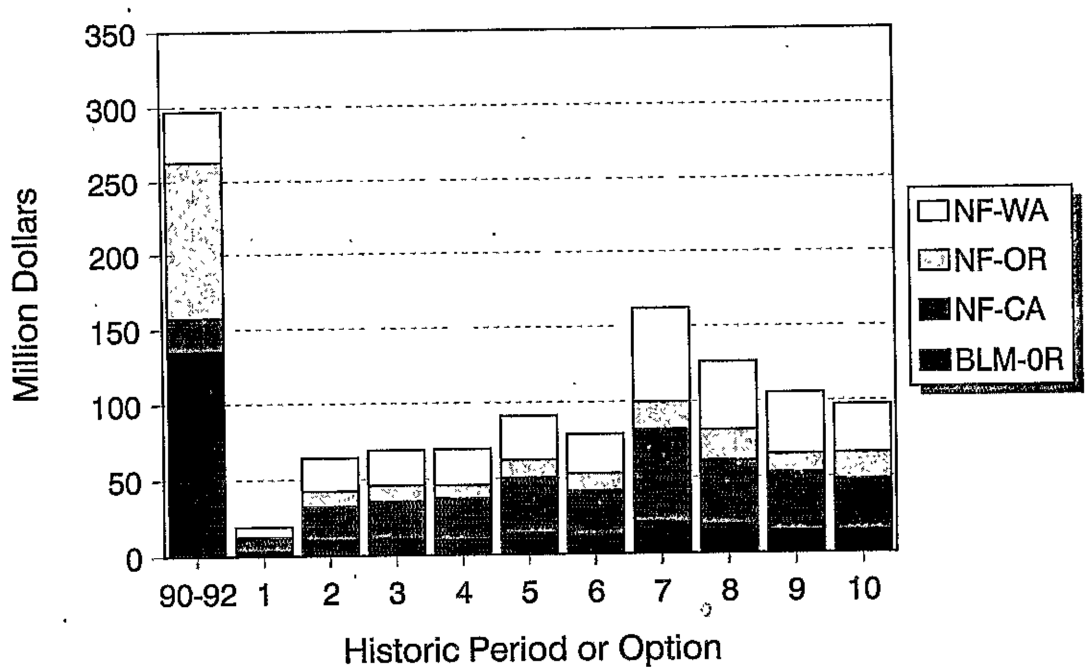


Figure II-22. Historic and projected timber payments to counties by state and option.

The reductions would largely impact county governments and county road funds, due to the nature of the distribution formula. Studies from western Oregon show that county governments derived 23 percent of their funds from timber receipts in 1988, while schools derived 2 percent of their funds from timber receipts. Because schools represent the vast majority of local government expenditures, the sum total of local government tax base reliance was 7 percent.

Southwestern Oregon counties would be the most impacted -- largely due to the large reductions in Oregon and California Railroad lands receipts. In addition, these counties have historically been the most timber reliant with 55 percent of county funds, 4 percent of school funds, and 20 percent of aggregate local government funds being derived from federal timber receipts in 1988. Studies for Washington and California are still in process.

Outlook for National Wood Products Markets

Several concerns relate to the future of U.S. forest products markets, especially about where future U.S. wood will come from and what will happen to consumer prices.

Regional Harvest Levels

Southern United States timber production will continue to increase, and southern producers are a benefactor of changes in the Pacific Northwest. The Pacific Coast harvest reductions coupled with southern expansion will lead to the Pacific Coast

States' share of softwood timber harvests falling from the 1990 level of 38 percent to 26 percent of the U.S. total by the year 2000.

International Trade

The United States has been and will continue to be a net importer of forest products, primarily Canadian lumber. Wood product imports into the United States are apt to show only modest changes in the decades ahead. Some moderate increases are anticipated from Canada, but no other large changes are expected in the United States' importation of wood products.

Consumer Costs

The production from other regions (domestic and international) and from regional nonfederal timber sources buffers the U.S. consumer somewhat from the changes in the Pacific Northwest federal timber management. Some increase in consumer cost is anticipated from reducing federal supplies and increasing consumer demands, but most of the anticipated increase already occurred between 1990 and 1992 when prices increased 20 percent (in real terms). The large price spike experienced in the early part of 1993 has subsided, and prices within a few percent of 1992 prices are apt to persist through the decade ahead under all options considered (fig. II-23). No perceptible differences exist among the options on the average cost of United States homes.

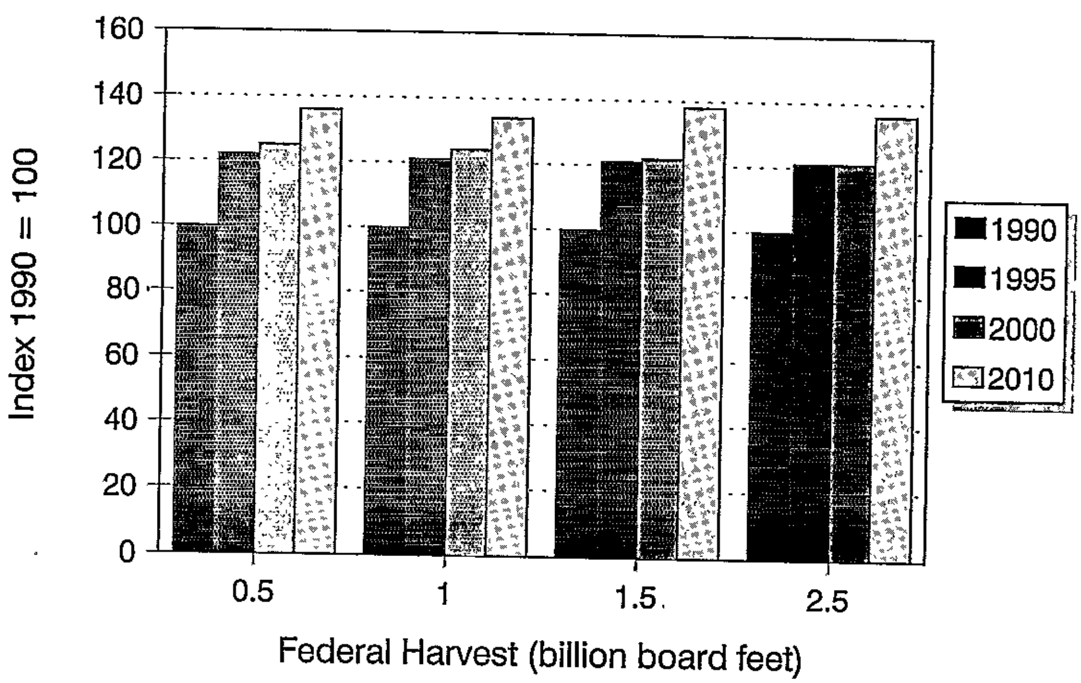


Figure II-23. Projected softwood lumber price index under various federal forest harvest levels in the owl region (United States Dollars).

Additional Policy Considerations

Changing federal timber management will reduce wood quantity and quality in the region and place pressure upon the timber industry and the communities of the region. Wood quality available for milling will decline with the declining amount of fine-grained old-growth trees available to the market.

Timber Industry Considerations

Forest products will continue to be a major economic factor in the region. The combined federal and nonfederal harvests will still support employment of over 112,900 individuals in the region. Many questions, however, arise as to how to strengthen the operating position of the remaining industry.

Log supplies to mills will continue to be a concern in the region. These supplies may be increased by (1) more aggressively pursuing fiber supplies on nonindustrial private lands, (2) redirecting currently exported logs, and (3) increasing the importation of wood products that are suitable for further manufacturing.

Market forces will promote much of the incentive for active management of nonindustrial private lands, but in addition some education and training is required, and many landowners will still be hesitant to make long-term investments in timber. Increased management of the nonindustrial private lands could thus be further promoted through more active public service forestry, encouragement of industrial/nonindustrial partnerships through cooperative forest management programs, and increased public assistance either through current cost-share programs or forest trust programs such as that being proposed in Oregon. Currently, the infrastructure is not in place in the region for mobilizing this valuable nonindustrial private resource. Hastening the establishment of this infrastructure should pay benefits to the region in terms of short-term and long-term timber supply and near-term jobs. In the near-term, more than 100 million board feet per year could be realized through rehabilitation of poorly stocked lands.

Export restrictions would likely expand the volume of timber available for domestic processing, but the effects of bans may be less than expected. A ban on log exports would reduce stumpage prices in the log-exporting regions, and would result in less incentive to harvest. Thus, not all the volume of log exports would be realized as volume flowing into domestic mills. Most discussions of the bans ignore quality and geographic differences between the log export and domestic log markets. Much of the log export activity originates in Washington, yet some of the more impacted regions are in southern Oregon and northern California. Finally, there is apt to be a substitution of mill jobs for longshore jobs (in an already troubled coastal economy), and the net effect upon jobs is uncertain.

Sliding-scale tariffs in Japan serve to provide strong, effective rates of protection for Japanese wood products manufacturers and provide additional impetus for exporting lesser-manufactured products. These tariffs inhibit the ability of U.S. wood products manufacturers (particularly high value added manufacturers) to compete within the Japanese markets. A re-assessment of barriers to trade in the Pacific Rim countries may aid in increasing the vitality of the region's producers and redirecting the flow of raw materials.

Wood products imports are becoming increasingly important to wood products manufacturers in the region -- particularly secondary wood products manufacturers. Attempts should be made to investigate how the region's Pacific Rim location can be exploited on an import basis. Logs, lumber, and cutstock from New Zealand, Australia, Chile, and other Pacific Rim countries are valuable raw materials to the mills in the region. Policies that could channel more of these materials into this distressed region for further manufacturing would serve to buffer impacts from domestic harvest reductions.

Technology could also help to extend the utilization of raw material in the mills and create new forms of products that are less old-growth dependent. New generation composite wood products include a variety of structural and nonstructural wood products that can be made from smaller trees and combinations of lumber, veneer, particles, fibers, and plastics. The region has not moved aggressively into adoption of these composite technologies partly because of the uncertainty over the timber supply outlook.

Such product technologies require substantial capital investment. Overcoming the barriers to capital markets in this time of great uncertainty in the region is of great importance. Many of the composite products can serve as inputs to secondary wood products firms and assist in the difficult transitions that these industries must make.

Currently, a large secondary wood products industry exists in the region (over 25,000 employees). Many people are looking to secondary manufacturing of wood products as a source of "mitigating" employment opportunities, yet many existing manufacturers are at risk because, in addition to wood quantity changing, wood quality will as well. The secondary manufacturers of the region have focused on the production of high quality molding and millwork for door and window components. This industry will see a large change and restructuring in the years ahead.

The industry will be seeing greater proportions of construction grades of lumber and less of the type of lumber suitable for the current types of secondary manufacturing. A key to increasing the use of construction grades of wood products is increasing the adoption of manufactured housing and panelized housing. These technologies substitute factory labor for site-based construction labor. The technologies may result in lower wood use per house and may be more economical, particularly as wood prices rise. But the adoption of panelized housing and alternatives to conventional U.S. frame ("stick") housing is slowed by building codes, contractor knowledge, and tradition. Intensive public education programs along with research and development in the area of alternative building technologies could pay long-term dividends to the region and the utilization of forest resources.

One place to start public education would be with smaller manufacturers in the region. Industrial extension activities carried out by the region's universities and community colleges could augment technology transfer to these small manufacturers and provide some impetus for growth and diversification in the forest products sector. Manufacturing technology centers could speed the development and implementation of new technologies that could simultaneously increase raw material recovery and business success. Establishment and promotion of manufacturing and marketing networks provide synergism among the region's various forest products firms.

Recreation and Tourism Considerations

Policies that provide more recreation opportunities that are deemed in short-supply could bolster the region's tourism. This primarily means offering more opportunities for primitive and semiprimitive nonmotorized activities. Retirement of road systems within some Key Watersheds as part of watershed restoration activities could thus provide side benefits for recreation and tourism.

Because currently we fail to fully charge for recreational use of the forest, we tend to understate the value of recreation outputs. Recreation fees, while contentious with much of the public, could provide a source of replacement revenues to the agencies and the local governments. Traditionally, much of the recreation improvement had been funded out of timber receipts. With declining receipts, charges may be required to guarantee a continual offering of public recreation opportunities.

Commercial Fisheries Considerations

A key concern in the commercial fishing industry is the failure to institute adequate limits on the offshore catch and processing of Pacific whiting. The potential job losses to the coastal communities from this resource "drain" are apt to be substantial. While this is not a policy directly related to the management issues at hand, it is a confounding factor in the coastal communities that will be simultaneously impacted by the changes in federal forest management.

Special Forest Products Considerations

This is a rapidly expanding industry in the region. To adequately capture the economic value of products such as mushrooms, boughs and ferns, and to guarantee that the inherent productivity of the resources is not adversely impacted by harvesting of timber, the agencies will need to take a more active role. Standards and guidelines for harvesting special products could be established, and appropriate fee structures could be investigated. Once sustainable supplies need to be established, and then the appropriate role of these products in the region's economy can be fully considered.

Summary

The economics of the alternatives can be viewed at three scales: national, regional, and local. From a national perspective the assessment of the options indicates that the financial costs are apt to be fairly negligible when one views the aggregate markets. There are gainers and losers among the region's forest products producers, and the consumer costs appear low. The national intrinsic values placed upon the forests of the Pacific Northwest also must be considered and can serve to offset the national costs incurred.

At the regional level, the economy has been rapidly expanding for more than two decades and appears poised for continued growth. The changes in federal forest management appear to have modest impacts on this overall rate of growth in the regional economy. In the longer term, maintenance of a high quality environment may be a factor in allowing economic growth to continue in the region.

Much of this regional economic growth is apt to be centered within the more metropolitan areas of the region, and hence these statistics mask much of the hardship that individuals and communities may be confronted with in the decade ahead. Employment in the timber industries will be down 15 - 22 percent from the level of 1990, and much of this reduction will be centered in the nonmetropolitan areas. Many communities are currently distressed, as market conditions and legal circumstances have already created many of the anticipated job losses. The changes in federal forest management does represent a severe impact to many of the individuals, firms, and communities within the region. In addition to job losses, disruptions in local government funding are inevitable without compensating legislation. These local economic costs are real and represent a major policy issue in the region.

Overview: Social Assessment of the Options

Not all is well in the forests and communities of the Pacific Northwest.

On April 2, 1993, President Clinton held a Forest Conference in Portland, Oregon. At this Conference, speaker after speaker talked of how in many forest-dependent rural communities, unemployment is high, hope is low, and despair common. People, living in communities long dependent on the forests near them, are reeling under the effects of the changes that are sweeping across the region. As Robert Lee explained to the President at the Forest Conference:

> *We're moving into a process which looks an awful lot like what happened to the inner city. We're seeing the collapse of families, disintegration of families, disintegration of communities, loss of morale, homelessness, stranded elderly people, people whose lives are in disarray because of substance abuse; it's a very difficult situation.*

As Chuck Meslow said to President Clinton:

> *At the time of settlement...the Northwest was blanketed with forests...perhaps 60 to 70 percent was old growth...over 200 years old. Those stands are mostly gone now. Essentially all old forest has been cut on the private lands....on national forest or BLM lands [only] 10 to perhaps...50 percent [remains and]...what remains has been highly fragmented.*

It is the clash of values, institutions, organizations, and policy commitments that define this complex policy issue. To break the gridlock of inaction will require moving beyond the politics of division. One wonders -- in a country with our wealth, ingenuity, resources, and capacity -- how could this have happened?

The Purpose of the Social Assessment

The purpose of the social assessment is to provide policy makers with an understanding of how potential policy options might affect constituents and stakeholders and an analysis of potential effects on important social values and activities. Our instructions directed that both economic and social consequences, costs and benefits be assessed, and thus social and economic assessments should be jointly considered. In addition to analyzing the consequences of changes in federal forest policy across the options, we suggest strategies for dealing with expected consequences as well as unanticipated ones. We also identify opportunities for collaboration among resource management agencies and citizens, and opportunities for rural citizens to participate in self-assessments leading to effective new strategies for sustaining rural forest communities. As part of our evaluation, we examine the limits of current research and education and suggest ways to enhance both. In sum, our social assessment covers a wide range of the elements related to the questions and concerns associated with the development of policy options for a conservation and management plan for the federal lands in the Pacific Northwest within the range of the northern spotted owl.

Forest Values in Conflict

All forest values represent social valuations of the worth and importance of aspects of the forest. The paradox is that **those social values for which our ability to define and measure is poorest, are the very ones that appear to be of increasing importance in our society.** For example, the value of old growth as a source of timber can be established in the marketplace; the high quality, clear grade lumber it provides commands premium monetary returns. When other values of old growth, such as the repository of scientific knowledge about forest ecosystems or for the spiritual rejuvenation it brings us, are recognized, it is possible to move beyond the market place and easy ways to express, much less measure, these important social values.

A key point -- this conflict in values is not a new problem, there is no technical solution, and current institutional arrangements sustain it. A forest's value is what society perceives it to be; hence, as social values change so do the meaning and value of forests. To successfully develop and implement a conservation and management plan for the federal lands in the Pacific Northwest, it must be recognized that forest management is inherently a political process. Science and analysis can clarify the tradeoffs of alternative policy options but cannot make choices. Current institutional structures often impede our ability to resolve forest management conflicts. An enhanced organizational capacity to respond to changing social, economic, and political conditions is essential to avoiding gridlock. Trust must be recreated. Agencies that act with openness and honesty, in ways that meet the letter and spirit of the law, and that enter into collaborative decisionmaking with citizens are an essential part in moving toward trustworthy institutions.

Effects of the Options on Rural Communities

Forest-based communities in the region are more complex than previous analyses suggest. Rural communities, rather than a unitary homogeneous phenomena, are highly differentiated, composed of a variety of groups, each with different needs, often within the same geographic locality. Understanding effects from federal timber harvest policy requires knowledge about details of the local situation in terms of community demography and infrastructure, the age class and spatial distribution of forests on proposed Matrix lands, and the capacity or age of local mills. Changes in federal forest management must be seen in the context of a variety of factors such as management of other public, industrial, and holdings of nonindustrial private forest lands, technological changes in wood processing, and the dynamics of international trade.

Workshops involving rural community experts revealed a range of possible effects flowing from changes in federal forest policy. These include the degree to which forest management influences the ability of local residents to have their needs and expectations satisfied by community conditions and opportunities; effects on basic income and sustenance needs; the relative adequacy of facilities, services, and infrastructure (both public and private sector); the needs for association, affiliation, and social integration (e.g., the presence of an array of organizations and institutions for expression of interests, provision of emotional support), and employment and income generation opportunities.

Most negative community effects will be concentrated in rural areas, but some urban areas also will be affected, notably those with substantial forest products employment. Communities dependent upon recreation, amenity, or other environmental quality resources may be positively affected by the proposed changes in federal forest management.

Community Consequences Vary

Consequences are the outcomes -- positive, negative, or mixed -- that result from forest management policies.

Experts on rural communities reported different levels of consequences from the options for each state (figs. II-24-27) (see chapter VII). On the basis of expert ratings from two workshops, the negative effects of federal harvest reductions appear to be most dramatic at the state level in Washington. The effects for Oregon communities, although significant, appear most variable across the options. The outlook for the California communities assessed is not much more optimistic, but not particularly as a result of federal land management. Experts from California indicated that communities surrounded by federal lands, which were typically smaller and in isolated mountainous areas, were likely to have more negative consequences regardless of option.

Groups Within Communities are Affected Differently by Options

In addition to impacts at the community level, groups within communities can be affected differently. If one focuses on groups and individuals most negatively affected, it is apparent that, even in communities near urban centers, some occupational groups and their families will feel serious impacts.

Groups within communities vary in their ability, willingness or both to respond to economic shifts. What might seem like rational adaptation from one perspective might be "out of the question" for others. Social mitigation strategies can backfire if not sensitive to differences among community groups; such strategies might even increase conflicts and frustrations on the part of groups "left behind." These conflicts pose serious questions about the ability of groups in the region to work together to solve common problems.

Community Capacity

Community capacity involves the ability of residents and community institutions, organizations, and leadership to meet local needs and expectations. Community capacity is related to structural and locational characteristics and varies in reasonably predictable

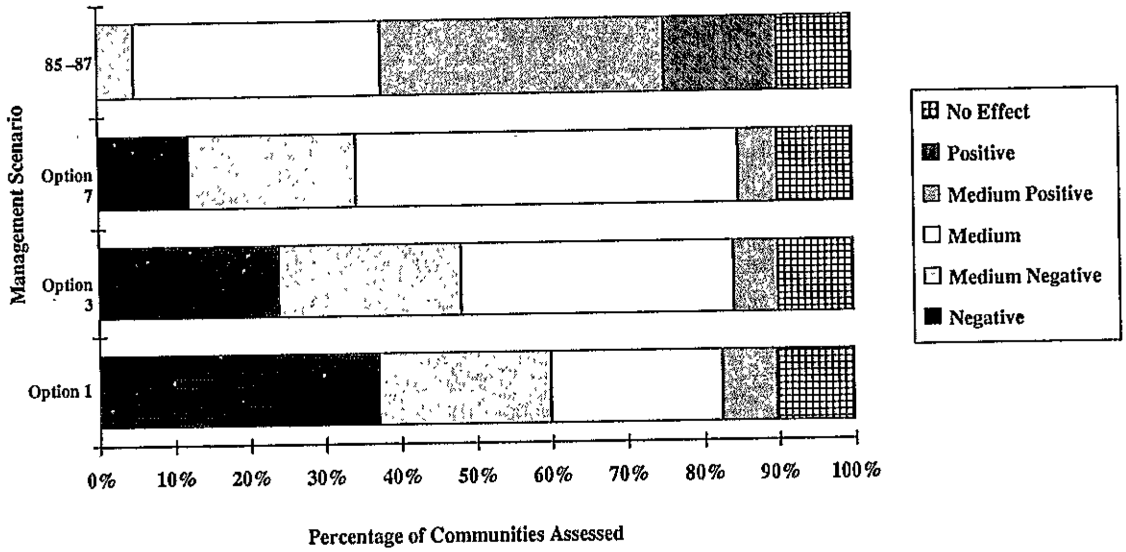


Figure II-24. Predicted Consequences of Four federal Land Management Scenarios on Communities in Northern California, Oregon and Washington.

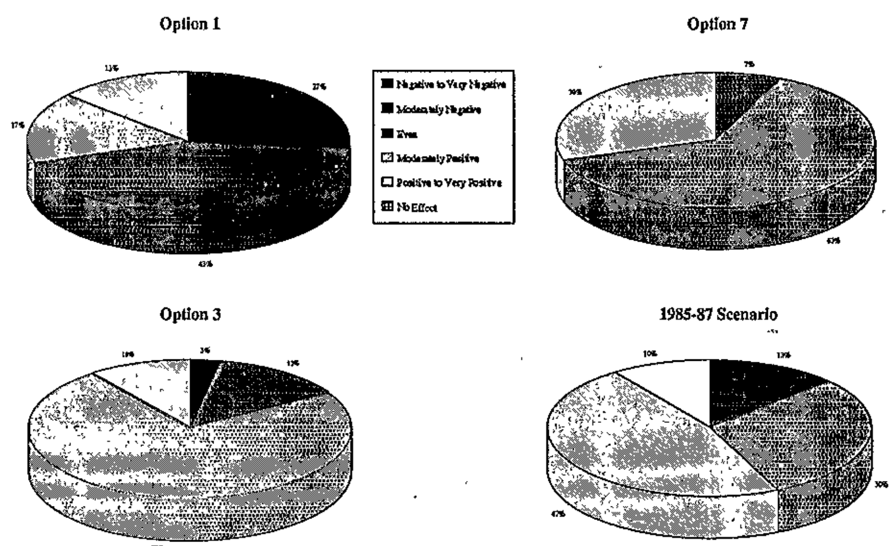


Figure II-25. Consequences of Options 1, 3, 7 and the 1985-87 scenario for the state of California.

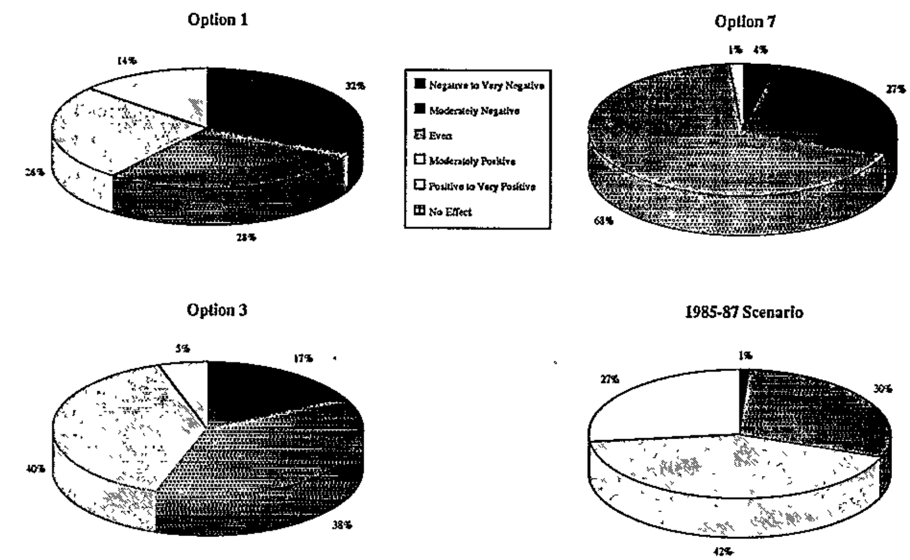


Figure II-26. Consequences of Options 1 ,3, 7 and the 1985-87 scenario for the state of Oregon.

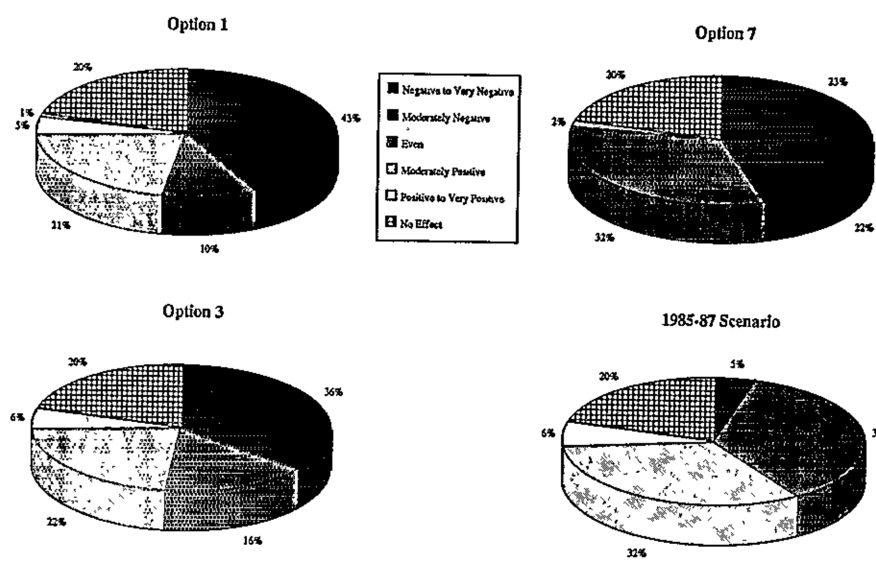


Figure II-27. Consequences of Options 1, 3 , 7 and the 1985-87 scenario for the state of Washington patterns. Those communities with the best access to transportation, markets, and raw materials, and that have the greatest economic diversification tend, on balance, to have the greatest capacity. Community capacity is also related to the quality of community leadership (e.g., energetic, active, inclusive, well connected with community assistance). Such leadership varies widely across communities and suffers in communities with divisive politics.

High capacity communities are judged to be less sensitive to variation in consequences across the options. Many coastal communities in all three states are likely to have higher capacities and more positive consequences. Many of these communities have more developed tourist industries and often more diversified economies.

Community capacity varies little across the three-state region (fig. II-28). It does, however, vary considerably within subregions of Oregon and Washington (northern California is one subregion).

Policies that focus on improving community capacity cannot be conceived as quick fixes because considerable time is required for people to develop trust needed for cooperative action and skills for new activities. Community capacity can be enhanced by interventions such as sustained technical assistance, leadership training, improved access to capital, and increased genuine involvement in forest planning and management.

Consequence ratings for the options for high capacity communities tend to be close to the mid-point of the scale (even mix of effects) and ratings for each option are close to one another, while ratings for low capacity communities tend to be concentrated more toward the negative end of the consequences scale (see fig. II-29). Consequence ratings for low capacity communities also vary among options, reinforcing the notion of these communities' greater reliance on federal timber.

Communities at Risk

The decision as to how to define "acceptable risk" is ultimately a political decision. Perceptions of what constitutes acceptable risk will differ among different stakeholders. Because of these variable conceptions among constituents, any judgment as to what will be considered acceptable risk must involve negotiations among all relevant stakeholders, with scientists and technical experts playing the role of advisors.

To assist policymakers and others concerned with risk, we have defined those communities with low capacity and facing negative consequences from the management options (see the shaded area of table II-5) as "most at risk" communities. Under Option 1, one-third of the communities assessed fell into the category of "most at risk." With Option 3, the total fell to 27 percent, and to 22 percent with Option 7.

Not surprisingly, the communities "most at risk" in Options 1, 3, and 7 appear to be those highly dependent on the timber industry. We judge that few of these communities (only 3 percent of all assessed communities) would experience negative consequences with the 1985-1987 forest management scenario (this period was selected as representing a mid-point of federal timber sale levels over the period 1980-1992). Obviously, though, these levels of harvest are not sustainable from public lands under present circumstances of law. Options 1, 3, and 7 likely would lead to additional mill

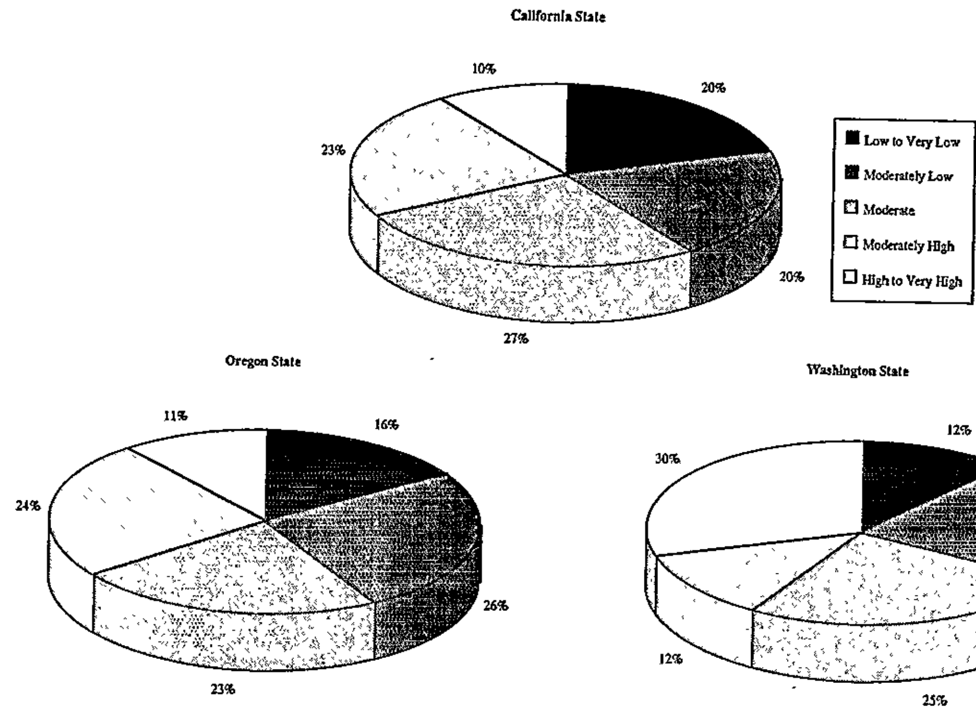


Figure II-28. Community capacity in the states of California, Oregon and Washington.

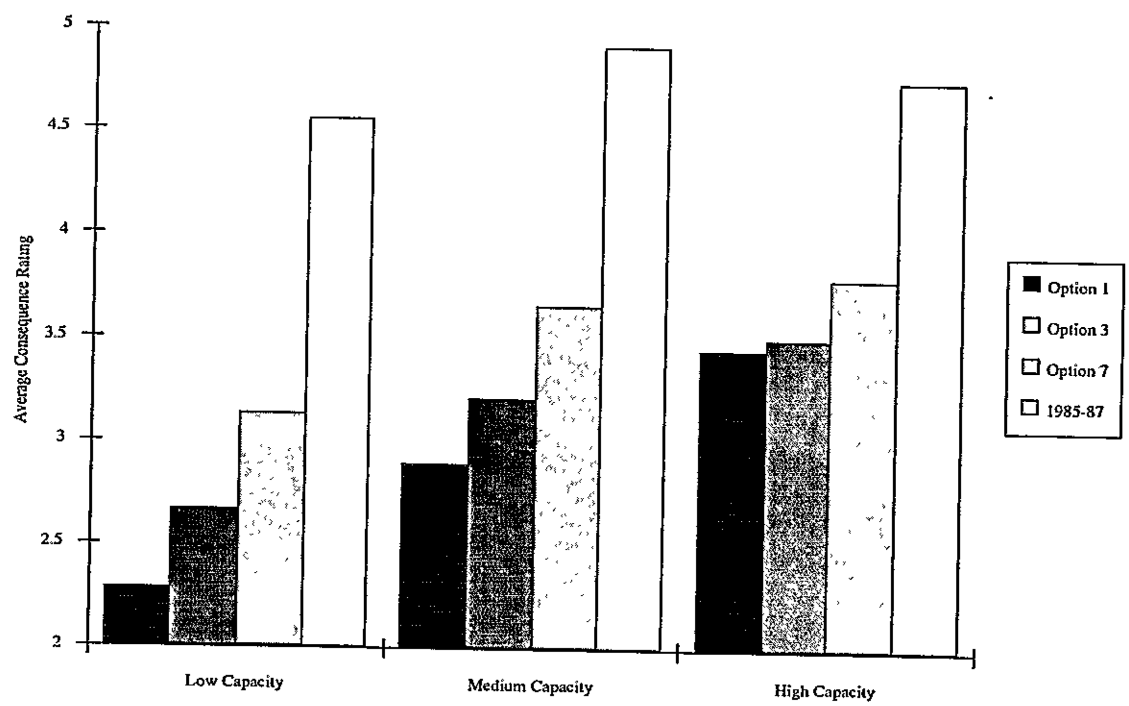


Figure II-29. Consequence ratings by option by capacity category.

closures and reduced employment from present levels in the forests, and the economic and social infrastructure in these communities would suffer.

As an alternative, "most at risk" communities can be defined as those with medium to very low capacity and even to very negative consequences. With this definition, the proportion of communities defined as "most at risk" increases dramatically (noted the dotted line on table II-5); for example, nearly 60 percent of the communities under Option 1 would be so defined.

Some experts in the workshops stated that isolated communities were more likely to experience negative consequences with Options 1, 3, and to a lesser degree Option 7, because they had few options available locally or in nearby communities and because of limited access to capital and other resources.

Communities that are small, isolated, lack economic diversity, are dependent upon public harvests, and have low leadership capacity are more likely to be "most at risk" than others. These communities are less able to mobilize and respond to changing conditions that may affect a variety of social groups. These communities are likely to suffer unemployment, increased poverty, and social disruption.

Factors other than those associated with the options place these particular communities at risk. Their very structure and location are part of the equation. Policy responses to assist these communities should go beyond timber and jobs. Policies that address limited structural diversity, lack of infrastructure, and coping strategies will be potentially helpful to these communities.

Risk labels can be a double-edged sword. The perception of risk can mobilize individuals and community leadership into action (e.g., woods products workers may start a small business in anticipation of layoffs and their children may show increased motivation for education; groups may respond with economic development efforts or participate more actively in influencing forest management policy decisions). However, the label of "being at risk" can also paralyze and demoralize community members, increase social disruption, and create indirect impacts on communities (e.g., red-lining of communities by banks).

Although poverty in rural forest dependent communities has increased over the past decade for numerous reasons, the current and lengthy gridlock is adding to poverty levels. The increase appears related to a variety of factors that vary by state; in Washington, it appears more directly linked to changes in federal forest management than in California.

Transition in Rural Communities

Some negative consequences can be explained by economic shifts already under way. For example, globalization of the economy and replacement of labor by technology in mills and factories is having a profound effect on the economic well-being of many rural communities.

Even communities undergoing positive economic and social transitions from reductions in federal timber harvests may have only limited options. As these communities make the transition from a commodity-based economy, issues related to economic diversity and isolation may persist. Growth in any one sector -- be it tourism, health care, agriculture, or light industry -- is not a panacea for all timber-based communities.

Although small communities are noted for their internal ties among community members, they are increasingly linked in significant ways with outside organizations and interests. In the Pacific Northwest, the most significant linkages are federal land management agencies, state fiscal and institutional support services, and private industry headquartered outside the community. Local residents feel that outside support efforts often lack clear goals and integration (e.g., federal retraining programs, state jobs programs, and county jobs corps). Many programs "from above" are perceived as demeaning.

Periods of transition do not always result in severe social disruption, and in many instances, disruptive consequences of instability and rapid change are temporary. However, the circumstances associated with possible changes in management of old-growth forests substantially alter the nature and pace of transitions confronting some rural communities. A decision to reduce timber harvest from federal lands would not only accelerate a downturn in some communities, but might cause a permanent rather than transitory shift in social and economic contexts.

Certainty about harvest levels has never been achieved in the past, nor is it likely to be achieved in the future. Nothing in the options proposed by the Forest Ecosystem Management Assessment Team addresses management of other public and private forest lands. This implies that a measure of harvest uncertainty will persist even if predictability on federal lands is possible. In addition, ecosystem management is a new approach, and we must be cautious when predicting future harvest levels.

Implications for Community Policy

The plight of many rural Pacific Northwest communities is a serious concern. At the root of the problem lies the inability of many communities to respond adequately in the face of significant and rapid changes that characterize forest management.

In our discussions with community experts, a number of key policy issues were raised. We discuss several here. They are elaborated in the chapter Social Assessment of Options.

1. Communities desire stability, predictability, and certainty. Attempts on the part of communities to cope with change are greatly constrained by the recent high levels of uncertainty.

2. Communities need an improved, stable tax base to support basic infrastructure such as schools, social services, and transportation.

3. Communities feel they are not a part of decisions that affect their well-being; they want agencies to be more responsive to their concerns.

4. Some communities feel themselves and their culture under siege from a hostile urban world that neither understands nor cares about them.

5. Additional family and individual stresses result from job loss, declining incomes, and other economic factors.

6. Rural communities often feel at the short end of larger economic and social changes over which they have little or no control.

From these broad policy concerns, we can derive a number of specific strategies and programs.

1. Land management resource policies urgently need to be predictable, unified, and realistic in both the short and long term. This will help reduce uncertainty under which communities find themselves today and will improve their ability to work with managing agencies.

2. Means must be found by which local communities can expand their capacity to help themselves.

3. The need to increase the role of the community in decisionmaking, includes, but is not limited to, the application of local skills and knowledge in the implementation of forest management plans and watershed restoration.

4. Collaborative relations are needed among governmental levels and agencies and between government and citizens.

5. Individuals and communities need to use existing network of programs and expertise at local, state, and federal levels.

6. It is important to distinguish between short- and long-term needs. Short-term responses are designed to mitigate immediate community impacts of harvest reductions, and long-term responses are designed to enhance the communities' capacity so they are less vulnerable to any single external event.

7. Assembling appropriate and comparable information would aid communities, states, and the federal government to develop, implement, and monitor problem-solving programs.

8. Job retraining is the focus of much interest. Community experts confirm its importance but also identified the limitations of retraining. Although it can mitigate some impacts, retraining may also increase others if designed and implemented without adequate attention to broader community issues and individual needs.

Selection of an option should be viewed as a starting point for the involvement of communities in discussions of forest management, not decisions to be imposed from above. As Louise Fortmann noted at the Forest Conference:

> *"We need healthy forest communities ... that can take responsibility for successfully solving their own problems ... we need locally based planning processes that enable local people to develop and implement diverse policy options ... and we need state and federal policies that will facilitate these local processes."*

Under all of the options, involvement of communities and interest groups will come primarily during the implementation phase of the process. This will begin with the opportunity to comment on the draft environmental impact statement that will be issued with an identified preferred alternative. Community involvement should be expected to come most effectively to bear during the implementation phase of reinstituted forest and district planning (i.e., Phase II Planning).

Effects of the Options on Native American Peoples and Culture

Indian tribes and groups are governments and communities that are affected by natural resource policy. Federally recognized tribes possess legal status, and in Washington and Oregon they also possess off-reservation rights held in trust by the U.S. government. Treaty rights have been interpreted to have precedence over subsequent resource uses and must be accommodated by agencies.

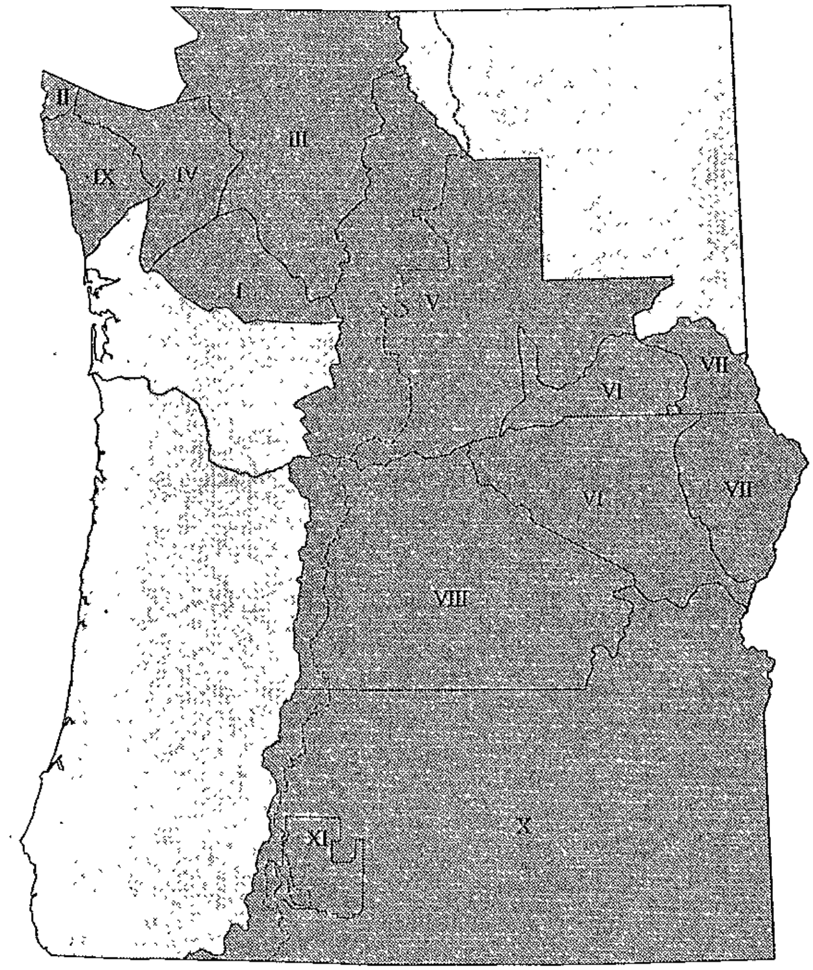
The 25 federally recognized tribes in California and the 36 tribes within Oregon and Washington have cultural interest or have reserved treaty rights within the area of study (fig. II-30). Of these tribes, 25 have treaties and 10 have Executive Orders that affirm certain rights -- both on and off reservations -- for water, gathering, hunting, fishing, and other activities and resources.

Access to and use of certain plants (e.g., sedges, cedar), animals (e.g., deer, eagles), and locations (e.g., fishing locations) are vital to the cultural survival of a number of Indian tribes and communities. Plants provide food, medicines, and materials for utilitarian and ceremonial items. Certain plants are essential for items that play key roles in renewal of the earth, becoming an adult in society, and are ultimately critical for "being Indian."

Because individual tribes were not represented in the Forest Ecosystem Management Assessment operations, and information available from the agencies is inadequate, it is difficult to determine all ways tribal concerns may be affected by federal forest policy and practices. Comments from the affected tribes should be solicited during the environmental impact statement review process.

Mixed impacts are associated with various tribes and groups. Oregon and Washington tribes probably would find Option 1 beneficial, but the Hoopa Tribe might drop a proposed land exchange with the Six Rivers National Forest under either Option 1 or 3. Tribal members have come to depend on public lands and resources for employment, subsistence, and cultural identity. Restrictions on access and harvesting in Reserves could constrain Native American access to forest materials used to support traditional practices and subsistence activities and to harvest of timber as an employment opportunity. Reduced access in Reserves might, however, help ensure greater privacy to engage in spiritual and cultural practices.

The implementation of standards and guidelines -- the specific rules that govern management within different management areas in the forests -- have the potential to either constrain or facilitate many of the practices and activities undertaken by Native Americans. For example, standards and guidelines that prohibit or discourage the collection of certain plant materials could affect tribal rights and cultural subsistence practices. Habitat protection measures, such as controls on use of fire, could also have



I MEDICINE CREEK TREATY
II MAKAH TREATY
III POINT ELLIOT TREATY
IV POINT NO POINT TREATY
V YAKIMA TREATY
VI WALLA WALLA, CAYUSE TREATY
VII NEZ PERCE TREATY
VIII MIDDLE OREGON TREATY
IX QUINAULT TREATY
X KLAMATH TREATY
XI FORMER KLAMATH RESERVATION

Spotted Owl Range Line

June 1993 14041204

Figure II-30. Treaty boundaries for Oregon and Washington.

substantial effects if these controls occur within traditional gathering areas (e.g., for grasses) that need to be burned. Prohibitions on removal of Port Orford cedar in old growth on the Klamath National Forest would adversely affect Karuk Tribe members engaged in "rites of passage" ceremonies.

As with many rural residents (tribal and nontribal), there was concern with constraints imposed on timber harvesting in all options; specific areas that the Karuk and Klamath Tribes have requested be managed for "full yield" would be located in Reserves in both Options 1 and 3, and there generally appears to be little difference in consequences associated with Options 1 and 3.

Effects of the Options on Recreation, Scenery, Amenities, and Subsistence

Recreation, scenic, and related amenity values of forests have been central to both the popularity of forests and the concern expressed in public involvement. Indeed, it was the burgeoning recreational use on National Forests and other public lands in the 1950's that foreshadowed much of the public awareness and concern regarding forest management that arose in the 1960's. Subsistence activities on forest lands embrace many levels of effort, ranging from casual collection of firewood to significant economic enterprises such as harvesting mushrooms, floral materials, and other forest products. Collectively, these activities represent a major source of values that people derive from forests.

Recreation

Both the Bureau of Land Management and Forest Service have made broad recreation management allocations on lands under their jurisdiction. The allocations are based on the recreation opportunity spectrum with six basic categories: primitive, semiprimitive nonmotorized, semiprimitive motorized, roaded natural, rural, and urban.

We were particularly interested how the options would affect the current allocations of primitive and semiprimitive nonmotorized recreation. To what extent would these allocations be located in the Matrix as opposed to one of the Reserve classifications? The basis for this particular concern is that recreation-demand information, reported in both the Oregon and Washington State Comprehensive Outdoor Recreation Plans, indicates a high and increasing demand for recreation settings featuring low levels of development and management activity, with relatively low levels of use, and where motorized access is not permitted. Thus, it is clear that settings catering to these forms of recreation are especially valuable to the public. Decisions that might affect these areas by making them more accessible or subject to modification (e.g., road building, timber harvesting) need to be carefully considered in light of this information.

We examined the way in which current primitive and semiprimitive nonmotorized acres would end up in the Matrix in Options 1 and 7. As table II-6 indicates, over half of the primitive and semiprimitive nonmotorized acreage in each state will lie within the Matrix, in both Option 1 and 7; nearly two-thirds of the acreage in California and Washington would be in the Matrix in Option 1. In Washington, Option 7 actually would result in slightly less acreage being located in the Matrix than would Option 1. Although the range between Option 1 and 7 in Oregon is only 6 percent, this represents over 100,000 acres. Combined with distributional effects of the different options (which we were unable to fully capture in our analysis), the effects of the two options could be quite different.

It remains problematic as to what the implications of these effects will be because options vary significantly lending to uncertainty about how and what specific management actions will be prescribed for either the Matrix or Reserves. The fact that areas currently allocated to primitive or semiprimitive nonmotorized recreation are located in the Matrix does not automatically mean they would become roaded or otherwise developed. Conversely, the fact that they are located within a Reserve does not automatically preclude the possibility of some developmental activity. However, given the conservation objectives and species viability concerns associated with Reserves, it is likely their overlap with these types of recreation areas will result in additional protection, as well as an opportunity to provide a desired and demanded recreational setting.

Scenery

Negative effects on scenery from extensive timber harvesting are a major public concern. We examined the extent to which areas currently managed for the most natural appearance (either for retention or preservation visual quality objectives) would be located in the Matrix. The preservation visual quality objectives permits only ecological changes in the landscape; retention objectives require that management activities are not visually evident. As table II-7 indicates, over half of these visual quality objective areas would lie within the Matrix in each state in Option 1. There are not large differences among the three states. In Option 7, the percentage rises in all three states, but especially in California.

Option 1 would result in between 35 and 60 percent of the modification and maximum modification landscapes falling within Reserves as table II-8 shows. When Option 7 is considered, the figures drop sharply; only in Washington would a significant proportion of these areas be located within Reserves.

Locating areas managed for these visual quality objectives in the Reserves again does not necessarily imply that changes in the visual quality objectives would occur (e.g., from modification to retention). However, it does provide an opportunity to re-examine the objectives and to undertake steps to create a more naturally appearing landscape.

For both recreation and scenic values, the options present opportunities to meet important public concerns and interests. The provision of primitive, nonmotorized recreational opportunities and creation of more naturally appearing landscapes are consistent in many ways with conservation objectives associated with Reserves. Specific management of both the Matrix and Reserves will be guided by standards and guidelines developed for these areas. The opportunity to increase the flow of human benefits to the community that this discussion reveals should be an important influence upon the standards and guidelines.

Roadless Areas

A contentious issue in forest management is the status of roadless areas. Despite efforts to resolve the roadless question (Roadless Area Review and Evaluation I and II and land management planning), those areas where road development has yet to occur remain a major public concern. Many remaining roadless areas will be included within the Reserves in the options but are open to logging after watershed analysis in some options. However, some key areas will be in the Matrix and this will lead to public concerns about potential development and roading of these areas particularly where Riparian Reserves are concerned.

For example, on the Siskiyou National Forest, under Option 1, about 20 percent of the nearly one-quarter million acres of unroaded lands will remain outside reserved areas and within partial- or full-yield timber management areas. This includes the North and

Table II-7 Percentage of retention and preservation visual quality objective lands located in Matrix in Option 1 and 7 (by state).

	Current Acreage	*Option 1*	*Option 7*
California	1,575,770	58	79
Oregon	1,837,338	54	64
Washington	3,207,015	58	63

Table II-8 Percentage of modification and maximum modification visual quality objective lands located in the Reserves in Option 1 and 7 (by state.

	Current Acreage	*Option 1*	*Option 7*
California	2,517,272	35	13
Oregon	4,858,015	40	28
Washington	1,903,733	61	45

South Kalmiopsis and Shasta Costa, areas of regional and national debate since the early 1970's. Under Option 7, 37 percent of this roadless acreage would be outside the Reserves.

Special Forest Products

A large and expanding range of products are gathered for both commercial and personal use from the region's forests. Products include mushrooms, firewood, and floral materials such as salal and ferns. Several participants at the Forest Conference also addressed this issue, arguing that in some cases the monetary value of these alternative products exceeded that associated with timber harvesting as Louise Fortmann commented, *"Let me stress that forest dependence is not synonymous with timber dependence. There are diverse forest-based livelihoods."*

Information on which to judge effects of the options on special forest products is largely absent. The availability of special forest products might be constrained in Reserves to protect plant and animal species and habitat, although the sustainability of these products also deserves consideration. Effects would be particularly felt by commercial collectors who represent a growing cottage industry in rural communities. Migration of Asian and Hispanic populations into rural communities has increased demand for many of these products, both for commercial purposes and to support their way of life.

Barriers and Solutions to Interagency Collaboration

At the Forest Conference, President Clinton stated a vision wherein there will be "one government" focused on public service with respect to management of the federal forests. There seems wide concurrence that federal agencies are not working together, at least not as they might or should. Our workshop participants agree. We found that:

1. A strong consensus exists among participants about the nature of the problems and needed solutions.

2. This group of workshop participants showed a capacity to engage in collaborative, self-critical thinking. As Jack Ward Thomas commented to the President at the Forest Conference, "*You command incredibly talented people...they are highly skilled. They are incredibly motivated. They can do marvelous things...*" Within the organizations is a rich body of creative, energetic, and innovative people capable of bringing about significant change.

3. There is wide recognition of the need for fundamental change, and there is an appreciation that marginal changes will not suffice.

4. A rich mix of ideas and suggestions exists, ranging from the relatively simple (e.g., detailing personnel between agencies) to the fundamental and complex (e.g., consolidating agencies, drafting new legislation).

5. Ideas this group identified are consistent with many of the findings we discovered in the course of this social assessment. There is strong support for collaborative decisionmaking processes involving local communities and the full range of interests; there is concern with the inadequate databases from which critical decisions must be made; there is a recognition that the loss of trust must be overcome; there is a concern about the failure of leadership within the land management agencies.

Agency and Citizen Collaboration

Criticizing government agencies often seems to be a national sport. But there are a variety of examples of successful collaboration between land management agencies and citizens. Such efforts are characterized by motivated individuals, agency incentives, and support from agency superiors. Conversely, barriers to successful collaboration include tradition-bound superiors, lack of time, money, and energy; and lack of experience, skills, and confidence.

Various opportunities could increase the quantity and quality of interactions among agencies and citizens: (1) deal with the nonagency world honestly, effectively, and durably; (2) provide incentives to encourage innovation, creativity, and risk taking; (3) legitimize, sanction, and reward efforts to build effective linkages to the nonagency world; (4) make it easier for nonagency groups and individuals to interact with the agencies; and (5) encourage management agencies to see communities and interested citizens as equal partners in management of public lands.

Lessons Learned

Some key lessons emerged from the social assessment. Several of the more important lessons include the following:

The current situation (gridlock) is a legacy of many failures.

Fragmented land ownership patterns, unresponsive forest management policies and practices, inadequate monitoring and evaluation of the conditions of both federal and nonfederal lands, fears (often well-founded) about effects of changes on community health and stability, and lack of a shared vision about the future all contribute to gridlock. Skepticism and cynical views mean that actions will be evaluated, not slogans or labels. Observers will quickly determine if pronouncements are real, or mere window dressing for business as usual. Clarity of vision, inclusion of all potentially affected interests, and consistency of action are fundamental to successfully resolving the situation.

Information about diverse societal values is inadequate.

Our assessment was severely hampered by inadequate information. Critical knowledge was either unavailable or not in a readily useful form. We documented how ill-equipped the agencies are to deal with issues such as Native American values, recreation, scenery, special forest products, and subsistence. Information is collected and stored in different forms, even in neighboring units of the same agency. Relatively little information is readily accessible in the geographic information system. Consequently, it was not possible in an easy way to compare the options to some of the values of concern to society. How can we make informed, sensitive, responsible decisions when we lack essential information?

The negative effects of polarization of political agendas impedes effective communications, coordination, and collaboration.

Valid concerns exist on all sides of the issues at stake in the ongoing debate over natural resources in the United States. However, the shrillness of the dialogue and the vilification of people of opposing values are disturbing. Loggers, foresters, urbanites, scientists, bureaucrats, politicians, and environmentalists have all been painted as villains by each other. Such a tactic makes hollow the claim by the same people that a middle ground or common ground is needed. Processes must be developed that contribute to understanding all the values at stake regardless of who holds them. This also means examining the extent to which current institutions and agency programs and processes exacerbate, rather than alleviate, conflict and polarization. Decisionmaking processes need to fairly consider all values of concern. Failure to choose an appropriate course of action will leave the same polarized extremes at the table, making further gridlock inevitable.

Distrust is a symptom of underlying problems.

The lack of trust underlies forest management conflicts. It exists for many reasons and at a variety of levels: between agencies (regulatory versus management), within agencies (line managers versus professional staff, management versus research), between agencies and citizens, and among various citizen groups. Distrust undermines the best laid plans and often leads to restrictive laws, policies, and practices that compound rather than solve problems. One strategy to build trust is to work together to solve common problems.

Clear definition of the roles of scientists and policy makers is needed.

Social and political factors are at the root of the problems facing forest policy makers and managers. The role of science is to inform those who are in the business of making social choices. Scientists, politicians, and policy makers together need to clearly define the role of science to avoid inappropriate or incomplete solutions and further gridlock. Failure to make the roles clear might result in scientists being viewed as scapegoats for failed policy.

A clear demarcation between the roles of policy makers and scientists must be made to ensure that controversial decisions are founded upon the best and most objective knowledge available, not on how articulate advocates on both sides of the issues may be. As a nation that must make controversial decisions about natural resources, we need advocates who champion important causes and we need scientists who inform and clarify what we do and do not know. But we must know who is in what role.

Credible scientists affirm weaknesses as well as strengths in alternatives and will facilitate policy makers' and the public's understanding of the implications of choosing one management approach over another. They will not argue for a particular choice. The scientist who espouses a personal position under the mantle of objective science is not serving that process whereby decisions are made that have profound consequences for the natural resources and on the people whose livelihoods and lifestyles may be in jeopardy.

Paralysis and myopia can be avoided by looking across institutional and geographic boundaries.

The issues under consideration cannot be solved within any one institution or within the federal forests. Appropriate boundaries must account for both physical and biological resources and other considerations that society believes are important. It became clear during this assessment that a complete solution (or even an adequate understanding of the issues) cannot occur without including nonfederal lands (e.g., state, tribal, and private).

People will not support what they do not understand and cannot understand that in which they are not involved.

Many professionals bemoan the seeming lack of understanding the public has for natural resource issues. In many respects this is probably true. But professionals do not understand the public well either. The situation will change when public and agency education and involvement processes become truly participatory, with the public an active partner. Scientists, managers, and citizens all have knowledge important to understanding and resolving issues. Having mutual respect for the people who have information, and creating an environment for mutual learning, are critical for success. Not doing so will likely lead to further polarization.

The process must be open, fair, and inclusive.

We must focus on the process as well as the endpoint. For example, the process of planning is often more important than the plan itself, and the process we use to make decisions can be the key to whether the decision is understood and accepted. The success of any new approach to forest management will require development, use, and careful monitoring of an open process that fairly considers all points of view and that fosters mutual learning and adaptive management. Solutions must be founded on the principles of inclusion, leadership, and vision. Top-down social engineering, particularly targeted at the community level, is a thing of the past. Leadership -- both within the agencies and at various levels within the broader society -- is essential to breaking gridlock and finding innovative solutions.

Major Recommendations

Based on our assessment, a wide range of specific recommendations are possible. These are described in the chapter Social Assessment of Options. In this overview, we focus on recommendations central to resolving key concerns documented in the chapter.

Recognize that ecosystem management will require collaboration by all people across all forests. The President stated a vision at the Forest Conference wherein all the federal agencies would act in concert to serve the American people. Our findings validate this need. But there is more. We recommend that the federal agencies be encouraged to provide leadership by moving beyond the limits of federal jurisdictions to engage states, tribes, forest industry, and other private forest managers as equal and essential partners in discussing their relative roles in sustaining the region's forests and communities. A common vision, a shared framework for action, and an interactive process for creating both are central to successful resolution of the political gridlock. To continue to bow to those interested in delay and inaction will inevitably put our forests and communities at further risk and more people out of work.

Fundamentally change federal land management planning processes to provide the leadership for effective collaboration. Preoccupation with the technical aspects of federal land management planning processes has led to little attention to the fundamental reasons society is concerned about federal land management. Federal land and resource management plans are now inadequate in large measure due to the reluctance of the agencies to recognize the public issues that lead to the current gridlock. In our judgment, **marginal changes in the current plans are not sufficient.** There must be fundamental reform in the land management planning process. Land and resource management plans must begin from a regional perspective and place all the federal lands into a landscape of forest lands, including both urban centers and rural communities. As part of the planning process, a new way of incorporating the wide array of societal values is required. Considerable attention must be paid to the relationship among local, regional, and national values. Which takes precedence, where, and why? And the relationship between the agencies and citizens in reaching decisions must be clearly defined.

Immediately develop a comprehensive, regionwide understanding of the effects of the selected option for federal land management on communities, tribal rights and values, recreational opportunities, and amenity values. This social assessment is just a beginning. Crisis-oriented policy analysis is not a substitute for comprehensive assessment and adequate research. A full assessment of effects on communities, important resource values, future opportunities, and economic costs and benefits is essential to implementation of new federal direction for land and resource management.

Attend to the short-term consequences from shifts in federal policy. While information is gathered, effects are analyzed, and collaborative relationships are built, some communities are being immediately impacted by loss of federal timber supply and some jobs will be eliminated. These short-term effects can be mitigated by public policy programs. These communities can be identified, and jobs immediately dependent on near-term federal timber sales can also be identified. One alternative may be to accelerate timber harvest levels consistent with species viability considerations in early years of a planning period (say 5 to 10 years) and reduce them in subsequent years. The "ramp down" would provide additional time for woodsworkers, communities, and businesses to adjust to significantly reduced tree harvest from federal lands. Trust would seem to be the major obstacle to this approach.

Specific policy relief can be accorded to both communities and occupational groups. Federal programs might first seek opportunities to enhance and augment local and state programs focused on communities and workers. Sometimes the limiting resource will be access to finances, other times it may be access to technical expertise in effectively competing for existing programs.

Declining federal timber harvest will, however, immediately impact particular communities and specific jobs. In some instances, new federal programs may be appropriate. State and local government should be included in deciding how and where scarce resources are allocated. Above all, our assessment indicates that strategies must fit the needs of the community in question. One size will not fit all. Citizens and communities must be included in the process of evaluation and self-determination of their future.

Future Forests For Society: Where To Next?

Some may ask, why bother to respond to threats confronting endangered species such as the owl ("species go extinct all the time") or to rural communities at risk because of changes in forest policy ("communities will adapt to change")? Is not change inevitable and any effort to intervene through policy pointless and futile?

One response to such questions is that the **forest management issue is fundamentally a moral question.** This would suggest that a society that fails to take care of its environment or its people risks collapse; history is replete with examples. The focus upon the survival of a particular species (the northern spotted owl) has deflected attention from the more fundamental concern: the declining status of the owl reflects an overall decline in the health of the environment upon which we humans all depend, whether for economic or psychic sustenance. Likewise, denigration and dismissal of a sector of our society (e.g., timber workers) as not worthy of concern and support has the familiar ring of intolerance, prejudice, and arrogance. To dismiss one group of citizenry raises the possibility of being dismissive of others.

Unfortunately, the range of options for responding to the many demands on our natural resources is increasingly becoming limited. This shrinking decision space provides little latitude for choice, if the requirements of current legislation (e.g., National Forest

Management Act, Federal Land Policy and Management Act, Endangered Species Act) are to be met. Our shrinking latitude is a legacy of the failure to come to grips adequately with a range of problems -- social, economic, and ecological -- over the past decades. The legacy includes the inability of resource management institutions to be responsive to change and, as a result, the courtroom has become the forum for debate and resolution about forest management.

Responsive administrative decisionmaking structures are required, with a central element of participative management. Natural resource professionals from multiple jurisdictions need to take the lead collectively in interacting with members of the public to address complex problems.

Shared decisionmaking is critical if people are to be part of the solutions rather than adding to or becoming the problem. Tapping into the rich body of knowledge held by the citizenry, working in collaboration with citizens to formulate alternative conceptions of the future, helping people understand the consequences of alternatives, enhancing our awareness of the distribution of costs and benefits associated with alternative management -- all these represent features of participatory management. Ultimately, the institutions of government serve only at the sufferance of the governed. If these institutions are perceived as dysfunctional, they will be replaced. New ways of doing business will need to be undertaken if we hope to achieve the idea of "one government." As Ted Strong noted at the Forest Conference, "*Status quo management is completely unacceptable. We must go on.*"

Research institutions need to focus on the key questions confronting society and on how to make the resulting knowledge available to a wide range of constituents. Scientists and researchers need to focus on an expanded array of questions and with methodologies appropriate for clarifying the complex social choices confronting society. New science is needed and its policy role is waiting as it helps define the range of possibilities, expected consequences, costs, and benefits associated with choices, and the means by which these choices might be achieved. Society is the ultimate beneficiary and consumer of research. The incapacity of research institutions to be responsive to the major concerns of society will diminish their long-term support and relevance.

Educational institutions need to refocus and become responsive to changing public perceptions and values of forests and forestry. Natural resource professionals need to be educated as citizens, as individuals who have a capacity to teach as well as to learn, and as people who can foster a sense of understanding, awareness, and appreciation among those around them. Above all, they need to be adept at asking the right questions and being critical thinkers. Like the institutions of management and research, educational institutions must help us understand today's problems while anticipating for changes in what will be relevant in the future. Concern is growing that educational programs and curricula are not preparing future professionals to deal with the priority issues facing society. The educational institutions must be more aggressive in demonstrating their responsibility and responsiveness to the wider society; failure to do so will diminish their value to, and therefore their support from, society.

Toward Breaking the Gridlock

In the face of intense conflict and acrimony surrounding the forest management issue, it is tempting to not make any decision to avoid offending some interest. It is not possible, however, to do nothing; "no decision" is a decision. The failure to act proactively defaults to a decision to act passively. Events overtake us and outcomes unfold without deliberation and thought. In such an event, consequences will fall without reflection and without the possibility of appropriate mitigative action. Moreover, failure to act will only further shrink the range of choice before us; the status quo will prevail, with all its acrimony.

There is nothing permanent except change.

Hereaclitus (540-475 BC)

Overview: Implementation and Adaptive Management

Implementation of a Pacific Northwest forest management strategy requires several actions by the relevant resource agencies. These actions include developing a common vision, implementing an adaptive management process, developing new monitoring and information systems, increasing research, modifying planning methods, and following an implementation strategy. Greatly increased multiagency collaboration will be required, as well as increased coordination with state and local governments and landowners to improve agency planning processes by increasing local participation and ensuring that potential regulatory conflicts are identified and resolved early in the planning process.

Introduction

The desired future condition of federal forest and riverine ecosystems of the Pacific Northwest will involve levels of biotic diversity, ecological processes and functions, including habitats, that sustain viable populations of native species as well as the productive capacity of the ecosystems. All lands, public and private, are important to supporting and maintaining healthy, functioning ecosystems. This requires close collaboration among federal agencies, nonfederal landowners, and the public.

Conservation strategies and adaptive management could result in quite different future landscapes, ranging from a series of fixed reserves growing into old-growth, nested within managed Matrix lands, to a landscape without visible reserves where management activities occur throughout with varying degrees of alteration of natural processes. In the long term, the landscape may behave as a dynamic mosaic of old and young forests shifting through time and space. The processes of monitoring, adaptive management, and implementation described here is intended to help us move in the appropriate direction of achieving the common vision.

Ecosystem Management

The concept of ecosystem management directs the attention of land managers and others to understanding ecosystems and developing appropriate site-specific management to achieve overarching ecosystem management objectives. However, our understanding of the underpinnings (supporting science, ecological constructs, legal interpretation, and societal acceptance) of natural resource management is in rapid flux and deals with imprecise concepts such as "ecosystem management" itself and sustainable development as a means of achieving ecosystem management.

Given current laws, ecosystem oriented management begins with strategies that involve layering relatively independent management schemes to accommodate northern spotted owls, old-growth ecosystems, marbled murrelets, and selected fish stocks. The next step toward ecosystem management is to assign multiple roles to the individual land allocations in an overall conservation strategy. This step leads to development of a single conservation strategy with multiple phases to accommodate the various species and ecosystems (e.g., riparian and old-growth) of concern. Including ecosystem concerns will require adaptive management actions that will accelerate the transition from conservation strategies for individual species to ecosystem management (fig. II-31).

A critical element of managing the future landscape of the Pacific Northwest will be an understanding of and appreciation for the fact that ecosystems extend across ownerships -- federal, state, and private. Streamflow and species of fish, wildlife, and other organisms know no jurisdictional or ownership boundaries. Consequently, increased ecological knowledge, concern with environmental protection, and an ecosystem approach to management must foster interownership cooperation and improved efficiency in balancing ecological and economic objectives.

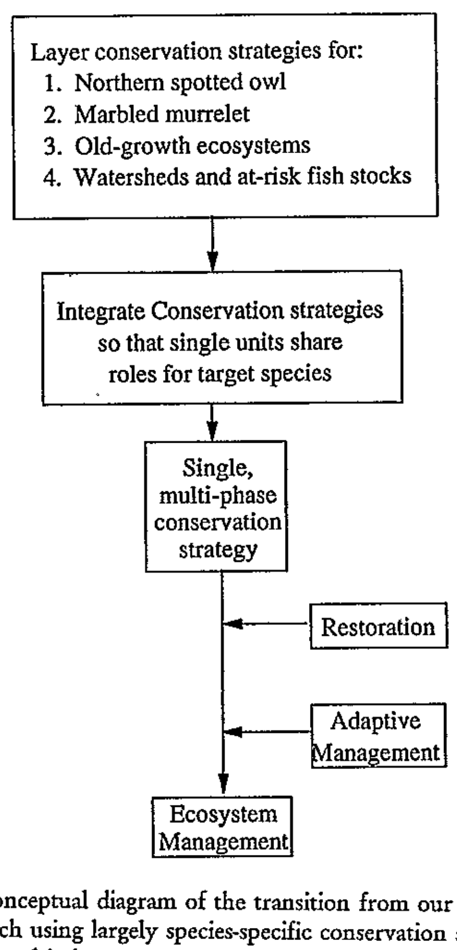


Figure II-31. Conceptual diagram of the transition from our current "layering" approach using largely species-specific conservation strategies, through a single, multi-phase strategy to an ecosystem-based, rather than species-based system of management.

Watersheds as Basis for Management

Watersheds represent a physically and ecologically relevant and socially meaningful scale for managing forest resources. Watersheds link regional and provincial conservation strategies and objectives for terrestrial and riparian species with project implementation, providing a rational and effective spatial scale for citizens to participate in natural resource decisionmaking.

Ecosystem planning may need to be conducted at four spatial scales: regional, province/river-basin, watershed, and site. At each scale, analyses describe human needs, environmental values, and important watershed and ecosystem functions. Information collected at the broader spatial scales (regional and provincial) guides analysis and development of management options at the finer scales (watershed and site). Conversely, information collected at the finer scales provides feedback on cumulative effects at the larger scales. These concepts are more fully developed in chapter V.

Adaptive Management

The Process

Adaptive management is a continuing process of planning, monitoring, researching, evaluating, and adjusting management approaches (fig. II-32). A formal process of adaptive management would maximize the benefits of any option described in this report and achieve the long-term objective of ecosystem management.

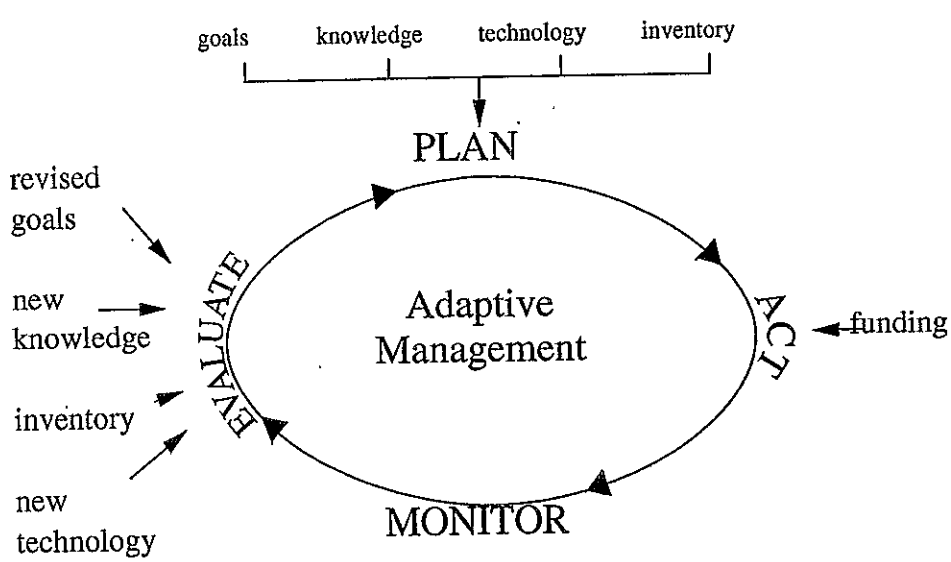


Figure II-32. Adaptive management process.

Planning

Planning processes executed by federal land management agencies have not consistently produced legally, scientifically, or socially defensible products. A new or greatly modified planning process is needed to implement the options and objectives described in this report. Recommendations for this process are described in chapter VIII and in the report of the Agency Coordination Working Group.

Monitoring

Monitoring is a critical component of adaptive management and a required activity for ecosystem management. It is also necessary to ensure compliance with forest management laws and policy. The current shortage of "science" makes monitoring critical because of the uncertainty of our predictions. Though currently required, this activity, up to now, has not been well designed, effectively implemented, or adequately funded.

Monitoring should be sufficiently sensitive to detect changes of ecological importance at all resource scales -- region, province, watershed, and project levels. The monitoring system should have sufficient independence and quality control to provide an acceptable basis for natural resource policy decisions. Because monitoring can be costly, the system should be designed specifically to serve the policy needs. Additionally, it should strive to achieve the greatest degree of collective efficiency such as using common guidelines and standards for integration of data from individual projects into a common regional data base.

Evaluation and Adjustment

"Managing to learn -- learn to manage" is a phrase used to characterize organizations whose culture is committed to experimentation, learning, and improvement over time. It is an important extension of the concept of adaptive management. It increases societal participation and the role of science and diversifies management practices to provide an opportunity to test a variety of techniques. Managing to learn entails implementing an array of practices, then taking a scientific approach in describing anticipated outcomes and comparing them to actual outcomes. These comparisons are part of the foundation of knowledge of ecosystem management.

Scientists, managers, and members of society would help evaluate the effects of the different treatments. Together, these groups would gain the information needed to design the next experiment and to ensure that the information gained would be shared with managers of nonexperimental landscapes. Managers, for their part, must take the evaluation process seriously because it will probably lead to changes in the way they do business -- the whole point of adaptive management.

Research

Our evaluations of the use, management, and conservation of Pacific Northwest forests have identified major gaps in our knowledge and understanding of these resources. In addition to the need for basic information on ecosystem function and processes, research is needed to develop and refine the analytical tools critical to ecosystem management and to help expand the resource productivity options within Pacific Northwest forests.

However, society is demanding an increased sophistication and refinement of management strategies as well as programs that address specific organisms or components of ecosystems that have had limited previous study. The inability to respond to these needs leads to serious gaps in knowledge and uncertainty that restrict the total benefits to society from any conservation strategy implemented. Due largely to funding limitations since the late 1970's, the natural resource research organizations in the Northwest have fallen behind in their ability to provide the science required to effectively address many of the evermore rapidly emerging issues and conflicts.

Strategic Information Resources

A key element for accommodating ecosystem management is the need for consistent, accurate, and current information about basic physical and biological resources and their distribution across the landscape. As all forest resources become limited and their use more intensely debated, it is essential that a substantially more accurate accounting of the amount, condition, and trends become available.

A multiorganizational, multivalue inventory system will be important for effective implementation, appropriate modification, and meaningful evaluation of management and protection strategies in Pacific Northwest forests. Even the more traditional commodity based inventories such as timber volume are not standardized across ownerships and are not reliably aggregative at the various scales needed for decisionmaking. To implement the several interagency recommendations in this report it will be necessary that a multivalue inventory be accessible to all concerned parties. This will require common protocols, database management, quality control, and a centralized delivery mechanism.

Implementation Strategy

The current status of the late-successional and old-growth forests and associated forest species, and the concerns of local communities and the public, require prompt decisions about implementation of a forest ecosystem management strategy in the Pacific Northwest. However, no set of options could be constructed to avoid or minimize every potential ecological problem or societal concern. The solution is to establish a workable process where potential problems can be identified and resolved *before* they become major conflicts.

Current planning and regulatory processes provide the basis for implementing a conservation strategy, but ecosystem planning on federal lands will drastically change the way that agencies conduct business. It will require an unprecedented level of interagency cooperation, involving the coordinated efforts of all federal agencies involved in planning and regulating of forest and forest-related activities in the Pacific Northwest and northern California. The land management and regulatory agencies, through the Agency Coordination Working Group, have been working together to develop more specific guidance based upon the following concepts.

Planning Levels

Implementation of the selected option will rely on general recommendations (standards and guidelines) that will need to be refined at increasingly more site-specific levels:

- *A regionwide conservation strategy* that provides general guidance to be considered at lower planning levels. This guidance should not set quantitative goals for goods and services as should emerge from land capability assessments.

- *A physiographic province (or river basin) conservation strategy* that provides more specific guidance for land managers to consider as they develop site-specific planning strategies for watersheds or other units of analysis and planning.

- *A watershed level analysis* for individual watersheds that takes into consideration site-specific information and needs, and which provides the basis for refinement of provincial conservation strategies as well as project-level decisions.

Although the regionwide plan provides a method for standardizing processes across provinces, the physiographic province is intended to become the focal point for ecosystem planning and is expected, ultimately, to replace the current National Forest and Bureau of Land Management District plans.

Watershed analysis is proposed as a key component of the general framework for identifying and assessing appropriate actions at the local level. Watershed analysis would be the foundation for revising province-level plans as information is collected and assessed through the adaptive management process. Watershed analysis would provide a method to assess the current situation and relationships between species and mechanisms that should be considered as a whole.

Considerable effort will be needed through interagency planning teams to make a smooth transition from the current to the proposed planning scenario (fig. II-33). The intent during this transition is three-fold: (1) to refine the preferred options and accompanying standards and guidelines in the initial phases of implementation so that local differences and needs can be more thoroughly addressed through the planning process; (2) to initiate an adaptive management process where approaches can be developed and integrated through a phased approach into a more ecosystem-oriented approach to land use planning; and (3) to identify and resolve potential regulatory conflicts (e.g., endangered species concerns) early in agencies' planning process so delays and negative impacts can be avoided or successfully mitigated.

Components of the Strategy

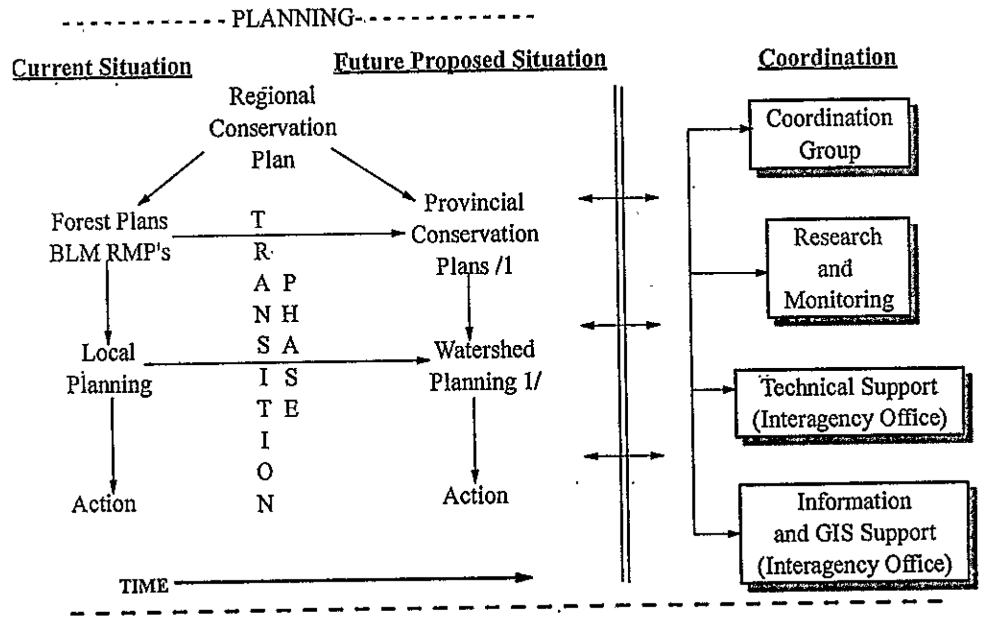
There are four similar components in all the options that will need to be considered in implementation as we move through the planning levels noted above:

1. Late-Successional Reserves and Riparian Reserves with specific boundaries delineating the areas.

2. Standards and guidelines for managing the reserves.

3. Standards and guidelines for managing the forest Matrix (between reserves) and Key Watersheds.

4. Watershed analysis procedures.



1/ Planning Support For Development Of Provincial Plans And Watershed Analyses And Planning Will Be Provided By Interagency Planning Teams Established On An As-Needed Basis To Assist With Specific Levels Of Planning

Figure II-33. Relationship between current and proposed planning, and interagency coordination efforts.

Refinement of these components will occur through a series of steps in agency planning. Through these steps information will be integrated and aggregated at different planning levels and adjustments made in the regional as well as more locally based plans, as appropriate. This will require an interim phase during which time the current plans will need to be revised and actions taken to meet specific timeframes, and will require an extensive training and education program for professional staff.

Phases of Implementation

Implementation should occur in three phases. Some of the actions identified here should be implemented *immediately* and *concurrently* to reduce the time involved in making the transition from current operations to a focus on the watershed and provincial levels.

Phase I: Develop options (this effort).

- Select preferred alternative.
- Process required environmental impact statements.

Phase II: Identify and carry out actions that need to be completed in the immediate future (e.g., within the first year).

- Refine regionwide components (reserve boundaries, standards and guidelines).

- Complete development of the watershed analysis approach.

- Initiate training, education, and public information programs.

- Proceed with harvesting timber sales.

Phase III: Identify and carry out actions that need to be completed in the short term (e.g., 4 years).

- Refine the components described in the regionwide strategy at the province level (e.g., boundaries and standards and guidelines applicable to each of the physiographic provinces) and begin development of provincial conservation plans.

- Refine the watershed analysis process and initiate high priority watershed analysis and restoration activities.

- Continue with the short-term timber sale program.

Phase IV: Identify and carry out actions that need to be completed to implement a selected (and refined) option over the planning period (e.g., 1-10 years).

- Refine the provincial guidelines at the watershed level for each watershed identified within the planning process.

- Refine National Forest/District or provincial level plans as necessary to meet the goals and objectives resulting from the watershed planning process.

Actions in the Transition Phase

An orderly transition is needed as we move toward implementation of a preferred option for future forest management. A major issue is continuation of ongoing programs (e.g., timber sale programs) and, specifically, decisions on existing timber sales that were planned under previous agency management plans. An evaluation of these sales has been initiated by the Forest Service and Bureau of Land Management. Over 1,300 timber sales currently exist, including sales developed under Section 318 of Public Law 101-121, sales that are currently enjoined, and new sales that have been planned. Most sales have already passed through the regulatory and planning requirements of applicable laws and policies. Steps should be taken to provide for completion of the review for remaining planned sales. Evaluation of these sales will require careful consideration of the effects these sales may have on the ability of the options to meet the specified objectives. Priority should be given to existing sales that have the least impact on the described options. Emphasis should be on sales outside of Key Watersheds, roadless areas, marbled murrelet habitat, and spotted owl critical habitat.

Planning and Regulatory Mechanisms

One aspect of the Forest Ecosystem Management Assessment Team's analysis rated the sufficiency, quality, distribution, and abundance of habitat to allow the species populations to stabilize across federal lands. This viability of federal habitat does not directly correspond to viability of the affected species. Furthermore, regulatory statutes for the Endangered Species Act and the National Forest Management Act contain different standards. As a result, it is not possible to construct an option for forest management that obviates the need for continued regulatory review of the impacts of actions that may affect (1) species listed under the Endangered Species Act, (2) water quality, or (3) other laws.

For example, the Team did not attempt to determine whether implementation of any of the options, or actions under any option, would result in jeopardy or destruction or adverse modification of critical habitat or offset listing under the Endangered Species Act. The Fish and Wildlife Service and the National Marine Fisheries Service are the agencies authorized to make such decisions. Appropriate regulatory processes (e.g., through Section 7 of the Endangered Species Act or Environmental Protection Agency water quality programs) could profitably be integrated with the applicable planning processes at an early stage in planning to avoid delays or future conflicts. If this occurs, it would result in a shift in regulatory review from later in the planning process to an earlier phase to help identify potential regulatory conflicts (e.g., actions that may impact listed or candidate species) so that actions can be taken to avoid or reduce those conflicts before irretrievable commitments of resources have been made. Regulatory processes can be coordinated with ongoing planning without causing problems in regulatory review, although it may require a need to increase the size of regulatory staff to accommodate their increased involvement in planning.

Interagency Coordination

The achievement of ecosystem management goals will involve a much greater level of coordination and cooperation than has ever existed. Improved coordination will include the establishment of regional/provincial coordinating groups, which includes representatives of the primary participants in land management planning (fig. II-33). These groups should be responsible for such tasks as ensuring adequate participation and timeliness in planning, monitoring, guiding, analyzing new information, and providing a forum for deliberating questions. Tasks would include:

- Review and refinement of options (from the regionwide to the local level, including refinement of boundaries and standards and guidelines).
- Information and education to appropriate parties.
- Agency guidance on key issues.
- Response to problems and concerns -- including biological, human/social, and legal.
- Future adjustments to plans and activities.
- Coordination of monitoring activities, data information management, and sharing of information.

Planning teams would assist in coordinating the appropriate planning and regulatory processes at the local level (e.g., province and watershed) to help respond to problems and concerns and to provide technical support to agencies as those agencies carry out planning. The number and types of groups involved in coordination will depend on the type of planning being undertaken. Both regional and local efforts should include close coordination with the appropriate state agencies, tribes, interest groups, and local communities.

To assist in the immediate transition from development of the set of options described through the selection, refinement, and implementation of a preferred option over the next year may require establishment of an interagency working group to continue analysis of the issues raised through the initial planning process described herein, address questions raised by the planning and regulatory agencies as they move toward implementation, expand the selected option into a more detailed plan, and assist in developing concepts of watershed and adaptive management processes.

Relationships to Nonfederal Lands

The majority of species inhabiting late-successional forests in the Pacific Northwest are not restricted to habitat on federal lands. Nonfederal lands are an integral part of any strategy that seeks to address the overall landscape as an ecosystem. Therefore, this interrelationship will require close cooperation between state agencies, tribes, private landowners, and federal agencies. This is particularly important for threatened and endangered species or other at risk species.

Because of the importance of the watershed scale for successful ecosystem management, planning activities for mixed ownership areas should be coordinated with nonfederal agencies or landowners wherever appropriate. Coordination of activities will play an integral part of ecosystem management at the regional, provincial, and watershed scales, regardless of the landowner or manager. The states should be actively involved by taking the lead in developing conservation ecosystem management objectives applicable to nonfederal lands.

Mechanisms for providing incentives to nonfederal landowners should be explored to encourage cooperative and coordinated efforts. Participation of nonfederal interests in planning for ecosystem management can identify opportunities to provide these incentives. A proactive approach to reduce potential conflicts, such as reducing the need for future listings, should be emphasized here. In these types of planning processes, priority should be given to finding ways of gaining maximum benefit from conservation activities to account for multiple species (e.g., the spotted owl, anadromous fish, marbled murrelet).

Partnerships between local, state, and federal parties offer unique opportunities to share information on these practices and to test different management techniques (e.g., Applegate Project in Oregon). These cooperative projects are intended to integrate the applicable authorities and techniques into a multiorganizational action to address the ecosystem problem.

Administrative, Budget, and Staffing Needs

The interagency approach requires that past methods of operation must be altered to accommodate a more interactive and up front approach to planning along with opportunities for others (e.g., states, interest groups) to participate. The current budget process may not be compatible with integrated resource management and may require a change in the way budgets are allocated, particularly for the land managing agencies that

Regulatory agencies should also change the focus of their involvement from a reactive to a more proactive and cooperative role. This will entail not only a change in the way they carry out their mandates but also a shift in workload from pure regulatory review to a more planning-oriented process, which will result in a heavier involvement in land planning efforts.

The Forest Ecosystem Management Assessment Team did not examine the potential costs to the federal government of implementation of the options described in this report. However, considerable effort will be needed to carry out the expected planning, monitoring, research, and associated projects that are important to the success of this effort. This includes a recognition that roles and needs for current staff do not disappear, but evolve as we implement new ways of conducting business are implemented.

Pending additional analysis, we emphasize that, regardless of the option selected, it is likely incorrect to conclude that reductions in funding and personnel are possible because of the possibly inaccurate assumption that ecosystem management will be somehow cheaper than management with more emphasis on traditional revenue-generating activities.

Overview: Policy Conclusions

Managing Risk: Recognizing the Implicit Tradeoffs

The Forest Ecosystem Management Assessment Team analyzed the ecological, social, and economic implications of 10 management options for the federal forests in the range of the northern spotted owl. The Team worked to integrate assessments of biophysical processes with assessments of community capacity and economic factors.

This report presents the analysis of the implications of satisfying the biophysical requirements of protecting wildlife and fish species, providing adequate distribution of late successional/old growth forests, and protecting riparian and watershed systems in the context of a social and economic system dependent upon a wide range of forest values and resources. Figure II-34 presents some of our findings in graphic terms.

Figure II-34 demonstrates, by option, the effect on the Probable Sale Quantity of timber on tradeoffs between acres of late-successional forest in the Matrix (open to timber management for commercial purposes) and acres in Reserves. Figure II-35 shows the tradeoffs as they affect the number of species (plants and animals) that the panels of experts rated as 60 percent or more likelihood of having habitat on federal lands capable of supporting a viable population well-distributed in the planning area.

It can be seen in figure II-34 that nearly all the difference in the Probable Sale Quantity expected from each Option is accounted for by the amount of late-successional forest in the Matrix that is subject to timber harvest ($R^2 = .90$). This is not surprising as most of

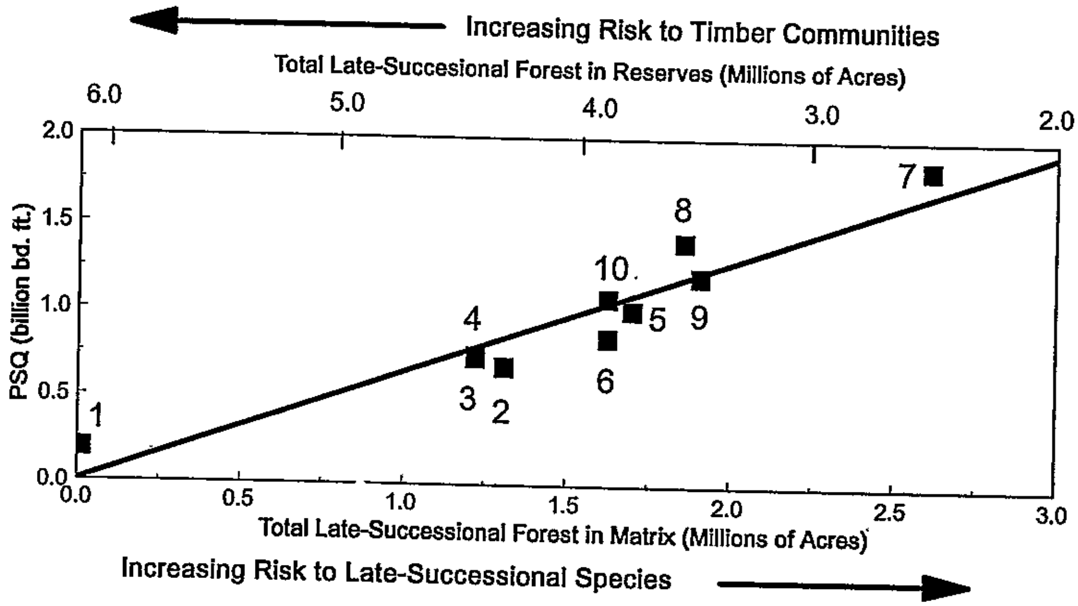


Figure II-34. Area of late-successional forest in Reserves and Matrix for each option. No data available for Option 3. Reserves include Late-Successional and Riparian Reserves; additional late-successional forest occurs within Congressionally and Administratively Withdrawn Areas (Read up from an option point to derive the acres in Reserves. Read down to derive the acres in the Matrix.. Read left to derive probable sale quantity, PSQ.)

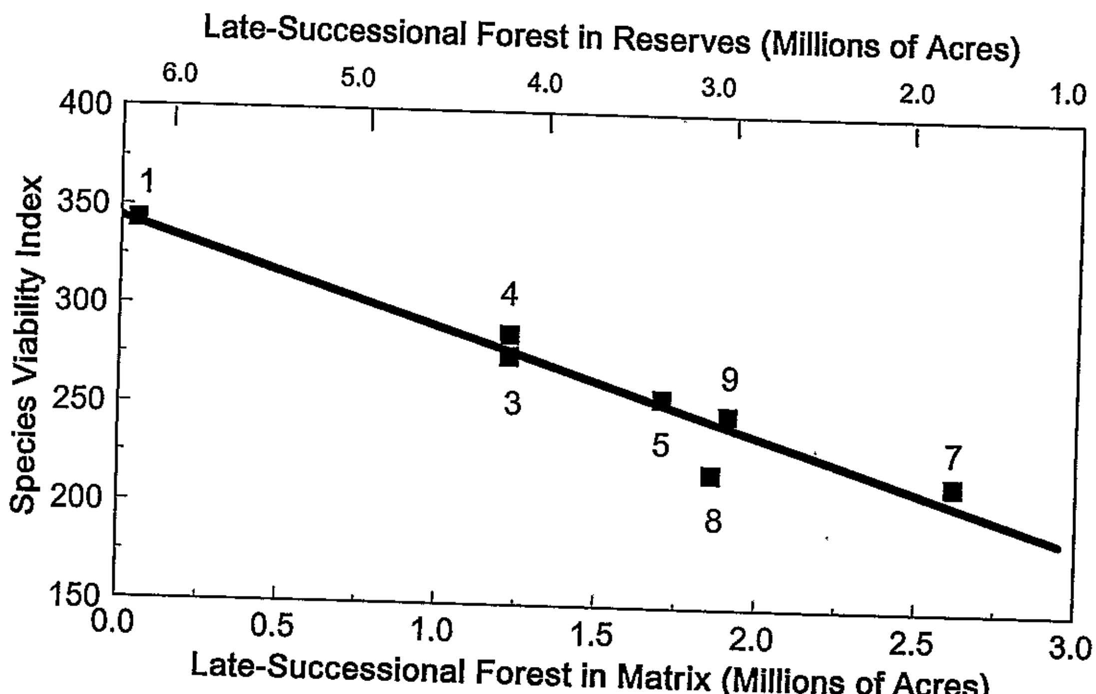


Figure II-35. Expected number of viable species in relation to acres in Reserve and in the Matrix. (Read up from an option to determine acres in Reserve. Read down to determine acres in Matrix. Read left to derive the number of viable species.)

the anticipated timber harvest from the federal lands over the next decade will come from late-successional forest stands.

Increasing the Probable Sale Quantity by increasing the acres of late-successional forest in the Matrix (and decreasing that in reserve status) reduces the risk to the welfare of timber dependent communities and increases the risk to species associated with late-successional forest habitats. The inverse relationship, obviously, holds.

Examination of Figure II-35 indicates that there is a significant relationship ($R^2 = .92$) between the amount of late-successional forest in the Matrix and the probability of maintaining habitat for species associated with late-successional forests in a condition where viable populations exist in a well-distributed state within the planning area. While this measure is qualitative in nature and based on the evaluation of panels of experts, the relationship seems clear.

Being in compliance with laws and regulations while maintaining the maximum Probable Sale Quantity under those conditions requires the decisionmaker to weigh these competing trends and choose an option. Inherent in that choice is the weighing of risk to species and the benefits associated with increased timber sale levels. That is a policy call for those in authority - not for scientists or technical experts. What is the appropriate balance?

Providing information useful to decision makers in this regard was exacerbated for scientists by the maddening process of trying to make biological reality fit into an analysis framework defined by the regulations issued pursuant to the National Forest Management Act related to viability and distribution of species on the National Forests. The intent of the regulation seemed clear and in keeping with the thrust of the Endangered Species Act and the newly adopted policy of ecosystem management.

However, it was in the details of the regulation that difficult, perhaps essentially unresolvable, technical problems arise. Following the letter of that regulation produces a situation in which any broadscale ecosystem management strategy that involves significant manipulation of forest habitats will cause some change, ranging from minor to significant, in distribution (certainly) and viability (perhaps) of every associated species. These species vary greatly in distribution (contiguous or fragmented -- on and off federal lands), numbers (to the extent that numbers can be estimated), viability (which can be quantitatively determined for only a fraction of the species), occurrence across federal/nonfederal ownerships, and the fact that the land management agencies may control only a portion of the habitat and that factors beyond their control may be the primary factors influencing viability.

It may be time to reconsider the regulations promulgated under the National Forest Management Act regarding the "viability" of species on National Forests in order to make the specifics of those regulations better fit the "real world" situation while preserving the spirit of those regulations.

Meeting the Law -- A Policy Dilemma

The Forest Ecosystem Management Assessment Team has undertaken probably the most extensive evaluation of biological risk ever attempted in an effort to help decisionmakers evaluate the degree to which the array of options might meet legal requirements. To conduct this assessment, the Team reviewed the National Forest Management Act and the Endangered Species Act to highlight the key phrases that might guide the analysis. This was not an easy task.

Which species count? At one level, the National Forest Management Act might be interpreted to apply only to vertebrates ("...habitat shall be managed to maintain viable populations of existing native and desired non-native vertebrate species in the planning area."). But the Act also speaks to "diversity of plant and animal communities," and this phrase clearly implies a broader mandate. How much broader? Should the phrase "plant and animal" include all life forms, including invertebrates and nonvascular plants? Certainly the Endangered Species Act applies to all species. Arguably, the National Forest Management Act could be interpreted as a protective measure to avoid conditions that would lead to threatened or endangered status for any species within the federal lands. The Endangered Species Act would provide support for those species that would need further protection. As we did not know the answers to these questions, we assessed the consequences of the options for all species and leave to others to interpret the statute and regulations.

What does "ensure" mean? Our viabilility assessments resulted in estimates of the likelihood, under each of the options, that habitat conditions might result in each of four outcomes (A = viable, well distributed; B = viable, but with gaps in distribution; C = restricted to small patches or refugia; D = extirpated from the planning area). The Team was charged with analyzing and displaying the consequences of a set of land management options. Would an 80 percent likelihood of outcome A ensure viability? What about 60 percent, or 90 percent? The Forest Ecosystem Management Assessment Team cannot interpret the legal standard for viability. Is the consideration of the combined likelihood of Outcome A and B appropriate when dealing with species that currently have gaps in their distribution? It is for others to translate these results into legal standards.

What is well distributed? Our viability outcomes were meant to specifically address the distributional aspect of species viability. As we discuss in chapter IV, the concept of "well distributed" is difficult to assess and is not clearly specified in the law. The National Forest Management Act states that "...habitat must be well distributed so that...individuals can interact with others in the planning area." Well distributed is described in relation to the dispersal or movement capabilities of particular species, but we have no policy guidance as to the degree to which movement would be legally acceptable. Is it sufficient to provide for only occasional contact between reproductive individuals? Some species, especially those associated with specialized habitats, occur naturally in small, relatively isolated patches. For such species, well distributed means something entirely different from what it does for widely distributed, habitat generalists. We tried to adjust our assessments to the expected distributions of each species and to assess whether a given option might cause further restriction of a species' distribution. This was a difficult task given the paucity of scientific knowledge on many species and the less than optimal environmental conditions from past forest management activities.

The evaluation of a species distribution is also contingent on defining a suitable benchmark. Should the species' distribution be evaluated relative to its current or its historic distribution? Past land management activities and other factors have clearly caused changes in species distributions. For example, the American marten and fisher both occur in a much smaller area than they once occupied, due to a combination of habitat loss and overharvest. Should the land management objective be to restore the animals to their former range or to maintain the status quo in terms of distribution?

Regional strategies versus local responses. The options were designed as broad, regional strategies, focused primarily on the habitat requirements of wide-ranging, threatened species such as the northern spotted owl and marbled murrelet, and at-risk fish stocks stuch as anadromous fish. But the majority of the species assessed, such as fungi, lichens, mosses, arthropods, and mollusks, respond to site-specific conditions at the microsite scale. For some species, their entire distributional range might cover an area of a few acres. As a result, the kinds of attributes we assessed, such as total amount and distribution of Late-Successional Reserves, distribution of Riparian Reserves, and general guidelines for the management of Matrix lands, were not specific enough or not described at a fine enough spatial resolution to fully address the microhabitat requirements of these smaller organisms. These plants and animals respond to local conditions, but the options were designed around regional objectives. How will these different scales be resolved? Presumably, the viability of some species will be affected as much by the site-specific management decisions that are made in implementing the strategy as by the regional strategy itself.

Every action has an effect. Broadly distributed species will be affected, to varying degrees, by any land management activity. The falling of one tree will remove a finite portion of the habitat for, say, a canopy-dwelling lichen. The species may survive, but in reduced numbers. Viability assessment is meant to help determine when the cumulative effects of such incremental losses of habitat might result in unacceptable risk to the species' survival. But as discussed above, this determination is problematic. We do not have the knowledge, in many cases, about the exact habitat requirements of many organisms, nor can we predict the exact consequences of each potential land management activity for all species. So we are left with more general assessments of the likely consequences of large-scale patterns (e.g., distributions of seral stages or major habitat components such as snags and logs) across the landscape. How do we address site-specific needs for every species in light of the potential influence of an array of actions many of which may occur off-site on a significantly difference scale?

Change happens. Change is an inevitable and necessary attribute of biological systems. Species have evolved in an environment characterized by change, sometimes gradual as in succession, and sometimes sudden as in catastrophic storms or fires or as caused by human activities. How can viability assessments fully account for the level of change that can be tolerated by species? We attempted to account for change in our assessment by thinking about the capacity of species to recover from catastrophic events, but our ability to fully evaluate such responses is limited by lack of knowledge and uncertainty in predicting the severity and frequency of such events. We cannot expect a static forest ecosystem. What is an acceptable level of variability in species populations over time, given the range of variability these species have experienced in their evolutionary history?

Alternative Approaches To Assessments of Species and Ecosystems

Two Complementary Methods to Conservation: Species and Ecosystems

We used two complementary methods to assessing options: evaluation of species and evaluation of ecosystems. In the first method, we assessed the viability of a suite of plant and animal species as influenced by habitat management on federal lands. In the second method, we assessed the fate of entire late-successional forest ecosystems on federal lands. In both cases the focus was on habitat. The two methods are complementary in that evaluating and prescribing for viability of individual species does not necessarily address the range of all factors pertinent to sustaining ecosystems and maintaining ecosystem attributes does not necessarily entail ensuring high viability of every associated species.

Species viability. Species viability was defined as the likelihood of a species persisting well distributed throughout its range for a specified period, in this case for a century or longer, on federally administered lands within the range of the northern spotted owl. Essentially, population persistence is measured as the size and trend of the population over time and is influenced by habitat, biology, and environment. Depending on the range of the species, habitat can be contributed from both federal and nonfederal lands. Biological factors are effects of other species including disease and parasites. Environmental factors include changes in regional or local climate, air and water quality, and catastrophic events such as fires and storms.

Each of these factors can affect population persistence and viability. Populations respond to these conditions by their internal demography (patterns of survival and reproduction), how they occupy habitats across the landscape (metapopulation dynamics), their genetic diversity, and other aspects of their life history, principally dispersal capability, movement patterns, and types of breeding and social structures.

All of these factors should be addressed to conduct a full population viability analysis. That analysis has as its goal an evaluation of the potential persistence of populations under one or more management scenarios. The assessments conducted for this report, however, centered on understanding how provision of habitat on federal lands under each option could contribute to population persistence and distribution over a century. Although the effects of demography, metapopulation dynamics, genetics, and life history of each species on population persistence were considered to the extent possible, the primary emphasis was on how the amount, quality, and distribution of habitat on federal lands could influence persistence and viability of plant and animal populations.

Ecosystem persistence. Ecosystem persistence was defined as the resilience and persistence of late-successional forests for a specified period, in this case for a century or longer. Ecosystem persistence was measured in terms of the amount, composition, and diversity of its ecological elements; the range of natural conditions; the representation of critical processes and functions; and the capacity of the system to respond to changes and perturbations, including catastrophic events. Each of these components is in turn affected by land allocations and conditions, as influenced by each option over time. Ecosystem persistence is modified by ecological processes, functions, and composition (chapter V). All of these factors would be analyzed in an ecosystem-based assessment of ecosystem persistence.

Interpreting Viability for Threatened and Endangered Species

Security of a population is related to population size and distribution. At very low population numbers and poor distributions, significant increases in these parameters need to be made to significantly increase security. At very high numbers and distributions, increases do not significantly raise an already-high level of security. At intermediate levels the contribution to population security per unit increase of population size or distribution is greatest.

There is some general level -- which likely differs by species and context -- at which security is low enough to warrant listing as threatened or endangered under the Endangered Species Act. There is a higher level -- again, which likely differs by species and context -- at which National Forest Management Act regulations for ensuring viability are met. Between these levels is a range of conditions, up to the level specified in the Act, in which recovery of a listed species should be met, although this may vary in accordance to a number of factors, such as endemism, land ownership, or other factors beside habitat.

Complicating this depiction is the contribution of nonfederal lands to the geographic range of the species. Significant declines in population or habitat over all or a significant portion of a species range would warrant species protection under the Endangered Species Act. A species distributed over multiple ownerships may be stable and well distributed on one ownership (for example, federal forest lands), but be listed due to declines and poor distribution on other ownerships (for example, state or private lands). The survival of a population on one ownership would not necessarily ensure that populations located on other ownerships remain extant. In addition, small or narrowly distributed populations are susceptible to demographic, genetic, and stochastic events that may result in extirpation even with intense proactive management and conservation, as on federal forest lands. Thus, it is critical to determine the extent to which conservation management on federal lands must "take the brunt" of viability effects felt from other lands, particularly for species whose range is largely in nonfederal lands. Policy for management of federal forest lands should reflect this.

Which Approach Best Meets Existing Policy Mandates?

Population viability assessments -- including use of professional judgment and qualitative evaluations of the contribution of habitat on federal lands to population persistence -- can help to meet the National Forest Management Act regulations dealing with population viability. Further, the mandates for evaluating species status and for deriving recovery objectives and standards, as found in the Endangered Species Act, can also be addressed by such an approach. The enormous number of plant and nonvertebrate species, however, makes this approach rather intractable to use in common forest planning activities for all such species on a species-by-species basis. We simply do not have sufficient scientific knowledge to apply this approach to every species.

How can regulations be met that deal with conservation of the entirety of biological diversity -- including all plant and animal species and communities and late-successional forest ecosystems? Clearly, conducting indepth, quantitative population viability analyses for each plant and animal species (vertebrate and invertebrate) is not a likely approach. The ecological indicator approach has also failed, primarily because a small set of species will not serve to represent the habitat requirements and population responses of all species.

Even conducting qualitative expert opinion assessments, as used in this report, is an enormous task when applied to all species of a particular ecosystem. Such assessments are wrought with difficulties of interpreting the relative contribution of habitat conservation on federal lands, as teased out from the array of other factors that can affect species viability. Confounding such interpretations is the fact that some species are naturally scarce and distributed in patches. Also, in a sense, we are now inheriting the results and problems of past forest management objectives and activities. How should assessments of current management options address naturally scarce species, and how should they be accountable for or respond to past actions? Ensuring that each and every species is provided for is of importance. And due credit should be given to forest management options that do much to provide for scarce species or species currently at risk, even if their prognosis is not good.

It seems to us that a combination of approaches to evaluating species and ecosystems is necessary to answer existing policy direction and legal mandates. The approaches, however, must remain tractable and understandable. They should allocate finite resources of talent and funding to identify and assess higher priority questions of species viability and ecosystem conservation. They must result in clear statements of likelihoods of various outcomes, to best inform publics and to aid decisionmakers in establishing a course of action. They also should help identify and give credit to management options that conserve habitat for at-risk, rare, or locally endemic species, even if the overall viability of such species remains low to moderate for the long term because of factors beyond the scope of habitat management.

Which Approach Should Be Used for Policy Direction?

We feel that we have helped refine the scope and bounds of such an assessment. Further work is needed, however, to definitively specify which approaches to risk analysis of species and ecosystems should become standard. We recommend that our methods be reviewed and that advice be given for analysis standards by a specially assigned technical panel comprising expert forest analysts and conservation biologists.

Prescribing Management and Planning Goals for Species Viability, Ecosystems, and Long-term Conservation Objectives

The lessons we learned from this assessment can help in interpreting existing laws, regulations, and agency policies dealing with management for species viability and ecosystems. In particular, the following criteria should be considered:

Management for Habitat and Species Viability

- Population viability remains a legitimate concern for management of forests on federal lands. Conserving or restoring population viability should remain a strong component of the regulations implementing the National Forest Management Act. Such regulations should also apply to management of forests on all other federal lands.

- Population viability should continue to be defined as the likelihood of continued existence of well-distributed populations over the long term, on the order of a century or longer.

- Assessment of population viability should be part of a regional planning program, although there should not be a requirement to conduct quantitative, indepth population viability analyses for each and every species of plant and animal. Rather, assessments can include a range of methods for (1) screening species for viability concern, (2) devising management guidelines to ensure that currently secure species remain secure and do not become listed, (3) conducting qualitative, expert-opinion evaluations of species status and responses to management options, and (4) conducting quantitative population viability analyses for selected species of special viability concern. In addition, some species can be evaluated in a broader sense of their functional role in ecosystems and might not need to be assessed on a species-specific basis. Still other species cannot be evaluated on a species-specific basis because of lack of scientific knowledge. Allocating available expertise, funding, and time for evaluating species viability and for devising and testing appropriate forest management activities needs to be made in a reasonable way.

- The desirable likelihood of population viability is not merely a biological question. The simple biological answer is to maintain a high likelihood; at least 95 percent likelihood over a century or longer is an often-touted objective, regardless of effects on local communities and economies. But in a more realistic context, it is a question of balance between the fate of plant and animal populations, social desires, economic ramifications, and other factors of managing public lands. Defining the "best" likelihood remains a problem-specific, difficult decision best relegated to decisionmakers, politicians, courts, and other authorities as appropriate, whose charge it is to balance environmental protection with the public good. The best science can significantly contribute to this decisionmaking process by evaluating risks to species and by helping to devise innovative programs to better meet concurrent goals of conservation and production.

- A clear recognition needs to be made, in management policy for federal agencies, between (1) providing habitat that contributes to species viability and (2) prescribing and conducting other management activities that influence species viability and persistence per se.

  The first recognition deals only with conservation of habitats and sites as a necessary (but likely insufficient) component in ensuring long-term viability of species. This is pertinent to management of National Forests and Bureau of Land Management Districts where habitat conservation is the primary charge. We should account for the degree to which habitat conservation on these lands can contribute to overall viability of the species, given effects from management of other lands and particularly for species ranging onto nonfederal lands.

  The second recognition deals with actions that affect biology, environment, demography, genetic, and other nonhabitat aspects of providing for viable populations of plant and animal species. This is pertinent to evaluating listing, jeopardy, and recovery activities under the Endangered Species Act.

- Management of habitat for viable populations should address (1) long-term conservation objectives for the target species and (2) appropriate spatial scales of habitats and forests that match the environmental conditions to which the species respond.

- Information needs, including inventory and monitoring of habitats and populations, should be clearly identified in evaluations and management programs, programmed into funding requirements, and conducted in interagency and/or interdisciplinary teams as appropriate. Conducting monitoring and research, however, should not be used as excuses for poor management decisions with unacceptably high risk.

Ensuring Healthy and Diverse Ecosystems

- Management of healthy and diverse ecological systems and protection of overall biological diversity should be goals complementary to population viability goals for management of federally administered public forest lands, and should be developed in concert with other goals for forest management such as timber production.

- Population viability evaluations can help determine management effects and requirements for ensuring healthy and diverse ecosystems. However, every species does not have to analyzed for devising and implementing ecosystem management guidelines.

- Managing for healthy and diverse ecosystems on multiple-use, federally administered public lands must account for disturbances likely to result from acceptable human activities. It is unreasonable to assume that all effects and evidence of human presence can be erased from such lands. At the same time, however, ecosystem conservation objectives cannot be compromised by allowing undue changes to natural ecosystems. As with defining acceptable levels of population viability likelihoods, it is a matter of decisionmaking that defines acceptable levels of change to ecosystems and their processes, functions, and composition. Such decisions could be aided by consulting with technical experts who could map out the range of conditions and responses to management options and who could recommend new ways to meet simultaneous objectives for ecosystem conservation and human use of natural resources.

There is No Technological Fix: Moving From Analysis to Action

Beginning in 1970's, consecutive panels of scientists and technical experts have been convened to address the consequences of meeting the requirements of protecting species adversely influenced by loss or alteration of forest habitat. Each consecutive panel has reached the same conclusion: a conservation strategy that will stand the test of time and evolving knowledge should include ecosystem protection. In response to requirements to develop conservation strategies for wildlife species listed as threatened, a conservation strategy was developed for the northern spotted owl (Thomas et al. 1990).

Within a year, concern with the status of late-successional, old-growth forests prompted several committees of the House of Representatives to sponsor the "Gang of Four" (Johnson et al. 1991) assessment of amounts and distribution of late-successional forests and to develop an array of alternatives of how the issue might be addressed in a management strategy. The Gang of Four developed 14 options for management with assessment of the effects on northern spotted owls, marbled murrelets, anadromous fish, other vertebrate species of species associated with late-successional/old-growth ecosystems, and the viability of the ecosystem itself. Concern with spawning and rearing habitat for fish species considered to be "at-risk" of listing as threatened emerged in this study and emerged as a full-blown issue in the management of forest lands.

The Northern Spotted Owl Recovery Team included an appendix listing a number of species that were likely to be associated with late-successional forest conditions (USDI 1992). The marbled murrelet joined the list of threatened species in 1992. The Scientific Assessment Team performed a detailed assessment using panels of technical experts to qualitatively evaluate the status of species associated with late-successional forest conditions (Thomas et al. 1993). Now the issue has expanded to the late-successional forest ecosystem. On June 4, 1992, the Chief of the Forest Service announced that agency would henceforth adopt a policy of "ecosystem management" on National Forest lands.

Clearly the developing circumstances over the past several decades have combined to produce a situation where the "decision space" for management of federal forests has been dramatically reduced. Among these factors are:

1. The continued effort to meet allowable sale quantity levels derived from planning models while accumulating experience with "real life" caused the estimates of allowable sale quantity to be revised downward.

2. Keeping roadless areas and other sensitive areas in the timber base while it became increasingly obvious that these areas would not likely be subject to timber harvest -- at least in the foreseeable future. This resulted in the concentration of timber cutting in those watersheds open to timber harvest.

3. Refusal or inability to comply with the requirements of environmental laws leading to the present "train wreck" of myriad court injunctions on management actions.

4. Inadequate actions to prevent the listing of species as threatened or endangered when such listings appeared imminent. Delays, for example, in effectively addressing the impending listings of the northern spotted owl, the marbled murrelet (and the now impending listing of some species of anadromous fishes) produced significant loss of management flexibility in addressing these issues. Then, when the species were listed, even more serious erosions of decision space resulted.

5. Delays in response to the increasingly obvious conclusion that, in some cases, allowable sale quantity targets could not be met while meeting other objectives of the forest plans (i.e. adherence to standards and guides) reduced flexibility to address evolving environmental concerns.

The situation seems to have reached a point where satisfaction of the requirements of the Endangered Species Act and the National Forest Management Act and other applicable laws requires a course of action that will produce an allowable sale quantity level of approximately 0.2 to 1.7 billion board feet (depending on the option chosen) over the next two decades from federal forests in the owl region. The consequences of such a level of harvest are apt to be debilitating to relatively isolated rural communities - many of which are already in difficulty. However, it is likewise increasingly clear that the only solutions available that seem likely will satisfy the law will still create hardship in some communities at least in the short term.

Facing Facts

In our last Team meeting the question was asked, "What did we learn?" The sub-team leader that had dealt with the work on terrestrial ecosystems replied. "Ecosystem management won't be easy. It won't be cheap. And, we probably can't save every species."

Hand-Off

We struggled to find the tightest possible fit between adherence to requirements of law and our charge to maximize the potential economic and social contribution of the federal lands given that adherence . We have done our best to fulfill the charge given to us. We believe the assessment of the situation and of the options is adequate to support a decision. Our work as scientists, economists, and analysts is complete. The decisions that may emerge from this work is now, most appropriately, in the hands of elected leaders.

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III

Option Development and Description

Chapter III

Option Development and Description

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Chapter III Contributors

Grant Gunderson, Richard Holthausen, Joe Lint, and Jack Ward Thomas were the primary contributors. Jerry Franklin, Martin Raphael, James Sedell, Gordon Reeves, John Steffenson, and Duane Dippon also contributed to the development and description of the options, along with the members of the Forest Ecosystem Management Assessment Team through ongoing discussions and reviews.

Chapter III

OPTION DEVELOPMENT AND DESCRIPTION

Development

Commencing with the first efforts in the 1970s, management plans for northern spotted owls and forest ecosystems have gone through a gradual evolution. Many of these plans were based on the hypothesis that providing sufficient habitat to ensure the continued existence of northern spotted owls would also provide for all other species associated with old-growth forests. However, the plans became increasingly complex as we gathered more information about both spotted owls and other species and about the entire late-successional forest ecosystem. In addition, instead of plans that would encompass the entire range of the northern spotted owl, some plans considered only specific areas such as the ecosystem plan for the Oregon Coast Range (Noss 1992) or the plan for the California subspecies of the spotted owl only in the Sierra Nevada Mountains (Verner et al. 1992).

In our current assignment, we considered all such plans--a total of 48--for application throughout the range of the northern spotted owl (table III-1). Other proposed plans represent slight variations of these 48, but we believe the 48 plans represent a full range of options.

In our consideration of these plans we reviewed whether any risk assessments or viability assessments had been made for five criteria: (1) viability of northern spotted owls, (2) viability of marbled murrelets, (3) viability of at-risk fish species and stocks, (4) viability of other species associated with old-growth forests, and (5) maintaining an interacting late-successional/old-growth forest ecosystem. These criteria were based on

Table III-1. Existing options considered with the Forest Ecosystem Management Assessment Team ratings for the five biological criteria.

Option or plan	Rating for spotted owls	Rating for marbled murrelets	Rating for at-risk fish stocks	Rating for other species closely associated with old-growth forests	Rating for providing interacting old-growth forest ecosystem
1. Regional guide interim direction (USDA 1984)	Low	Low	Low	Low	Low
2. 1000 Acre spotted owl habitat area network (USDA 1988)	Low	Low	Low	Low	Low
3. Spotted owl habitat network of varying sized reserves 1000-3000 acres (USDA 1988)	Medium	Low	Low	Low	Low
4. Spotted owl habitat network of 2500-4500 acre reserves (USDA 1988)	Low-Medium Low	Low	Low	Low	Low
5. BLM management framework plans and ODF&W agreement areas (USDA 1988)	Low	Low	Low	Low	Low
6. Forest plans	Low	Low	Low	Low	Low
7. Interagency Scientific Committee's conservation strategy (Thomas et al. 1990)	High	Medium-Low	Low	Medium-Low	Medium-Low
8. Jamison strategy (USDI 1990)	Medium	Low	Low	Low-Medium Low	Low-Medium Low
9. Johnson et al. (1991) Alt. 5A	Medium	Medium	Low	Medium	Medium
10. Johnson et al. (1991) Alt. 5B	Medium	Medium	Low	Medium	Medium
11. Johnson et al. (1991) Alt. 5C	Medium High	Medium High	Medium Low	Medium High	Medium High
12. Johnson et al. (1991) Alt. 6A	High	Medium	Medium-Low	Medium	Medium
13. Johnson et al. (1991) Alt. 6B	High	Medium	Medium Low	Medium	Medium
14. Johnson et al. (1991) Alt. 6C	High	Medium High	Medium Low	Medium	Medium High
15. Johnson et al. (1991) Alt. 7A	Medium	Medium	Medium	Medium	Medium
16. Johnson et al. (1991) Alt. 7B	Medium	Medium	Medium-High	Medium High	Medium High
17. Johnson et al. (1991) Alt. 7C	Medium High	Medium High	High	Medium High	High
18. Johnson et al. (1991) Alt. 8A	High	Medium	Medium High	Medium High	Medium
19. Johnson et al. (1991) Alt. 8B	High	Medium	Medium High	Medium High	Medium High
20. Johnson et al. (1991) Alt. 8C	High	Medium High	High	High	High
21. Johnson et al. (1991) Alt. 9A	High	Medium	Medium Low	Medium	Medium
22. Johnson et al. (1991) Alt. 9B	High	Medium	Medium	Medium	Medium High
23. Johnson et al. (1991) Alt. 9C	High	Medium High	Medium	Medium High	High
24. Johnson et al. (1991) Alt. 10A	High	Medium	Medium High	Medium High	Medium High
25. Johnson et al. (1991) Alt. 10B	High	Medium	High	Medium High	High
26. Johnson et al. (1991) Alt. 10C	High	Medium High	High	High	High
27. Johnson et al. (1991) Alt. 11A	High	Medium High	Medium Low	High	Medium High
28. Johnson et al. (1991) Alt. 11B	High	Medium High	Medium	High	High
29. Johnson et al. (1991) Alt. 11C	High	High	Medium	High	High
30. Johnson et al. (1991) Alt. 12A	High	Medium High	Medium High	High	Medium High
31. Johnson et al. (1991) Alt. 12B	High	Medium High	High	High	High
32. Johnson et al. (1991) Alt. 12C	High	High	High	High	High
33. Johnson et al. (1991) Alt. 13A	High	High	Medium Low	High	Medium High
34. Johnson et al. (1991) Alt. 13B	High	High	Medium	High	High
35. Johnson et al. (1991) Alt. 13C	High	High	Medium	High	High
36. Johnson et al. (1991) Alt. 14A	High	High	High	High	High
37. Johnson et al. (1991) Alt. 14B	High	High	High	High	High
38. Johnson et al. (1991) Alt. 14C	High	High	High	High	High
39. The multi-resource strategy (National Forest Products Assn. 1991)	Low	Low	Low	Low	Low
40. ISC strategy plus critical habitat units (USDA 1992)	High	Medium	Low	Medium Low	Medium Low
41. Preservation plan for the northern spotted owl (Lujan et al. 1992)	Low	Low	Low	Low	Low
42. BLM preferred alternative DRMPs (USDI 1992a)	Medium	Medium Low	Medium Low	Medium	Medium
43. California spotted owl plan (Verner et al. 1992)	Low	Low	Low-Medium Low	Medium Low	Medium Low
44. Final Draft Recovery Plan Northern Spotted Owl (USDI 1992c)	High	Medium	Low-Medium	Medium Low	Medium Low
45. Scientific Analysis Team Plan (Thomas et al. 1993)	High	High	High	High	Medium High
46. New BLM preferred alternative (USDI 1993)	Medium High	Medium High	Medium High	Medium - Medium High	Medium
47. Reed Noss Plan (Noss 1992)	Not rated because believed to be similar to Alt. 14c in Johnson et. al. (1991)				
48. No cutting on federal lands	High	High	High	High	High

the objectives expressed in the letter of instruction to the Forest Ecosystem Management Assessment Team from the White House (see Preface).

Initial Rating of the Options

Members of the Forest Ecosystem Management Assessment Team met on April 8, 1993, to review the existing assessments for the five major biological criteria for each option being considered, and either to validate existing ratings, update the rating, or provide a rating where no assessment had been done.

Team members present were given brief descriptions of the options being considered, the standards and guidelines of the options, a list of the five biological criteria and objectives, and a five-class rating scale with definitions of the ratings. The objective of the team effort was to rate the options at a coarse scale based on members' professional judgment of how well the options met the five biological criteria. The coarse ratings of the Forest Ecosystem Management Assessment Team are displayed in table III-1.

Other Options

From April 9 to April 16, the Forest Ecosystem Management Assessment Team met to develop other innovative options and select a set of options that would receive further, more refined, analysis. Six additional options were developed, including five hybrids containing mixtures of elements from assorted existing plans. Another option consisted of a long (300-350 year) timber harvest rotation with no Late-Successional Reserves. Each of these new options was rated using the same process described above.

Selection of the Options for Refined Assessment

The Team considered 29 of the existing options, the five hybrid options, and the new long-rotation option for selection for full analysis. The following criteria were used to make the selections. The Team's instructions (see Preface) are reflected in these criteria.

1. The option must be feasible to be analyzed within the time frame available to the team.

2. The majority of the options should have a relatively high probability of successfully meeting the objectives for each of the five biological criteria.

3. At least one of the options must have a medium probability rating.

4. At least one of the options must have a very high probability rating.

5. Options selected should include at least one developed from an approach focusing on species and at least one developed from an approach focusing on old-growth forest stands.

6. The economic and social implications of the options should be considered.

The process for the selection of options for further analysis was iterative. Eventually eight options were selected for full analysis. These eight appeared to pass a first screen for the five biological criteria and represented a range of probability ratings and social and economic values. Additional adjustments were made to some of the options during evaluation by the Team. Of the eight options initially selected for full analysis, one was dropped. Three other options were added resulting in a total of ten options. Tables III-2, III-3, and III-4 provide summarized information on the options.

Descriptions of the Options

Each of the Options analyzed includes late-successional forests found in National Parks, Wilderness Areas, Research Natural Areas, and other areas reserved by Congressional authority. Such designated areas are referred to in this report as "Congressionally Withdrawn Areas." Because they are constant in all the options, they are not displayed in the descriptions. Other areas have been withdrawn from timber harvest by the federal agencies. We call these Administratively Withdrawn Areas. Examples of such areas include roadless recreation areas, and lands that have unstable soils. While the extent of these areas vary by option (because the prescription for reserves supersede them) the Administratively Withdrawn Areas are not discussed option-by-option. This is because they are not specifically prescribed in the options, and these allocations could be changed by the agencies.

Fundamental to the options are late-successional forest areas where timber cutting will be restricted to some extent. These late-successional forest areas are categorized based on the levels of silvicultural treatment prescribed or allowed. Late-Successional Reserves are those areas where cutting of trees is generally limited to silvicultural treatment of young forests to attain or accelerate development of late-successional conditions. If young forest stands are moving toward such conditions, cutting is not appropriate. Managed Late-Successional Areas are where a wider application of silvicultural prescriptions may be employed to cut trees but where the primary objective remains the maintenance of late-successional forests on a landscape scale. See the section on ecological basis for managing late-successional forests in Chapter IV for additional discussion of the areas.

Riparian buffers, delineated along perennial and intermittent streams and wetlands, also create reserves where silvicultural treatment is limited. These buffers are called Riparian Reserves. Cutting trees in the Riparian Reserves is generally precluded unless such cutting will meet riparian objectives. Even within Late-Successional Reserves or Managed Late-Successional Areas, the standards and guidelines for Riparian Reserves must be followed along perennial and intermittent streams when silvicultural treatments take place. The Aquatics Ecosystem section of this report provides details regarding the standards and guidelines and objectives for Riparian Reserves.

Under all options, except Options 7 and 8, no roads are to be constructed in roadless areas (as identified in federal agency forest management plans) inside Key Watersheds. Key Watersheds are areas designated for special protection of either water quality or aquatic species. In all other watersheds road construction in roadless areas will not occur until a watershed analysis is completed and such analysis indicates that construction is compatible with riparian and other ecological objectives.

Table III-2. Summarized description of the options for forest ecosystem management. (See explanatory notes for origin of the Late-Successional Reserves, Managed Late-Successional Areas.)

Option number	Late-Successional Reserves	Managed Late-Successional Areas	Riparian Reserve strategy[a]	Matrix
Option 1	LS/OG1s;plusLS/OG2s;plus LS/OG3s; plus owl additions; plus occupied marbled murrelet sites; plus buffers for other species associated with old-growth forests. No timber harvest.	Buffers for other species associated with old-growth forests.	Riparian 1.	50-11-40 rule plus retention of six large green trees, two large logs, and two snags per acre. Timber harvest rotations of 180-years plus 10 percent of the matrix in stands over 180-years.
Option 2	LS/OG1s; plus LS/OG2s; plus owl additions; plus occupied marbled murrelet sites. Timber harvest only in younger forest stands and limited salvage.		Riparian 2.	50-11-40 rule plus retention of six large green trees, two large logs, and two snags per acre.
Option 3	LS/OG1s; plus LS/OG2s within marbled murrelet zone 1; plus owl additions in the western portion of the northern spotted owl range; plus buffers for other species associated with old-growth forests. Timber harvest only in younger forest stands and limited salvage.	LS/OG2s outside marbled murrelet zone 1 plus owl additions -- approximately 50% to be retained with other 50% to be managed on 250-350 year rotations or through uneven-age management in the eastern portion of the owls range. Six green trees retained in cutting units. Managed pair areas for the eastern portion of the northern spotted owl range. Number and management to be based on the provisions of the Final Draft Recovery Plan (USDI 1992c). Buffers for other species associated with old-growth forests.	Riparian 2.	50-11-40 rule plus retention of four large green trees, 2-12 logs per acre plus snag levels to support cavity excavators, plus protection of 10 percent of the matrix to be left in well distributed patches of late-successional (or oldest available) forests.

[a] Refer to table III-4 for a description of the Riparian Reserve strategies.

Table III-2. (continued)

Option number	Late-Successional Reserves	Managed Late-Successional Areas	Riparian Reserve strategy[a]	Matrix
Option 4	LS/OG1s; plus LS/OG2s in marbled murrelet zone 1; plus designated conservation areas; plus reserved pair areas; plus residual habitat areas; plus occupied marbled murrelet sites; plus buffers for other species associated with old-growth forests. Management based on treatments of younger forest stands and limited salvage adapted from provisions of the Final Draft Recovery Plan (USDI 1992c).	Managed pair areas -- number and management based on the provisions of the Final Draft Recovery Plan (USDI 1992c); plus buffers for other species associated with old-growth forests.	Riparian 1.	50-11-40 rule plus retention of green trees, logs, and snags based on forest plan prescriptions.
Option 5	LS/OG1s and LS/OG2s within marbled murrelet zone 1; plus designated conservation areas; plus reserved pair areas; plus residual habitat areas; plus occupied marbled murrelet sites; plus buffers for other species associated with old-growth forests. Management based on treatments of younger stands and limited salvage adapted from provisions of the Final Draft Recovery Plan (USDI 1992c).	Managed pair areas -- number and management based on the provisions of the Final Draft Recovery Plan (USDI 1992c); plus buffers for other species associated with old-growth forest.	Riparian 2.	50-11-40 rule plus retention of green trees, logs, and snags based on forest plan prescriptions.
Option 6	LS/OG1s; plus owl additions; plus LS/OG2s within marbled murrelet zone 1; plus occupied marbled murrelet sites. Timber harvest limited to treatment of younger forest stands and limited salvage.		Riparian 2.	50-11-40 rule plus retention of six large, green trees, two snags, and two logs per acre.
Option 7	Designated conservation areas; plus reserved pair areas; plus residual habitat areas. Management based on Federal agency interpretation of the provisions of the Final Draft Recovery Plan (USDI 1992c).	Managed pair areas -- number and management based on the provisions of the Final Draft Recovery Plan (USDI 1992c);	Riparian buffers as prescribed in the forest plans.	50-11-40 rule (as interpreted by the agencies) plus retention of trees, logs, and snags based on forest plan provisions.
Option 8	LS/OG1s; plus owl additions; plus LS/OG2s within marbled murrelet zone 1. Timber harvest only in younger stands and limited salvage within marbled murrelet zone 1. Outside marbled murrelet zone 1, timber harvest allowed in stands less than 180 years of age to produce or maintain spotted owl habitat, and salvage allowed that meets forest plan standards.		Riparian 3.	Retention of green trees, snags, and logs based on forest plan provisions.

[a] Refer to table III-4 for a description of the Riparian Reserve strategies.

Table III-2. (continued)

Option number	Late-Successional Reserves	Managed Late-Successional Areas	Riparian Reserve strategy[a]	Matrix
Option 9	Portions of LS/OG1s, LS/OG2s, and designated conservation areas from Johnson et al. (1991) and USDI (1992c); plus all LS/OG1s and LS/OG2s in marbled murrelet zone 1; plus occupied marbled murrelet sites; plus buffers for other species associated with old-growth forests. Placement of Late-Successional Reserves in Key Watersheds emphasized. Management adapted from provisions of Final Draft Recovery Plan for Northern Spotted Owls (USDI 1992c).	Buffers for other species associated with old-growth forests.	Riparian 2.	Coastal OR and WA Forests - No retention of green trees. Other National Forests in OR and WA - retention of 15 percent of the volume of a cutting unit in individual green trees or aggregation of 1/2 to four acres. Federal Forests in CA - 180 year rotations in conifer forests, 100 year rotations in hardwood forests. BLM administered lands in OR - Provisions of the revised preferred alternatives of Draft Resource Management Plans.
Option 10	Same as Option 6	Same as Option 6	Same as Option 6	Retention of six large, green trees, two snags, and two logs per acre.

Explanatory notes -

LS/OG1, LS/OG2, LS/OG3, owl additions - Terms for late-successional/old-growth reserve areas from the report of the Scientific Panel Late-Successional Forest Ecosystems (Johnson et al. 1991).

Designated conservation areas, reserved pair areas, residual habitat areas; and managed pair areas - Terms from the Final Draft Recovery Plan for the Northern Spotted Owl (USDI 1992c).

Occupied marbled murrelet sites - Forest stands outside reserves found to be occupied by marbled murrelets.

Marbled murrelet zone 1 - Washington, coast-inland 40 miles; Oregon, coast-inland 35 miles; California, coast-inland 35 miles narrowing to 10 miles.

Buffers for other species associated with old-growth forests - Forest areas around sites occupied by species identified in the report of the Scientific Analysis Team (Thomas et al. 1993) that will be protected from cutting (Late-Successional Reserves) or managed under special guidelines (Managed Late-Successional Areas) to provide protection for the occupied sites.

Forest plan elements - Land allocations or standards and guidelines from National Forest on BLM District land and resource management plans that protect late-successional forests (Late-Successional Reserves) or provide for timber harvest consistent with definitions of Managed Late-Successional Areas.

50-11-40 rule - A prescription that calls for at least 50 percent of the forest stands on Federal lands to be at least 11 inches in diameter at breast height and for such stands to have a canopy closure of at least 40 percent.

[a] Refer to table III-4 for a description of the Riparian Reserve strategies.

Table III-3. Summary of Aquatic Conservation Strategy.

Component	Role in Conservation Strategy
Riparian Reserves	• Portions of the landscape where riparian dependent and stream resources receive primary emphasis • Designated for all permanently flowing streams, lakes, wetlands greater than one acre, and intermittent streams • Includes the body of water, inner gorge, all riparian vegetation, 100-year floodplain, landslides and landslide prone areas • Interim widths will be at least some fraction of a site potential tree or a prescribed slope distance (See Table V-5) • Standards and Guidelines prohibits programmed timber harvest, manages roads, grazing, mining and recreation to achieve objectives of the Aquatic Conservation Strategy
Key Watersheds	• Tier 1 - Selected for directly contributing to anadromous salmonid and bull trout conservation • Tier 2 - May not contain at risks fish stocks but were selected as sources of high quality water • Inside roadless areas - no new roads will be built • Outside roadless areas - at a minimum, there will be no net increase in roads in Key Watersheds • Receives highest priority in restoration programs
Watershed Analysis	• A systematic procedure to characterize watersheds. The information guides management prescriptions, setting and refining Riparian Reserve boundaries, development of restoration strategies and monitoring programs. • Required in Key Watersheds prior to resource management • Required in all roadless areas prior to resource management • Recommended in all other watersheds • Required to change Riparian Reserve boundaries in all watersheds
Watershed Restoration	• Restore watershed processes to recover degraded habitat • Focus on road removal and upgrading • Silviculture treatments may be used to restore large conifers in Riparian Reserves • Restore channel complexity. In-stream structures should only be used in the short term and not as mitigation for poor land management practices

Table III-4. Minimum widths of Riparian Reserves expressed as whichever slope distance is greatest. In addition, Riparian Reserves must include the 100-year floodplain, inner gorge, unstable and potentially unstable areas. See Chapter V for other criteria used to determine Riparian Reserve widths. Options to which Riparian Reserve scenario apply are also listed.

Riparian Reserve Scenario	Stream class	Tier 1 Key watershed	Tier 2 Key watershed	All other watersheds
Riparian Reserve 1 Options 1,4	Fish Bearing Streams	Average Height of Two Site Potential Trees or 300 Feet	Average Height of Two Site Potential Trees or 300 Feet	Average Height of Two Site Potential Trees or 300 Feet
Riparian Reserve 1 Options 1,4	Permanently Flowing Non-Fish Bearing Streams	Average Height of One Site Potential Tree or 150 Feet	Average Height of One Site Potential Tree or 150 Feet	Average Height of One Site Potential Tree or 150 Feet
Riparian Reserve 1 Options 1,4	Intermittent Streams	Average Height of One Site Potential Tree or 100 Feet	Average Height of One Site Potential Tree or 100 Feet	Average Height of One Site Potential Tree or 100 Feet
Riparian Reserve 2 Options 2,3,5,6,9,10	Fish Bearing Streams	Average Height of Two Site Potential Trees or 300 Feet	Average Height of Two Site Potential Trees or 300 Feet	Average Height of Two Site Potential Trees or 300 Feet
Riparian Reserve 2 Options 2,3,5,6,9,10	Permanently Flowing Non-Fish Bearing Streams	Average Height of One Site Potential Tree or 150 Feet	Average Height of One Site Potential Tree or 150 Feet	Average Height of One Site Potential Tree or 150 Feet
Riparian Reserve 2 Options 2,3,5,6,9,10	Intermittent Streams	Average Height of One Site Potential Tree or 100 Feet	Average Height of One-half Site Potential Tree or 50 Feet	Average Height of One-half Site Potential Tree or 50 Feet
Riparian Reserve 3 Option 8	Fish Bearing Streams	Average Height of Two Site Potential Trees or 300 Feet	Average Height of Two Site Potential Trees or 300 Feet	Average Height of Two Site Potential Trees or 300 Feet
Riparian Reserve 3 Option 8	Permanently Flowing Non-Fish Bearing Streams	Average Height of One-half Site Potential Tree or 75 Feet	Average Height of One-half Site Potential Tree or 75 Feet	Average Height of One-half Site Potential Tree or 75 Feet
Riparian Reserve 3 Option 8	Intermittent Streams	Average Height of 1/6 Site Potential Tree or 25 Feet	Average Height of 1/6 Site Potential Tree or 25 Feet	Average Height of 1/6 Site Potential Tree or 25 Feet

In addition to withdrawn areas, reserves, and Managed Late-Successional Areas, the other major feature of the options is the set of management prescriptions for the intervening federal land referred to as the Matrix. The Matrix is the land base where a full range of silvicultural activities is allowed. In the descriptions of the options that follow, there are discussions of the Late-Successional Reserves, Managed Late-Successional Areas, Riparian Reserves, Matrix composition, and the "rules" by which management activities can be conducted in such areas. These "rules" are referred to as "standards and guidelines." Matrix acres include those outside other categories whether or not timber harvest can be regularly scheduled on them. The Matrix acres include nonforested acres and forested acres that are physically unsuitable for timber production due to their steep slopes, low site, and other characteristics. Thus, the acreage base for timber production (the acres used in calculation of probable sale quantities) is smaller than the acres shown as "Matrix acres". Table III-5 that follows the descriptions of the options provides estimated acres of federal land in each of the above categories by option. The estimates are further displayed by state and by physiographic province.

Option 1

Option 1 is a combination of option 14c from Johnson et al. (1991) and elements of the Scientific Analysis Team Report (Thomas et al. 1993). It was designed to have the highest probability of meeting the five biological criteria: (1) viability of northern spotted owls, (2) viability of marbled murrelets, (3) viability of fish species and stocks at-risk, (4) viability of other species associated with old-growth forests, and (5) maintenance of interacting late-successional forests.

Late-Successional Reserves

Under Option 1, Late-Successional Reserves consist of the most **significant late-successional forest areas (LS/OG1s)**, the **spotted owl additions,** and the **significant late-successional forest areas (LS/OG2s)**, and all other stands of late-successional forests (LS/OG3s) from Johnson et al. (1991). Under this option there would be no cutting of trees or salvage of dead trees in the Reserves.

Other Late-Successional Reserves result from:

1. Protection of all forest **sites occupied by marbled murrelets** found outside the larger Reserves. This consists of conducting surveys to a U.S. Fish and Wildlife Service protocol and designating the contiguous marbled murrelet nesting and recruitment habitat (stands that are capable of becoming suitable within 25 years) within 0.5 miles of the area where murrelet activity is detected as a Late-Successional Reserve.

2. The application of some of the **protection buffers for other species** associated with old-growth forests based on the provisions for such species. See Thomas et al. (1993) for details.

Managed Late-Successional Areas

Under Option 1, Managed Late-Successional Areas consist of:

1. The application of some of the **protection buffers for other species** associated with old-growth forests based on the provisions for such species. See Thomas et al. (1993) for the description of the standards and guidelines for other species associated with old-growth forests.

Riparian Reserves

Under Option 1, Riparian Reserve strategy 1 applies. Prescribed widths on both sides of streams for all watersheds are:

1. Fish-bearing streams - the combined average height of two site potential trees or 300 feet (whichever is greater).

2. Permanently flowing nonfish-bearing streams - the average height of one site-potential tree or 150 feet (whichever is greater).

3. Intermittent streams - the average height of one site-potential tree or 100 feet (whichever is greater).

The Matrix

Management of the Matrix under Option 1 is based on Matrix management option C in Johnson et al. (1991). This consists of the 50-11-40 rule plus the retention of at least six large, green trees per acre that exceed the average stand diameter, two large snags per acre, and two large logs per acre following logging. In addition to the above requirements, at least 10 percent of the Matrix should be over 180 years old at any one time. The remainder of the Matrix is to be managed using area control to achieve a rotation of 180 years. Matrix management will also be based on allocations and standards and guidelines of the federal agency forest plans where they are more restrictive than the provisions of this option. Forest plans are defined in all options as the existing land and resource management plans for the National Forests of the Pacific Northwest Region of the Forest Service, the preferred alternatives of the draft land and resource management plans of the National Forests of the Pacific Southwest Region of the Forest Service, and the revised preferred alternative of the Bureau of Land Management resource management plans currently in preparation.

Option 2

Option 2 consists of a modified version of option 12a from Johnson et al. (1991).

Late-Successional Reserves

Under Option 2, these consist of the most significant late-successional forest areas (LS/OG1s), the spotted owl additions, and the significant late-successional forest areas (LS/OG2s) from Johnson et al. (1991). Under this option cutting of trees in the Late-Successional Reserves is restricted to cutting that is designed to restore the integrity of the forest stands. This cutting would primarily be confined to precommercial and commercial thinning of forest stands less than 50 years old that have been established following logging. Cutting of forest stands in Late-Successional Reserves requires review by an oversight group established to ensure consistent application of the provisions of the option. Salvage of dead trees would be limited to areas of catastrophic loss exceeding 100 acres and would follow guidelines for salvage adapted from the Final Draft Recovery Plan for the Northern Spotted Owl (USDI 1992c: 70). Those guidelines are described at the end of this chapter.

Other Late-Successional Reserves result from:

1. Protection of all forest sites occupied by marbled murrelets found outside the larger reserves. See Option 1 for details.

Managed Late-Successional Areas

Under Option 2, no Managed Late-Successional Areas are designated.

Riparian Reserves

Under Option 2, Riparian Reserve strategy 2 applies. Prescribed widths on both sides of streams are:

1. Fish-bearing streams in all watersheds - the combined average height of two site potential trees or 300 feet (whichever is greater).

2. Permanently flowing nonfish bearing streams in all watersheds - the average height of one site-potential tree or 150 feet (whichever is greater).

3. Intermittent streams in aquatic conservation emphasis Key Watersheds - the average height of one site-potential tree or 100 feet (whichever is greater).

4. For intermittent streams in all other watersheds - one-half the average height of a site-potential tree or 50 feet (whichever is greater).

The Matrix

Management of the Matrix under Option 2 is based on Matrix management option A in Johnson et al. (1991). This consists of the 50-11-40 rule plus the retention of at least six large, green trees per acre that exceed the average stand diameter, two large snags per acre, and two large logs per acre following logging. The **allocations and standards and guidelines of the federal agency forest plans** will also be applied in the Matrix where they are more restrictive than the provisions of this option.

Option 3

The basis for Option 3 is Johnson et al. (1991) with elements of the Scientific Analysis Team Report (Thomas et al. 1993) and the Final Draft Recovery Plan for the Northern Spotted Owl (USDI 1992c). Management prescriptions in Option 3 vary for the Eastern Cascades in Oregon and Washington and the California Cascades. Therefore, the Option will be described separately for two areas.

Description of Option 3 for all physiographic provinces except the Eastern Cascades of Oregon and Washington and the California Cascades:

Late-Successional Reserves

Under Option 3, Late-Successional Reserves consist of the **most significant late-successional forest areas (LS/OG1s)** and the **spotted owl additions** and within the primary marbled murrelet zone, the **significant late-successional forest areas** (LS/OG2s) from Johnson et al. (1991). Whereas owl additions are initially included in the Late-Successional Reserves, they may eventually be reclassified as Managed Late-Successional Areas if and when spotted owl population performance has been demonstrated and there is additional experience indicating that forest stands can be successfully managed to create late-successional forests. Under this option, cutting of trees in the Late-Successional Reserves is restricted to restoring late-successional forest attributes, primarily through precommercial and commercial thinning of forest stands less than 50 years old that have been established following logging. Cutting in Late-successional Reserves requires review by an oversight group established to ensure consistent application of provisions of the option. Salvage of dead trees would be limited to areas of catastrophic loss exceeding 100 acres and would follow guidelines for salvage adapted from the Final Draft Recovery Plan for the Northern Spotted Owl (USDI 1992c: 70). Those guidelines are described at the end of this chapter.

Other Late-Successional Reserves result from:

1. Protection of all forest sites occupied by marbled murrelets found outside the larger reserves. (See Option 1 for details.)

2. The application of some of the protection buffers for other species associated with old-growth forests based on the provisions for such species. See Thomas et al. (1993) for the description of the standards and guidelines for other species associated with old-growth forests.

Managed Late-Successional Areas

Except in the primary marbled murrelet zone, the significant late-successional forest areas (LS/OG2s) identified by Johnson et al. (1991) are designated as Managed Late-Successional Areas under Option 3. Management prescribed for these areas includes the following:

1. Retention (no cutting) of 30 percent of each LS/OG2 area. Selection of the 30 percent of the forest stands to be retained would be based on occupancy by marbled murrelets or northern spotted owls, protection of fish-bearing streams within the area, sites occupied by other old-growth forest species, and the best developed old-growth forest stands.

2. Harvest rotations of 250 years for the remaining area within the LS/OG2s with area and inventory control. Cutting would proceed only if and when 40 percent of an entire LS/OG2 was in forest stands at least 100 years old.

3. Retention of 20 percent of the stands within each cutting unit. These retained areas are to consist of stands of late-successional forests (or the oldest available) left in configurations that would provide buffering of intermittent streams.

4. Retention of six of the largest and oldest green trees per acre on the actual cutting unit. These do not count toward the 20 percent retention.

Other Managed Late-Successional Areas result from:

1. The application of some protection buffers for other species associated with old-growth forests based on the provisions for such species. See Thomas et al. (1993) for the description of the standards and guidelines for other species associated with old-growth forests.

Riparian Reserves

Under Option 3, Riparian Reserve strategy 2 applies. Prescribed widths on both sides of streams are:

1. Fish-bearing streams in all watersheds - the combined average height of two site potential trees or 300 feet (whichever is greater).

2. Permanently flowing nonfish-bearing streams in all watersheds - the average height of one site-potential tree or 150 feet (whichever is greater).

3. Intermittent streams in aquatic conservation emphasis Key Watersheds - the average height of one site-potential tree or 100 feet (whichever is greater).

4. Intermittent streams in all other watersheds - one-half the average height of a site-potential tree or 50 feet (whichever is greater).

Description of Option 3 for the physiographic provinces of the Eastern Cascades in Oregon and Washington and the California Cascades:

Late-Successional Reserves

Under Option 3 in the eastern physiographic provinces, Late-Successional Reserves consist of the **most significant late-successional forest areas (LS/OG1s)** from Johnson et al. (1991). Under this option vegetation management in the Late-Successional Reserves in the eastern physiographic provinces would be conducted under provisions adapted from the Final Draft Recovery Plan for the Northern Spotted Owl (USDI 1992c: 75). This allows treatment of forest stands to reduce risk of fire and insect infestations within an objective of providing late-successional forest conditions at landscape scales. Guidelines for salvage adapted from the Final Draft Recovery Plan for the Northern Spotted Owl (USDI 1992c: 70) are also to be followed. Guidelines are described at the end of this chapter.

Also included are other Late-Successional Reserves that result from protection of some other species associated with old-growth forests (Thomas et al. 1993).

Managed Late-Successional Areas

Significant late-successional forest areas (LS/OG2s), owl additions identified by Johnson et al. (1991), and the **managed pair areas** based on the provisions of the Final Draft Recovery Plan for the Northern Spotted Owl (USDI 1992c: 86) are designated as Managed Late-Successional Areas under Option 3 for the Eastern Cascades and California Cascades provinces. Management of the managed pair areas is based on the provisions for such areas under the Final Draft Recovery Plan. Management for the LS/OG2s and owl additions has the objective of providing old-growth characteristics associated with both fire-dependent ponderosa pine sites and mixed conifer and sites with a long fire return interval. Management provisions for the LS/OG2s and owl additions include the following:

1. Retention (no cutting) of 30 percent of each LS/OG2 and owl addition area. Selection of the retained stands would be based on occupancy by marbled murrelets (east of the crest of the Cascades in Washington) or spotted owls, protection of fish-bearing streams within the area, sites occupied by other old-growth forest species, and identification of the best developed old-growth forest stands.

2. Management of the remaining forest stands in the LS/OG2s and owl additions through either uneven-aged or even-aged timber management or a combination

of the two. Prior to any harvest, stands should be inventoried to determine stand conditions relative to spotted owls, other species associated with old-growth forests, ecological functions, and susceptibility to insect infestations, disease, and catastrophic fire. Cutting would proceed only if and when at least 40 percent of an entire LS/OG2 or owl addition was in forest stands at least 80 years old.

3. Rotations of 250-350 years for the remaining area within an LS/OG2 or owl addition with area and inventory control, if even-aged management is conducted. For mixed conifer areas a rotation of 250 years would be used. For ponderosa pine or Jeffery pine areas, rotation would be 350 years. For other mesic series, rotation would be 200 years. For lodgepole pine, rotation would be 100 years. The goal of uneven-aged management would be to retain and grow large conifer trees.

4. Retention of 20 percent of the stands in each cutting unit. Retained areas are to consist of stands of late-successional forests (or the oldest available) left in configurations that will provide buffering of intermittent streams.

5. Retention of six of the largest and oldest green trees per acre on the actual cutting unit. These do not count toward the 20 percent retention target.

Other Managed Late-Successional Areas result from:

1. The application of some protection buffers for other species associated with old-growth forests based on the provisions for such species. See Thomas et al. (1993) for the description of the standards and guidelines for other species associated with old-growth forests.

Riparian Reserves

Under Option 3, Riparian Reserve strategy 2 applies. Prescribed widths on both sides of streams are:

1. Fish-bearing streams in all watersheds - the combined average height of two site potential trees or 300 feet (whichever is greater).

2. Permanently flowing nonfish-bearing streams in all watersheds - the average height of one site-potential tree or 150 feet (whichever is greater).

3. Intermittent streams in aquatic conservation emphasis Key Watersheds - the average height of one site-potential tree or 100 feet (whichever is greater).

4. Intermittent streams in all other watersheds - one-half the average height of a site-potential tree or 50 feet (whichever is greater).

Matrix - All Physiographic Provinces

Management of the Matrix under Option 3 is based on some provisions developed specifically for this option. The provisions incorporate the 50-11-40 rule plus retention of 10 percent of the Matrix area in late successional forest stands (or the oldest available) to be left in small 5 - 10 acre well-dispersed islands. On the units to be cut, management will retain four large green trees per acre, 12 large logs (decay class 1 and 2) (2-10 logs in the eastern physiographic provinces), and enough snags to support populations of cavity nesters at 40 percent of potential population levels. In addition, all logs that are in decay classes 3, 4, and 5 will be retained. The allocations and standards and guidelines of the federal agency forest plans will also be applied in the Matrix where they are more restrictive than the provisions of the option.

Option 4

Option 4 is a combination of the strategies for management of late-successional forests based on the Scientific Analysis Team Report (Thomas et al. 1993) and Johnson et al. (1991).

Late-Successional Reserves

Under Option 4, Late-Successional Reserves consist of the **most significant late-successional forest areas (LS/OG1s) and within the primary marbled murrelet zone the significant late-successional forest areas (LS/OG2s)** from Johnson et al. (1991). The areas established from the application of the Final Draft Recovery Plan for the Northern Spotted Owl (USDI 1992c: 63) are also Late-Successional Reserves. The areas resulting from the application of the Final Draft Recovery Plan include **designated conservation areas, reserved pair areas, and residual habitat areas.** Cutting of trees and salvage in Late-Successional Reserves would be guided by provisions adapted from the Final Draft Recovery Plan for the Northern Spotted Owl (USDI 1992c: 68). Those guidelines are described at the end of this chapter. Cutting of forest stands in Late-Successional Reserves requires review by an oversight group established to ensure consistent application of the provisions of the option.

Other Late-Successional Reserves result from:

1. Protection of all forest **sites occupied by marbled murrelets** outside the larger reserves. (See Option 1 for details.)

2. The application of **protection buffers for other species** associated with old-growth forests based on the provisions for such species. See Thomas et al. (1993) for the description of the standards and guidelines for other species associated with old-growth forests.

Managed Late-Successional Areas

Under Option 4, the Managed Late-Successional Areas consist of **managed pair areas** as prescribed in the Final Draft Recovery Plan for the Northern Spotted Owls (USDI 1992c: 86).

Other Managed Late-Successional Areas result from:

1. The application of some **protection buffers for other species** associated with old-growth forests based on the provisions for such species. See Thomas et al. (1993) for the description of the standards and guidelines for other species associated with old-growth forests.

Riparian Reserves

Under Option 4, Riparian Reserve strategy 1 applies. Prescribed widths on both sides of streams for all watersheds are:

1. Fish-bearing streams - the combined average height of two site potential trees or 300 feet (whichever is greater).

2. Permanently flowing nonfish-bearing streams - the average height of one site-potential tree or 150 feet (whichever is greater).

3. Intermittent streams - the average height of one site-potential tree or 100 feet (whichever is greater).

The Matrix

Management of the Matrix under Option 4 incorporates the 50-11-40 rule plus retention of green trees, snags, and coarse woody debris at levels specified in the forest plans. Retention of additional snags is required in the eastern Oregon and Washington Cascades and the Oregon and California Klamath as specified by Thomas et al. (1993). Additional allocations and standards and guidelines of the federal agency forest plans will also be applied in the Matrix where they are more restrictive than the provisions of this option.

Option 5

Option 5 is a strategy based on the Scientific Analysis Team Report (Thomas et al. 1993).

Late-Successional Reserves

Under Option 5, Late-Successional Reserves consist of areas established from the application of the Final Draft Recovery Plan for the Northern Spotted Owl (USDI 1992c: 63) that include designated conservation areas and reserved pair areas, and residual habitat areas. Within the primary marbled murrelet zone the most significant late-successional forest areas (LS/OG1s) and the significant late-successional forest areas (LS/OG2s) from Johnson et al. (1991) are also included as Late-Successional Reserves. Cutting of trees and salvage of dead trees in Late-Successional Reserves would be guided by provisions adapted from the Final Draft Recovery Plan for the Northern Spotted Owl (USDI 1992c: 68). The salvage guidelines are described at the end of this chapter. Cutting of stands in Late-Successional Reserves requires review by an oversight group established to ensure consistent application of the provisions of the option.

Other Late-Successional Reserves result from:

1. Protection of all forest sites occupied by marbled murrelets found outside the larger reserves. (See Option 1 for details.)

2. The application of some protection buffers for other species associated with old-growth forests based on the provisions for such species. See Thomas et al. (1993) for the description of the standards and guidelines for other species associated with old-growth forests.

Managed Late-Successional Areas

Under Option 5, the Managed Late-Successional Areas consist of managed pair areas as prescribed in the Final Draft Recovery Plan for the Northern Spotted Owl (USDI 1992c: 86).

Other Managed Late-Successional Areas result from:

1. The application of some **protection buffers for other species** associated with old-growth forests based on the provisions for such species. See Thomas et al. (1993) for the description of the standards and guidelines for other species associated with old-growth forests.

Riparian Reserves

Under Option 5, Riparian Reserve strategy 2 applies. Prescribed widths on both sides of streams are:

1. Fish-bearing streams in all watersheds - the combined average height of two site potential trees or 300 feet (whichever is greater).

2. Permanently flowing nonfish-bearing streams in all watersheds - the average height of one site-potential tree or 150 feet (whichever is greater).

3. Intermittent streams in aquatic conservation emphasis Key Watersheds - the average height of one site-potential tree or 100 feet (whichever is greater).

4. Intermittent streams in all other watersheds - one-half the average height of a site-potential tree of 50 feet (whichever is greater).

The Matrix

Management of the Matrix under Option 5 incorporates the 50-11-40 rule plus retention of green trees, snags, and coarse woody debris at levels specified in the forest plans. Retention of additional snags is required in the eastern Oregon and Washington Cascades and the Oregon and California Klamath as specified by Thomas et al. (1993). Additional allocations and standards and guidelines of the federal agency forest plans will be applied in the Matrix where they are more restrictive than the provisions in this option.

Option 6

Option 6 consists of a modified version of option 8a from Johnson et al. (1991).

Late-Successional Reserves

Under Option 6, Late-Successional Reserves consist of the **most significant late-successional forest areas (LS/OG1s)** and the **spotted owl additions** from Johnson et al. (1991); and within the primary marbled murrelet zone, the **significant late-successional forest areas (LS/OG2s)**. Under this option cutting of trees in the Late-Successional Reserves is restricted to precommercial and commercial thinning of forest stands less than 50 years old that have been established following logging. The objective is to accelerate development of late-successional conditions. Cutting in Late-Successional Reserves requires review by a group established to ensure consistent application. Salvage of dead trees would be based on application of the guidelines for salvage adapted from the Final Draft Recovery Plan for the Northern Spotted Owl (USDI 1992c: 70) and would be limited to areas where catastrophic loss exceeded 100 acres. The salvage guidelines are described at the end of this chapter.

Other Late-Successional Reserves result from:

1. Protection of all forest sites occupied by marbled murrelets found outside the larger reserves. (See Option 1 for details).

Managed Late-Successional Areas

Under Option 6, no Managed Late-Successional Areas are designated.

Riparian Reserves

Under Option 6, Riparian Reserve strategy 2 applies. Prescribed widths on both sides of streams are:

1. Fish-bearing streams in all watersheds - the combined average height of two site potential trees or 300 feet (whichever is greater).
2. Permanently flowing nonfish-bearing streams in all watersheds - the average height of one site-potential tree or 150 feet (whichever is greater).
3. Prescribed widths for aquatic conservation emphasis Key Watersheds - the average height of one site-potential tree or 100 feet (whichever is greater).
4. Intermittent streams in all other watersheds - one-half the average height of a site-potential tree or 50 feet (whichever is greater).

The Matrix

Management of the Matrix under Option 6, is based on Matrix management option A in Johnson et al. (1991). This consists of the 50-11-40 rule plus the retention of at least six large, green trees per acre that exceed the average stand diameter, two large snags per acre, and two large logs per acre following logging. Some of the allocations and standards and guidelines of the federal agency forest plans are applied in the Matrix where they are more restrictive than the provisions of this option.

Option 7

Option 7 approximates current direction that might be implemented if the federal agencies continued present land and resource management planning processes and if they were to adopt the elements of the Final Draft Recovery Plan for the Northern Spotted Owl (USDI 1992c).

Late-Successional Reserves

Under Option 7, Late-Successional Reserves consist of the areas established from the application of the Final Draft Recovery Plan for the Northern Spotted Owl (USDI 1992c: 63), specifically, designated conservation areas and reserved pair areas and residual habitat areas. Cutting of trees and salvage of dead trees in Late-Successional Reserves would be restricted to that provided by the Final Draft Recovery Plan (USDI 1992c: 68) as interpreted by the federal agencies. This could allow significant cutting in the future in Reserves on the Bureau of Land Management lands.

Managed Late-Successional Areas

Under Option 7, Managed Late-Successional Areas consist of **managed pair areas** as prescribed in the Final Draft Recovery Plan for the Northern Spotted Owl (USDI 1992c: 86).

Riparian Reserves

Under Option 7, these reserves include those that result from the **standards and guidelines of the federal agency forest plans** for riparian areas.

The Matrix

Management of the Matrix under Option 7 incorporates the 50-11-40 rule plus retention of green trees, snags, and coarse woody debris at levels specified in the forest plans. On lands administered by the Bureau of Land Management, the 50-11-40 rule is not applied. Other allocations and standards and guidelines of the federal agency forest plan would apply in the Matrix.

Option 8

Option 8 consists of a modified version of option 8a from Johnson et al. (1991).

Late-Successional Reserves

Under Option 8, Late-Successional Reserves consist of the **most significant late-successional forest areas (LS/OG1s)**, the **spotted owl additions** from Johnson et al. (1991), and within the primary marbled murrelet zone the **significant late-successional forest areas (LS/OG2s).** Under this option cutting of trees in the Late-Successional Reserves within the primary marbled murrelet zone, is restricted to precommercial and commercial thinning of forest stands less than 50 years old that have been established following logging. The objective is to accelerate development of late-successional conditions. Cutting in Late-Successional Reserves requires review by a group established to ensure consistent application. Salvage of dead trees would be based on application of the guidelines for salvage adapted from the Final Draft Recovery Plan for the Northern Spotted Owl (USDI 1992c: 70) and would be limited to areas where catastrophic loss exceeded 100 acres. The salvage guidelines are described at the end of this chapter.

Under this option cutting of trees in Late-Successional Reserves, outside of the primary marbled murrelet zone, is permitted in forest stands less than 180 years of age to produce or maintain northern spotted owl habitat. Salvage of dead trees would be permitted provided that forest plan standards for snags and logs were met after logging.

Managed Late-Successional Areas:

Under Option 8, no Managed Late-Successional Areas are designated.

Riparian Reserves

Under Option 8, Riparian Reserve strategy 3 applies. Prescribed widths on both sides of streams for all watersheds are:

1. Fish-bearing streams - the combined average height of two site-potential trees or 300 feet (whichever is greater).

2. Permanently flowing nonfish-bearing streams - one-half the average height of a site-potential tree or 75 feet (whichever is greater)

3. Intermittent streams - one-sixth the average height of a site-potential tree or 25 feet (whichever is greater).

The Matrix

Management of the Matrix under Option 8 consists of retention of green trees, snags, and logs to be left following logging at levels provided by the forest plans. Other allocations and standards and guidelines of the federal agency forest plans will be applied where they are more restrictive than the provisions of this option.

Option 9

Option 9 consists of elements from the Scientific Panel on Late-Successional Forest Ecosystems (Johnson et al. 1991), the Scientific Analysis Team Report (Thomas et al. 1993), the Final Draft Recovery Plan for the Northern Spotted Owl (USDA 1992), and Key Watersheds as described in this study.

Late-Successional Reserves

Under Option 9, Late-Successional Reserves are based on boundaries that represent an integration of previous efforts (Johnson et al. 1991; USDI 1992c). They incorporate some portion of the reserves from each of those previous efforts, and include new areas designated to protect Key Watersheds. Thinning or silvicultural treatments inside Reserves require review by an interagency oversight team to ensure that they are beneficial to the creation of late-successional forest conditions. Activities that would be permitted in the western and eastern portions of the range are described separately below. Salvage of dead trees would be based on guidelines adapted from the Final Draft Recovery Plan for the Northern Spotted Owl (USDI 1992c) and would be limited to areas where catastrophic loss exceeded 10 acres.

West of the Cascades

There is no entry allowed in stands older than 80 years of age. Thinnings (pre-commercial and commercial) may occur in stands up to 80 years of age regardless of the origin of the stands (plantations planted after logging or stands naturally regenerated after fire or blow down). The purpose of these silvicultural treatments is to be neutral or beneficial to the creation and maintenance of late-successional forest conditions.

East of the Cascades and the Eastern Portion of the Klamath Province

Given the increased risk of fire in these areas due to more xeric conditions and the rapid accumulation of fuels as the aftermath of insect outbreaks and drought, there are additional management activities allowed in Late-Successional Reserves. Guidelines to reduce risks to large-scale disturbance are adapted from the Final Draft Recovery Plan for the Northern Spotted Owl (USDI 1992c). These guidelines can be found at the end of the chapter.

Other Late-Successional Reserves result from:

1. Protection of all forest sites occupied by marbled murrelets found outside the larger reserves. See Option 1 for details.

2. The application of some of the protection buffers for other species associated with old-growth forests based on the provisions for such species. See Thomas et al. (1993) for details.

Managed Late-Successional Areas:

Under Option 9 these result from:

1. The application of some protection buffers for other species associated with old-growth forests based on the provisions for such species. See Thomas et al. (1993) for the description of the standards and guidelines for other species associated with old-growth forests.

Riparian Reserves

Under Option 9, Riparian Reserve strategy 2 applies. Prescribed widths on both sides of streams are:

1. Fish-bearing streams in all watersheds - the combined average height of two site potential trees or 300 feet (whichever is greater).

2. Permanently flowing nonfish-bearing streams in all watersheds - the average height of one site-potential tree or 150 feet (whichever is greater).

3. Intermittent streams in aquatic conservation emphasis Key Watersheds: - the average height of one site-potential tree or 100 feet (whichever is greater).

4. Intermittent streams in all other watersheds - one-half the average height of a site-potential tree or 50 feet (whichever is greater).

The Matrix

For the Oregon Coast Physiographic Province, the Olympic National Forest, and the Mount Baker-Snoqualmie National Forest (areas with high stream density):

Management of the Matrix is based on provisions of the forest plans for the retention of snags and logs in cutting units. No other retention provision is prescribed.

For other National Forests in Oregon and Washington within the range of the northern spotted owl:

Management of the Matrix under Option 9 consists of the retention of 15 percent of the volume of each cutting unit. This can be individual green trees, but one-half the amount must include some small (1/2 to 4 acre) late-successional stands that are intact. If late-successional stands are not available, the next oldest stands shall be retained.

For Bureau of Land Management administered lands in northern Oregon (north of Grant's Pass):

Management is based on providing 640 acre blocks of land (spaced 3 to 5 miles apart) that are managed on 150-year timber harvest rotations. When an area is cut 12 - 18 green trees will be retained. Overall 25 to 30 percent of the block must be in late successional forest at any point of time.

For Bureau of Land Management administered lands in southern Oregon (south of Grant's Pass):

Management consists of selective harvest where 16 to 25 large green trees per acre are left.

For the federal forests in California within the range of the northern spotted owl:

Management of the Matrix provides for retention of 15 percent of the volume of each cutting unit, plus use of 180-year harvest rotations for conifer and mixed evergreen forests and 100 years for hardwood forests.

In all cases, other allocations and standards and guidelines of the federal agency forest plans will be applied in the Matrix where they are more restrictive than the provisions of this option. However, administrative withdrawals that were specified in the forest plans to benefit martens, pileated woodpeckers, and other late-successional species would be returned to the Matrix under this option.

Option 9 incorporates another feature called **Adaptive Management Areas** where broad guidelines are developed for each area to manage forests for a variety of values, including late-successional forests. These areas allow the application of innovative management techniques to integrate ecological, social, and economic objectives. A separate discussion of the Adaptive Management Areas follows the description of the Options.

Option 10

Option 10 consists of a modified version of option 8a from Johnson et al. (1991).

Late-Successional Reserves

Under Option 10, Late-Successional Reserves consist of the **most significant late-successional forest areas (LS/OG1s)** and the **spotted owl additions** from Johnson et al. (1991); and within the primary marbled murrelet zone, the **significant late-successional forest areas (LS/OG2s)**. Under this option cutting of trees in the Late-Successional Reserves is restricted to precommercial and commercial thinning of forest stands less than 50 years old that have been established following logging. Cutting in Late-Successional Reserves requires review by a group established to ensure consistent application. Salvage of dead trees would be based on guidelines for salvage adapted from the Final Draft Recovery Plan for the Northern Spotted Owl (USDI 1992c: 70) and would be limited to areas where catastrophic loss exceeded 100 acres.

Other Late-Successional Reserves result from:

1. Protection of all forest sites **occupied by marbled murrelets** found outside the larger reserves. (See Option 1 for details).

Managed Late-Successional Areas

Under Option 10, no Managed Late-Successional Areas are designated.

Riparian Reserves

Under Option 10, Riparian Reserve strategy 2 applies. Prescribed widths on both sides of streams are:

1. Fish-bearing streams in all watersheds - the combined average height of two site potential trees or 300 feet (whichever is greater).

2. Permanently flowing nonfish-bearing streams in all watersheds - the average height of one site-potential tree or 150 feet (whichever is greater).

3. Intermittent streams in aquatic conservation emphasis Key Watersheds - the average height of one site-potential tree or 100 feet (whichever is greater).

4. Intermittent streams in all other watersheds - one-half the average height of a site-potential tree or 50 feet (whichever is greater).

The Matrix

Management of the Matrix under Option 10 calls for the retention of at least six large, green trees per acre that exceed the average stand diameter, two large snags per acre, and two large logs per acre following logging. Other allocations and standards and guidelines of the federal agency forest plans will be applied in the Matrix where they are more restrictive than the provisions of this option.

Adaptive Management Areas

Adaptive Management Areas are landscape units designated to encourage the development and testing of technical and social approaches to achieving desired ecological, economic, and other social objectives. Ten areas containing a range from about 84,000 to nearly 400,000 acres of federal lands have been identified. The areas are well distributed in the physiographic provinces. Most are associated with subregions impacted socially and economically by reduced timber harvest from the federal lands. The areas provide a diversity of biological challenges, intermixed land ownerships, natural resource objectives, and social contexts. In the Applegate Adaptive Management Area in Oregon, community-based activities have already begun from the grassroots.

The Adaptive Management Areas are specifically designated in Option 9, but the concept could be applied within any of the options. Specific boundaries of the areas would have to be modified consistent with particular options, and biological, economic, and social assessments would have to be revised to be consistent with those allocations.

The overarching objective for Adaptive Management Areas is to learn how to do ecosystem management in terms of both technical and social challenges, and in a manner consistent with applicable laws. It is hoped that localized, idiosyncratic approaches that may achieve the conservation objectives of this plan can be pursued. These approaches rely on the experience and ingenuity of resource managers and communities rather than traditionally derived and tightly prescriptive approaches that are generally applied in management of forests.

The Adaptive Management Areas are intended to contribute substantially to the achievement of objectives for Option 9. This includes provision of well-distributed late-successional habitat outside of reserves, retention of key structural elements of late-successional forests on lands subjected to regeneration harvest, and restoration and protection of riparian zones as well as provision of a stable timber supply.

The Adaptive Management Area concept incorporates the three adaptive management models/objectives discussed elsewhere in this report--technical, administrative, and cultural/social.

Key features of the Adaptive Management Areas:

- The areas are well-distributed geographically and represent a mix of technical and social challenges and are of sufficient size to provide for landscape-level management approaches.

- The areas provide for development and demonstration of monitoring protocols and new approaches to land management that integrate economic and ecological objectives based upon credible development programs and watershed and landscape analysis.

- Opportunities exist for education, including technical training to qualify local community residents for employment in monitoring and other management programs.

- Innovation in community involvement is encouraged, including approaches to implementation of initial management strategies and perhaps, over the longer term, development of new forest policies.

- Innovation is expected in developing adequate and stable funding sources for monitoring, research, retraining, restoration and other activities.

- Local processing (county level) of forest products harvested from the Adaptive Management Areas are encouraged.

- Innovation in integration of multi-ownership watersheds is to be encouraged between federal agencies and is likewise encouraged between state and federal agencies, and private landowners.

- Innovation in agency organization and personnel policies incluc :s tests and modification in recruitment and promotion procedures to encourage local longevity among the federal workforce.

Selection of the Adaptive Management Areas

Adaptive Management Areas were selected to provide opportunities for innovation, to provide examples in major physiographic provinces, and to provide a range of technical challenges, from an emphasis on restoration of late-successional forest conditions and riparian zones to integration of commercial timber harvest with ecological objectives.

The Adaptive Management Areas have been geographically located to minimize risk to the overall conservation strategy. The Adaptive Management Areas were intended to provide a mixture of public and private ownerships. In locating the Adaptive Management Areas, the proximity of communities that were subject to adverse economic impact resulting from reduced federal timber harvest was considered. The social and economic analysis of the Forest Ecosystem Management Assessment Team (reported elsewhere in this report) was a major source of information that helped guide these decisions.

The Adaptive Management Areas also provide a mixture of ownerships. Six areas include lands administered by the Forest Service and Bureau of Land Management. In two areas (Northern Oregon Coast Ranges and Olympic) there are significant opportunities for the states to participate in a major cooperative adaptive management effort with their forest lands. The majority of areas also have interspersed privately owned forest lands that could be incorporated into an overall plan if landowners so desired.

Establishment of the Adaptive Management Areas is not intended to discourage the development of innovative social and technical approaches to forest resource issues in other locales. These are intended to provide a geographic focus for innovation and experimentation with the intent that such experience will be widely shared. The array of areas provide a balance between having a system of areas that is: (1) so large and diffuse that it lacks focus and adequate resources and has extensive management constraints because of its size and overall impact on regional conservation strategies; and (2) too small to allow for meaningful ecological and social experimentation.

Technical Objectives

The Adaptive Management Areas have scientific and technical innovation and experimentation as objectives. These are difficult to achieve under traditional agency management. The guiding principle is to allow freedom in forest management approaches to encourage innovation in achieving the goals of Option 9. This challenge includes active involvement by the land management and regulatory agencies early in the planning process.

The primary technical objectives of the Adaptive Management Areas are development, demonstration, implementation, and evaluation of monitoring programs and innovative management practices that integrate ecological and economic values. Experiments, including some at quite large-scale, are likely. Demonstrations and pilot projects, while perhaps significant, useful, and encouraged in some circumstances, may not be sufficient to achieve the objectives in and of themselves.

Monitoring is essential to the success of any selected option and to an adaptive management program. Currently, adequate monitoring is essentially nonexistent throughout the federal resource management agencies despite being required by forest plans. Hence, development and demonstration of monitoring and training of the workforce are technical challenges and are suggested for emphasis.

Technical topics requiring demonstration or investigation are a priority for Adaptive Management Areas and cover a wide spectrum, from the welfare of organisms to ecosystems to landscapes. Included are development, demonstration, and testing of techniques for:

- Creation and maintenance of a variety of forest structural conditions including late-successional forest conditions and desired riparian habitat conditions.

- Integration of timber production with maintenance or restoration of fisheries habitat and water quality.

- Restoration of structural complexity and biological diversity in forests and streams that have been degraded by past management activities and natural events.

- Integration of wildlife welfare (particularly of sensitive and threatened species) with timber management.

- Development of logging and transportation systems with low impact on soil stability and water quality.

- Design and testing of effects of forest management activities at the landscape level.

- Restoration and maintenance of forest health using controlled fire and silvicultural approaches.

Each Adaptive Management Area should have an interdisciplinary technical advisory panel, including specialists from outside government agencies, that would provide advice on research, development, and demonstration programs.

Social Objectives

The primary social objective of Adaptive Management Areas is the provision of flexible experimentation with policies and management. These areas should provide opportunities for land managing and regulatory agencies, other government entities, nongovernmental organizations, local groups, land owners, communities, and citizens to work together to develop innovative management approaches. Broadly, Adaptive Management Areas are intended to be prototypes of how forest communities might be sustained.

Innovative approaches include social learning and adaptation, which depend upon local communities having sufficient political capacity, economic resources, and technical expertise to be full participants in ecosystem management. Similarly, management will need to be coordinated with collaboration across political jurisdictions and diverse ownerships. This will require mediating across interests and disciplines, strengthening local political capability, and enhancing access to technical expertise. Adaptive management is, by definition, information dependent. Setting objectives, developing management guidelines, educating and training a workforce, organizing interactive planning and management institutions, and monitoring accomplishments all require reliable, current inventories. New information technologies can be used to provide such information. But a well-trained workforce to collect and assimilate required information is largely lacking. Local persons might be ideally suited to this task if appropriately trained.

Agency Approaches and Management Oversight

Federal agencies are expected to use Adaptive Management Areas to explore alternative ways of doing business internally, with each other, and with other organizations, local and state government, and private landowners. In effect, the areas should be used to "learn to manage" as well as "manage to learn."

Agencies are expected to develop plans (jointly, where multiple agencies are involved) for the Adaptive Management Areas. Development of a broad plan that identifies general objectives and roles, and provides flexibility should be the goal. Such a plan could be used in competing for financial resources, garnering political support, providing a shared vision, and keeping track of experience.

If the Adaptive Management Areas are to make timely contributions to the regional conservation strategy and to the communities, it is absolutely critical that initiation of activities not be delayed by requirements for comprehensive plans or consensus documents beyond those required to meet existing legal requirements. Development of such documents can proceed simultaneously with other activities; the only area in which detailed planning must precede any activities is the Snoqualmie Pass Adaptive Management Area. Forest plans, as modified by the directions laid down in the selected conservation strategy, can provide the starting point for activities. Initial involvement of user groups and communities would emphasize how the strategy and plans should be implemented.

Initial direction and continuing oversight should be provided by a regional interagency group, possibly working through the Provincial Interagency Team if this concept is adopted from the implementation plan. It is important that the interagency coordination involve both the regulatory and management agencies and that the regulatory agencies participate in planning and regular review processes.

Funding the Adaptive Management Area Program

To achieve its multiple objectives the Adaptive Management Area program will require substantial and stable funding sources. Regular appropriations are one obvious source but are likely to be insufficient in amount and predictability to meet programmatic needs. Hence, developing innovative approaches to financing is an essential element of the Adaptive Management Area strategy.

Possible funding mechanisms for programs associated with Adaptive Management Areas include:

1. Using all or portions of the receipts from Adaptive Management Areas for accelerated monitoring, research, retraining, restoration and other innovative activities within these areas.

2. Authorizing agencies to assess user fees that could be retained for use within Adaptive Management Areas.

3. Using objective-based "end result" budgeting approaches with agency budgets.

4. Agency authorization for experimentation with nontraditional approaches to resource valuation, including market-based approaches to noncommodity resources, the purchasing, selling, and trading resources (e.g., private purchase of commercial timber for retention, rather than harvest).

5. Provision for other kinds of cooperative funding arrangements with other land owners, governmental bodies, organizations, and private individuals. In addition to funds needed for programs on the Adaptive Management Areas there may also be a need for risk capital for community-based efforts and pilot programs in incentive-based management agreements with private landowners.

If receipts are used as a source of funding for programs in Adaptive Management Areas several factors need to be considered. First, development of a common pool should be considered because all areas have the same basic needs -- such as in monitoring and retraining -- but differ greatly in their ability to generate revenues. Second, some portion of the funds should probably be reinvested on the same area, but care should be taken to avoid developing a negative feedback whereby resource exploitation is being stimulated by a desire for additional funds.

Development of additional innovative funding sources must not be viewed as a substitute for appropriate funds for management and research. Rapid implementation of programs within Adaptive Management Areas is essential to both their regional function and to the adjacent communities. In at least the short term, this implementation will only be possible through the regular appropriation process. Indeed, the intensity of activity proposed on the Adaptive Management Areas calls for higher levels of appropriated funds in the short term rather than lower levels.

Timber Supply

One reason for locating Adaptive Management Areas adjacent to adversely economically impacted communities is to provide opportunity for social and economic benefits to these areas. Adaptive Management Areas are expected to produce timber as part of their program of activities consistent with their specific direction under Option 9. The rates and methods of harvest will be determined on an area-by-area basis. Each area management team is expected to develop a strategy for ecosystem management to guide implementation, restoration, monitoring, and experimental activities involving timber sales. The strategy should contain a short-term (3 to 5 year) timber sale component and a long-term projection of timber yield.

Local processing of wood products harvested from federal lands within Adaptive Management Areas may be critical to the economic welfare of the associated communities as well as essential to creation of adaptive management approaches. If local processing is not achieved, the potential economic benefits to the local communities may not be realized. Hence, agencies are encouraged to develop approaches which encourage or require processing of a portion of the harvest within the local area, defined here as the county or counties within which the Adaptive Management Area is located. Sufficient legal authorities may already exist in laws such as the Cooperative Sustained Yield Act and the National Forest Dependent Rural Communities Economic Diversity Act (part of the 1990 Farm Bill).

Education

Each Adaptive Management Area was located adjacent to one or more communities with economies and culture long associated with utilization of forest resources. As a result, the people have a sense of place and desire for involvement. Many of these local workers already possess the woods skills and knowledge and sense of place that make them natural participants in ecosystem-based management and monitoring. Here adaptive management can bring indigenous knowledge together with formal studies, the local communities and the land management agencies in a mix that may provide creative common-sense approaches to complicated problems.

Technical and scientific training of a local workforce should be an educational priority of the Adaptive Management Area program. A program of formal schooling and field apprenticeship might provide the workforce needed to help implement ecosystem management, particularly in the area of monitoring. This program might be based on collaborations among local community colleges, state universities, and the agencies.

Descriptions of the Adaptive Management Areas

Adaptive Management Areas are shown on the appendix map for Option 9. Late-Successional Reserves provide for a major element of the Option 9 conservation strategy. Adaptive Management Areas would contribute to accomplishing the objectives of the option, such as protection or enhancement of riparian habitat and provision for distributed late-successional forest habitat. Detailed prescriptions for achieving such objectives are not provided, however, so that managers may develop and test alternative approaches, applicable to their areas and in a manner consistent with existing environmental and other laws.

Riparian protection in Adaptive Management Areas should be comparable to that prescribed for other federal land areas. For example, Key Watersheds with aquatic conservation emphasis within Adaptive Management Areas must have a full watershed analysis and initial buffers comparable to those for Tier 1 Key Watersheds. Riparian objectives (in terms of ecological functions) in other portions of Adaptive Management Areas should have expectations comparable to Tier 2 Key Watersheds. However, flexibility is provided to achieve these conditions, if desired, in a manner different from that prescribed for other areas and to conduct bonafide research projects within riparian zones.

Guidelines for sustaining marbled murrelet habitat necessitates management restrictions for Adaptive Management Areas within the primary murrelet zone if Option 9 is to rate at least an 80 percent likelihood of providing nesting habitat well-distributed in the planning area at 100 years (see Chapters IV and V). In the two Adaptive Management Areas where most late-successional forests have already been harvested (Northern Oregon Coast Ranges and Finney), required mitigation is: (1) survey for and protection of all occupied murrelet sites (see Option 1); (2) retention of LS/OG1s, LS/OG2s, and owl additions (from Johnson et al. 1991) as Late-Successional Reserves within the Adaptive Management Areas. These reserves should be managed as stipulated for such reserves under Option 9. On the Olympic Peninsula, where larger reserves of late-successional forests remain on federal lands, all sites occupied by marbled murrelets will be protected (see Option 1). In all the Adaptive Management Areas, management activities will be conducted to achieve the objectives described for Option 9. Full watershed assessments will be conducted prior to new management activities in identified Key Watersheds with Adaptive Management Areas.

Name:	**Applegate Adaptive Management Area, Oregon**
Size:	268,600 acres.
Ownership:	Medford District, Bureau of Land Management; Rogue River and Siskiyou National Forests; potentially state and private lands.
Associated communities:	Grants Pass and Medford, Oregon; Jackson and Josephine Counties, Oregon; and Siskiyou County, California.
Emphasis:	Development and testing of forest management practices, including partial cutting, prescribed burning, and low impact approaches to forest harvest (e.g., aerial systems) that provide for a broad range of forest values, including late-successional forest and high quality riparian habitat. Late-Successional Reserves are included in the Adaptive Management Area boundaries.

Name:	**Blue River Adaptive Management Area, Oregon**
Size:	153,200 acres.
Ownership:	Willamette National Forest; Eugene District Bureau of Land Management; potentially state and private lands.
Associated Communities:	Eugene, Springfield, and Sweet Home, Oregon.
Emphasis:	Intensive research on ecosystem and landscape processes and its application to forest management in experiments and demonstrations at the stand and watershed level; approaches for integrating forest and stream management objectives and on implications of natural disturbance regimes; and management of young and mature stands to accelerate development of late-succession conditions, a specific management objective for the forests within the Moose Lake block as well as in other portions of the Adaptive Management Area to be selected. Current status of the H. J. Andrews Experimental Forest as an Experimental Forest, i.e., maintenance of control areas and full flexibility to conduct experiments is retained. One Late-Successional Reserve is included in the area.

Name:	**Cispus Adaptive Management Area, Washington**
Size:	142,900 acres.
Ownership:	Gifford Pinchot National Forest; potentially state and private lands.
Associated Communities:	Randle, Morton, and Packwood, Washington; Lewis and Skamania Counties, Washington.
Emphasis:	Development and testing of innovative approaches at stand, landscape, and watershed level to integration of timber production with maintenance of late-successional forests, healthy riparian zones, and high quality recreational values.

Name:	**Finney Adaptive Management Area, Washington**
Size:	101,100 acres.
Ownership:	Mt. Baker-Snoqualmie National Forest; potentially state and private lands.
Associated Communities:	Darrington, Washington; Skagit and Snohomish Counties, Washington.
Emphasis:	Restoration of late-successional and riparian habitat components and provision of stable timber supply. Retention of habitat consistent with guidelines for marbled murrelet areas as noted at the beginning of this section. Sites occupied by spotted owls (pairs or territorial singles) will be protected by establishing Late-Successional Reserves using procedures to delineate Reserved Pair Areas under the Final Draft Recovery Plan for Northern Spotted Owls (USDI 1992c).

Name:	**Goosenest Adaptive Management Area, California**
Size:	169,600 acres.
Ownership:	Klamath National Forest; potentially private lands.
Associated Communities:	Yreka, Montague, Dorris, Hornibrook; Siskiyou County, California.
Emphasis:	Development of ecosystem management approaches, including use of prescribed burning and other silvicultural techniques, for management of pine forests, including objectives related to forest health, production and maintenance of late-successional forest and riparian habitat, and commercial timber production.

Name:	**Hayfork Adaptive Management Area, California**
Size:	399,500 acres.
Ownership:	Shasta-Trinity and Six Rivers National Forests and Yreka District Bureau of Land Management; potentially private and state lands.
Associated Communities:	Hayfork, California; Trinity and Humboldt Counties, California.
Emphasis:	Development, testing, and application of forest management practices, including partial cutting, prescribed burning, and low-impact approaches to forest harvest, which provide for a broad range of forest values, including commercial timber production and provision of late-successional and high quality riparian habitat. Maintain identified Late-Successional Reserves; conduct full watershed analysis in critical watersheds.

Name:	**Little River Adaptive Management Area, Oregon**
Size:	83,900 acres.
Ownership:	Umpqua National Forest and Roseburg District Bureau of Land Management; potentially private and state lands.
Associated Communities:	Roseburg, Myrtle Creek, Oregon; Douglas County, Oregon.
Emphasis:	Development and testing approaches to integration of intensive timber production with restoration and maintenance of high quality riparian habitat.

Name:	**Northern Coast Range Adaptive Management Area, Oregon**
Size:	247,000 acres.
Ownership:	Siuslaw National Forest and Salem District Bureau of Land Management; with potential participation by the Oregon Department of Forestry and private landowners.
Associated Communities:	Tillamook, Willamina, Grand Ronde, Oregon; Polk, Yamhill, Tillamook, and Washington Counties, Oregon.

Concept:	Management for restoration and maintenance of late-successional forest habitat, consistent with marbled murrelet guidelines noted at the beginning of this section. Conduct watershed analysis of the Nestucca River drainage. Subsequently, the Oregon Department of Forestry will be invited to collaborate in development of a comprehensive strategy for conservation of the fisheries and other elements of biological diversity in the northern Oregon Coast Ranges. All occupied marbled murrelet (see Option 1) and northern spotted owl sites will be protected by establishing Reserved Pair Areas under the Final Draft Recovery Plan for the Northern Spotted Owl (USDI 1992c).

Name: Olympic Adaptive Management Area, Washington

Size:	145,000 acres.
Ownership:	Olympic National Forest and potentially Washington Department of Natural Resources, Indian Reservations, and private lands; Jefferson, Clallam, Grays Harbor, and Mason Counties, Washington.
Emphasis:	Create a partnership with the Olympic State Experimental Forest established by Washington Department of Natural Resources. Develop and test innovative approaches at the stand and landscape level for integration of ecological and economic objectives, including restoration of structural complexity to simplified forests and streams and development of more diverse managed forests through appropriate silvicultural approaches such as long rotations and partial retention. All occupied marbled murrelet sites will be surveyed for and protected (see Option 1).

Name: Snoqualmie Pass Adaptive Management Area, Washington

Size:	261,300 acres
Ownership:	Wenatchee and Mt. Baker-Snoqualmie National Forests; Plum Creek Timber Company and other private land owners; state.
Associated Communities:	Cle Elum and Roslyn, Washington; Kittitas and King Counties, Washington.
Emphasis:	Development and implementation, with the participation of the U.S. Fish and Wildlife Service, of a scientifically credible, comprehensive plan for providing late-successional forest on the "checkerboard" lands. This plan should recognize the area as a critical connective link in north-south movement of organisms in the Cascade Range.

Guidelines for Silvicultural Activities and Salvage in Late-Successional Reserves

These guidelines are adapted from the Final Draft Recovery Plan for the Northern Spotted Owl (USDI 1992c). Some or all of these guidelines are applied in Options 2 through 10. See the individual option descriptions for specific application of the guidelines.

Guidelines for silviculture

The primary objective of silvicultural activities in Late-Successional Reserves is to improve habitat in younger stands. Consequently, activities are encouraged if empirical information and modeling indicate that the development of late-successional habitat conditions will be accelerated. Interdisciplinary teams of wildlife biologists, silviculturists, and other specialists are encouraged to develop prescriptions that meet these criteria. General guidelines for silvicultural activities follow.

1. To safeguard the conservation benefits of Late-Successional Reserves, silvicultural activities should be directed at young stands where stocking, structure, or composition will prevent or significantly retard development of late-successional conditions. This will generally include stands that are composed of trees less than 10 to 12 inches dbh, show no significant development of a multiple-canopy tree structure, and were regenerated following harvest activity. There will be exceptions to these guidelines, and judgments on stands to be managed will vary according to forest type and stand history. Activities in other types of stands that do not meet the general guidelines can be considered, particularly where those stands are heavily stocked and not being used by spotted owls or other late-successional associates. Examples may include stands that were planted following catastrophic fires or stands previously dominated by conifers that converted to hardwoods following harvest. Stands that have desired late-successional structure or that will soon develop it should not be treated unless such treatment is necessary to accomplish risk-reduction objectives (as described later).

2. Prescriptions to be used for each stand should be well thought out and documented. They will be designed to produce stand structure and components associated with late-successional conditions. These components include large trees, snags, logs, and dense, multi-storied canopies. Prescriptions should show the treatments to be applied and the anticipated effects on the stand over time. They should also include a discussion of the actions, coordination efforts, and oversight that will be necessary for successful implementation. This discussion should draw on previous efforts made to implement similar prescriptions. Finally, the prescriptions should identify key stand attributes or accomplishments that should be monitored. For example, if snags are to be created, or regeneration established, the accomplishment of these actions and their results should be monitored.

3. Silvicultural activities must maintain or reduce risk of large-scale natural disturbance. For example, activities should not be implemented if they significantly increase the risk of windthrow in a stand.

4. To promote late-successional structure in stands to be thinned, prescriptions will provide for leaving some trees as snags and others as down wood. Those

trees not needed for habitat development may be removed for commercial or fuel hazard reasons.

5. Key attributes of late-successional forests are their diversity and variability on individual sites and from site to site. To promote diversity and variability, a wide range of silvicultural practices should be applied, as opposed to reliance on a limited variety of techniques.

6. Activities that comply with these guidelines should provide positive conservation benefits. Actual implementation experience, however, is not extensive. A modest rate of implementation is prudent and will provide the opportunity to assess and refine activities. Acreage to be manipulated by silvicultural activities should generally be limited to 5 percent of the total area in any Late-Successional Reserve in the initial 5-year period of implementation, unless the need for larger-scale actions explicitly are justified.

7. Some habitat modification activities in Late-Successional Reserves will generate enough revenue to pay for themselves. Others will not and need to be supported by appropriated funds. It is not appropriate to conduct only those activities that generate a commercial return and ignore the needs of stands that cannot be treated commercially.

Guidelines to reduce risks of large-scale disturbance

Large-scale disturbances are natural events, such as fire, that can eliminate owl habitat on hundreds or thousands of acres. Certain risk management activities, if properly planned and implemented, may reduce the probability of these major stand-replacing events. There is considerable risk of such events in Late-Successional Forest Reserves in the eastern Oregon Cascades, eastern Washington Cascades, and California Cascades provinces and a lesser risk in the Oregon Klamath and California Klamath provinces. Elevated risk levels are attributed to changes in the characteristics and distribution of the mixed-conifer forests resulting from past fire protection. These forests occur in drier environments, have had repeated insect infestations, and are susceptible to major fires. Risk reduction efforts are encouraged where they are consistent with the overall recommendations in this section.

Silvicultural activities aimed at reducing risk shall focus on younger stands in Late-Successional Forest Reserves. The objective will be to accelerate development of late-successional conditions while making the future stand less susceptible to natural disturbances. Salvage activities should focus on the reduction of catastrophic insect, disease, and fire threats. Treatments should be designed to provide effective fuel breaks wherever possible. However, the scale of salvage and other treatments should not generally result in degeneration of currently suitable owl habitat or other late-successional conditions.

In some Late-Successional Forest Reserves in these provinces, management that goes beyond these guidelines may be considered. Levels of risk in those Late-Successional Forest Reserves are particularly high and may require additional measures. Consequently, management activities designed to reduce risk levels are encouraged in those Late-Successional Forest Reserves even if a portion of the activities must take place in currently late-successional habitat. While risk-reduction efforts should generally be focused on young stands, activities in older stands may be appropriate if: (1) the proposed management activities will clearly result in greater assurance of long-term maintenance of habitat, (2) the activities are clearly needed to reduce risks, and (3) the activities will not prevent the Late-Successional Forest Reserves from playing an effective role in the objectives for which it was established.

Guidelines for salvage

Salvage is defined as the removal of trees from an area following a stand-replacing event caused by wind, fires, insect infestations, volcanic eruptions, or diseases. Salvage guidelines are intended to prevent negative effects on late-successional habitat, while permitting some commercial wood volume removal. In some cases, salvage operations may actually facilitate habitat recovery. For example, excessive amounts of coarse woody debris may interfere with stand regeneration activities following some disturbances. In other cases, salvage may help reduce the risk of future stand-replacing disturbances. Priority should be given to salvage in areas where it will have a positive effect on late-successional forest habitat, but salvage operations should not diminish habitat suitability now or in the future.

Tree mortality is a natural process in a forest ecosystem. Diseased and damaged trees are key structural components of late-successional forests. Accordingly, management planning for Late-Successional Reserves must acknowledge the considerable value of retaining dead and dying trees in the forest as well as the benefits from salvage activities.

In all cases, planning for salvage should focus on long-range objectives, which are based on desired future condition of the forest. Since Late-Successional Reserves have been established to provide high-quality habitat for species associated with late-successional forest conditions, management following a stand-replacing event should be designed to accelerate or not impede the development of those conditions. The rate of development of this habitat will vary among provinces and forest types and will be influenced by a complex interaction of stand-level factors that include site-productivity, population dynamics of live trees and snags, and decay rates of coarse woody debris. Because there is much to learn about the development of species associated with these forests and their habitat, it seems prudent to only allow removal of conservative quantities of salvage material from Late-Successional Reserves and retain management options until understanding of the process has improved.

The following guidelines are general. Specific guidelines should be developed for each physiographic province, and possibly for different forest types within provinces.

1. The potential for benefit to species associated with late-successional forest conditions from salvage is greatest when stand-replacing events are involved. Salvage in small disturbed sites is not appropriate because small forest openings are an important component of old-growth forests. Depending on the option, salvage is not permitted in disturbed sites that are either less than 10 acres or less then 100 acres. In addition, salvage should occur only in stands where disturbance has reduced canopy closure to less than 40 percent, as stands with more closure are likely to provide some value for species associated with these forests.

2. Surviving trees will provide a significant residual of larger trees in the developing stand. In addition, defects caused by fire in residual trees may accelerate development of structural characteristics suitable for associated species. Also, those damaged trees that eventually die will provide additional snags. Consequently, all standing live trees should be retained, including those injured (e.g., scorched) but likely to survive. Inspection of the cambium layer can provide an indication of potential tree mortality.

3. Snags provide a variety of habitat benefits for a variety of wildlife species associated with late-successional forests. Accordingly, following stand-replacing disturbance, management should focus on retaining snags that are likely to persist until late-successional conditions have developed and the new stand is again producing large snags. Late-successional conditions are not associated with stands less then 80 years old.

4. Following a stand replacing disturbance, management should retain adequate coarse woody debris quantities in the new stand so that in the future it will still contain amounts similar to naturally regenerated stands. The analysis that determines the amount of coarse woody debris to leave must account for the full period of time before the new stand begins to contribute coarse woody debris. As in the case of snags, province level specifications must be provided for this guideline. Since coarse woody debris decay rates, forest dynamics, and site productivity undoubtedly will vary among provinces and forest types, the specifications also will vary.

5. Some salvage that does not meet the preceding guidelines will be allowed when salvage is essential to reduce the future risk of fire or insect damage to late-successional forest conditions. This circumstance is most likely to occur in the eastern Oregon Cascades, eastern Washington Cascades, and California Cascades provinces, and somewhat less likely to occur in the Oregon Klamath and California Klamath provinces. It is important to understand that some risk associated with fire and insects is acceptable because they are natural forces influencing late-successional forest development. Consequently, salvage to reduce such risks should focus only on those areas where there is high risk of large scale disturbance.

6. Removal of snags and logs may be necessary to reduce hazards to humans along roads and trails and in or adjacent to campgrounds. Where materials must be removed from the site, as in a campground, a salvage sale is appropriate. In other areas, such as along roads, leaving material on site should be considered. Also, material will be left where available coarse woody debris is inadequate.

7. Where green trees, snags, and logs are present following disturbance, the green tree and snag guidelines will be applied first, and completely satisfied where possible. The biomass left in snags can be credited toward the amount of coarse woody debris biomass needed to achieve management objectives.

8. These basic guidelines may not be applicable after disturbances in younger stands since remnant coarse woody debris may be relatively small. In these cases, diameter and biomass retention guidelines should be developed consistent with the intention of regenerating late-successional forest conditions.

9. Logs present on the forest floor before a disturbance event provide habitat benefits that are likely to continue. It seldom will be appropriate to remove them. Where these logs are in an advanced state of decay, they will not be credited toward objectives for coarse woody debris retention developed after a disturbance event. Advanced state of decay should defined as logs not expected to persist to the time when the new stand begins producing coarse woody debris.

10. The coarse woody debris retained should approximate the species composition of the original stand to help replicate preexisting suitable habitat conditions.

11. Some deviation from these general guidelines may be allowed to provide reasonable access to salvage sites and feasible logging operations. Such deviation should occur on as small a portion of the area as possible, and should not result in violation of the basic intent that late-successional forest habitat or the development of future such habitat should not be impaired throughout the area. While exceptions to the guidelines may be allowed to provide access and operability, some salvage opportunities will undoubtedly be foregone because of access, feasibility, and safety concerns.

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Table III-5. Estimated acres of federal land by allocation for each option by state and physiographic province.

			OPTION 1 Acres of federal land by allocation				OPTION 2 Acres of federal land by allocation			
State/ Physiographic province	Total acres federal land	Congressionally Withdrawn Areas	Late-Sucessional Reserves	Administrative Withdrawn Areas	Riparian Reserves	Matrix	Late-Sucessional Reserves	Administrative Withdrawn Areas	Riparian Reserves	Matrix
Washington										
Eastern Cascades	3,472,400	1,473,800	1,151,400	222,400	212,500	412,200	952,800	261,700	195,200	588,800
Western Cascades	3,721,700	1,749,400	1,405,100	191,600	151,100	224,600	1,216,900	265,100	150,600	339,700
Western Lowlands	126,300	1,700	90,600	0	0	34,100	0	0	0	124,700
Olympic Peninsula	1,518,800	976,700	413,300	1,900	63,500	63,400	402,000	2,200	56,600	81,300
Total:	**8,839,200**	**4,201,600**	**3,060,400**	**415,900**	**427,100**	**734,300**	**2,571,700**	**529,000**	**402,400**	**1,134,500**
Oregon										
Klamath	2,106,200	259,100	1,367,400	60,200	165,500	254,000	1,049,700	73,600	223,100	500,900
Eastern Cascades	1,557,400	425,200	642,000	109,200	102,900	278,100	562,800	130,100	82,400	356,900
Western Cascades	4,478,200	721,800	2,669,500	126,700	393,100	567,100	2,108,900	188,800	423,200	1,035,400
Coast Range	1,396,800	22,100	951,000	34,900	191,800	197,000	838,100	36,600	191,800	308,200
Willamette Valley	25,600	0	4,200	0	5,800	15,500	2,800	0	5,100	17,600
Total:	**9,564,200**	**1,428,200**	**5,634,100**	**331,000**	**859,100**	**1,311,700**	**4,562,300**	**429,100**	**925,600**	**2,219,000**
California										
Coast Range	388,200	94,700	129,900	31,700	40,500	91,400	118,200	33,900	29,300	112,100
Klamath	4,459,900	1,214,300	2,119,000	226,500	401,600	498,400	1,322,700	428,600	474,900	1,019,400
Cascades	1,009,200	44,300	552,100	76,100	141,900	194,800	342,500	96,000	160,500	365,900
Total:	**5,857,300**	**1,353,300**	**2,801,000**	**334,300**	**584,000**	**784,600**	**1,783,400**	**558,500**	**664,700**	**1,497,400**
Three-State Total:	**24,260,700**	**6,983,100**	**11,495,500**	**1,081,200**	**1,870,200**	**2,830,600**	**8,917,400**	**1,516,600**	**1,992,700**	**4,850,900**

Table III-5. (continued)

State/ Physiographic province	Total acres federal land	Congressionally Withdrawn Areas	OPTION 3 Acres of federal land by allocation: Late-Successional Reserves	Managed Late-Successional Areas	Administrative Withdrawn Areas	Riparian Reserves	Matrix	OPTION 4 Acres of federal land by allocation: Late-Sucessional Reserves*	Administrative Withdrawn Areas	Riparian Reserves	Matrix
Washington											
Eastern Cascades	3,472,400	1,473,800	1,035,600	0**	255,200	199,200	508,600	992,500	265,100	244,600	496,400
Western Cascades	3,721,700	1,749,400	1,105,700	79,500	301,900	167,800	317,400	1,220,900	252,900	211,900	286,500
Western Lowlands	126,300	1,700	0	0	0	0	124,700	90,600	0	0	34,100
Olympic Peninsula	1,518,800	976,700	404,600	0	2,200	59,100	76,100	418,400	1,700	61,000	61,000
Total:	8,839,200	4,201,600	2,545,900	79,500	559,300	426,100	1,026,800	2,722,400	519,700	517,500	878,000
Oregon											
Klamath	2,106,200	259,100	881,300	145,900	99,600	227,100	493,300	973,900	90,900	292,900	489,500
Eastern Cascades	1,557,400	425,200	575,600	0**	126,700	86,400	343,400	457,600	176,900	135,100	362,600
Western Cascades	4,478,200	721,800	1,528,300	516,900	252,600	467,900	990,800	1,706,400	229,400	734,600	1,086,000
Coast Range	1,396,800	22,100	870,100	2,600	36,900	183,400	281,700	919,300	36,400	205,800	213,200
Willamette Valley	25,600	0	2,500	300	0	5,100	17,500	3,200	0	6,300	16,000
Total:	9,564,200	1,428,200	3,857,800	665,700	515,800	969,900	2,126,700	4,060,400	533,600	1,374,700	2,167,300
California											
Coast Range	388,200	94,700	118,600	0	33,500	31,100	110,200	119,400	44,300	40,400	89,400
Klamath	4,459,900	1,214,300	1,170,300	101,100	480,000	534,100	960,100	1,262,200	432,900	693,500	856,900
Cascades	1,009,200	44,300	346,600	0**	96,000	159,200	363,200	242,300	129,400	254,700	338,600
Total:	5,857,300	1,353,300	1,635,500	101,100	609,500	724,400	1,433,500	1,623,900	606,600	988,600	1,284,900
Three-State Total:	24,260,700	6,983,100	8,039,200	846,300	1,684,600	2,120,400	4,587,000	8,406,700	1,659,900	2,880,800	4,330,200

* Includes 147,000 acres of managed late-successional areas
** Managed Late Successional Areas have been included in Late-Successional Reserves. Approximate acreages follow: Eastern Washington Cascades - 434,000 acres, Eastern Oregon Cascades - 190,000 acres, and California Cascades - 204,000 acres.

Table III-5. (continued)

State/ Physiographic province	Total acres federal land	Congressionally Withdrawn Areas	OPTION 5 Acres of federal land by allocation: Late-Sucessional Reserves*	Administrative Withdrawn Areas	Riparian Reserves	Matrix	OPTION 6 Acres of federal land by allocation: Late-Sucessional Reserves	Administrative Withdrawn Areas	Riparian Reserves	Matrix
Washington										
Eastern Cascades	3,472,400	1,473,800	730,700	409,800	235,600	622,400	809,500	300,400	219,700	668,900
Western Cascades	3,721,700	1,749,400	1,072,800	290,200	225,300	384,100	1,105,700	301,900	180,100	384,600
Western Lowlands	126,300	1,700	90,600	0	0	34,100	0	0	0	124,700
Olympic Peninsula	1,518,800	976,700	418,400	1,700	53,400	68,600	404,600	2,200	55,500	79,700
Total:	**8,839,200**	**4,201,600**	**2,312,500**	**701,700**	**514,300**	**1,109,200**	**2,319,800**	**604,500**	**455,300**	**1,257,900**
Oregon										
Klamath	2,106,200	259,100	877,100	108,800	272,000	589,300	881,300	99,600	260,900	605,400
Eastern Cascades	1,557,400	425,200	217,800	260,600	133,500	520,200	413,700	190,900	101,300	426,300
Western Cascades	4,478,200	721,800	1,123,600	317,900	741,800	1,573,200	1,528,300	252,600	566,500	1,409,000
Coast Range	1,396,800	22,100	916,200	36,400	166,300	255,800	870,100	36,900	177,200	290,500
Willamette Valley	25,600	0	2,200	200	5,400	17,800	2,500	0	5,200	17,800
Total:	**9,564,200**	**1,428,200**	**3,136,900**	**723,900**	**1,319,000**	**2,956,300**	**3,695,900**	**580,000**	**1,111,100**	**2,749,000**
California										
Coast Range	388,200	94,700	119,200	44,400	28,200	101,700	118,600	33,500	29,300	112,100
Klamath	4,459,900	1,214,300	1,070,800	476,400	604,700	1,093,700	1,170,300	480,000	505,600	1,089,700
Cascades	1,009,200	44,300	223,200	131,800	185,100	424,800	212,800	135,800	187,100	429,300
Total:	**5,857,300**	**1,353,300**	**1,413,200**	**652,600**	**818,000**	**1,620,200**	**1,501,700**	**649,300**	**722,000**	**1,631,100**
Three-State Total:	**24,260,700**	**6,983,100**	**6,862,600**	**2,078,200**	**2,651,300**	**5,685,700**	**7,517,400**	**1,833,800**	**2,288,400**	**5,638,000**

* Includes 147,000 acres of managed late-successional areas

Table III-5. (continued)

State/ Physiographic province	Total acres federal land	Congressionally Withdrawn Areas	OPTION 7 Acres of federal land by allocation				OPTION 8 Acres of federal land by allocation			
			Late-Sucessional Reserves*	Administrative Withdrawn Areas	Riparian Reserves	Matrix	Late-Sucessional Reserves	Administrative Withdrawn Areas	Riparian Reserves	Matrix
Washington										
Eastern Cascades	3,472,400	1,473,800	730,700	409,800	54,700	803,400	809,500	300,400	143,200	745,400
Western Cascades	3,721,700	1,749,400	982,200	330,800	52,500	606,800	1,105,700	301,900	124,500	440,300
Western Lowlands	126,300	1,700	90,600	0	0	34,100	0	0	0	124,700
Olympic Peninsula	1,518,800	976,700	353,000	5,700	15,300	168,100	404,600	2,200	44,200	91,100
Total:	8,839,200	4,201,600	2,156,500	746,300	122,500	1,612,400	2,319,800	604,500	311,900	1,401,500
Oregon										
Klamath	2,106,200	259,100	485,900	219,700	74,600	1,067,000	881,300	99,600	159,600	706,700
Eastern Cascades	1,557,400	425,200	216,500	260,600	29,200	626,000	413,700	190,900	61,500	466,100
Western Cascades	4,478,200	721,800	1,111,900	318,000	155,800	2,170,700	1,528,300	252,600	358,400	1,617,100
Coast Range	1,396,800	22,100	685,800	40,000	51,700	597,200	870,100	36,900	121,400	346,300
Willamette Valley	25,600	0	1,100	200	1,200	23,100	2,500	0	3,400	19,600
Total:	9,564,200	1,428,200	2,501,200	838,500	312,500	4,484,000	3,695,900	580,000	704,300	3,155,800
California										
Coast Range	388,200	94,700	118,200	45,000	6,600	123,600	118,600	33,500	19,300	122,000
Klamath	4,459,900	1,214,300	913,500	524,300	133,600	1,674,200	1,170,300	480,000	333,600	1,261,700
Cascades	1,009,200	44,300	223,200	131,800	44,200	565,600	212,800	135,800	126,200	490,100
Total:	5,857,300	1,353,300	1,254,900	701,100	184,400	2,363,400	1,501,700	649,300	479,100	1,873,800
Three-State Total:	24,260,700	6,983,100	5,912,600	2,285,900	619,400	8,459,800	7,517,400	1,833,800	1,495,300	6,431,100

* Includes 147,000 acres of managed late-successional areas

Table III-5. (continued)

State/ Physiographic province	Total acres federal land	Congressionally Withdrawn Areas	OPTION 9 Acres of federal land by allocation: Late-Sucessional Reserves	Adaptive Management Areas	Administrative Withdrawn Areas	Riparian Reserves	Matrix	OPTION 10 Acres of federal land by allocation: Late-Sucessional Reserves	Administrative Withdrawn Areas	Riparian Reserves	Matrix
Washington											
Eastern Cascades	3,472,400	1,473,800	874,600	78,800	243,600	235,000	566,500	809,500	300,400	219,700	668,900
Western Cascades	3,721,700	1,749,400	973,900	247,800	215,400	190,800	344,500	1,105,700	301,900	180,100	384,600
Western Lowlands	126,300	1,700	90,600	0	0	0	34,100	0	0	0	124,700
Olympic Peninsula	1,518,800	976,700	398,400	141,800	0	200	1,700	404,600	2,200	55,500	79,700
Total:	8,839,200	4,201,600	2,337,500	468,400	459,000	426,000	946,800	2,319,800	604,500	455,300	1,257,900
Oregon											
Klamath	2,106,200	259,100	746,300	251,600	86,900	263,900	498,500	881,300	99,600	260,900	605,400
Eastern Cascades	1,557,400	425,200	374,000	0	196,600	117,700	443,900	413,700	190,900	101,300	426,300
Western Cascades	4,478,200	721,800	1,324,500	237,000	277,400	578,000	1,339,400	1,528,300	252,600	566,500	1,409,000
Coast Range	1,396,800	22,100	715,900	232,100	33,800	145,300	247,600	870,100	36,900	177,200	290,500
Willamette Valley	25,600	0	1,600	200	100	5,500	18,200	2,500	0	5,200	17,800
Total:	9,564,200	1,428,200	3,162,300	720,900	594,800	1,110,400	2,547,600	3,695,900	580,000	1,111,100	2,749,000
California											
Coast Range	388,200	94,700	119,500	0	43,800	28,300	101,900	118,600	33,500	29,300	112,100
Klamath	4,459,900	1,214,300	1,176,200	298,400	428,200	490,400	852,400	1,170,300	480,000	505,600	1,089,700
Cascades	1,009,200	44,300	257,100	0	127,100	176,200	404,600	212,800	135,800	187,100	429,300
Total:	5,857,300	1,353,300	1,552,800	298,400	599,100	694,900	1,358,900	1,501,700	649,300	722,000	1,631,100
Three-State Total:	24,260,700	6,983,100	7,052,600	1,487,700	1,652,900	2,231,300	4,853,300	7,517,400	1,833,800	2,288,400	5,638,000

IV

Terrestrial Forest Ecosystem Assessment

Chapter IV

Terrestrial Forest Ecosystem Assessment

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Chapter IV Contributors

Richard Holthausen and Charles Meslow shared the assignment of coordinating activities of the Terrestrial Group. Much of the activity of the group centered on arranging, conducting and analyzing the information gained during the series of expert panels -- the "viability panels." The following persons served as panel leaders or panel members and provided the analysis and write-up of the taxa panel evaluations; several individuals took responsibility for more than one taxa: Bob Anthony, John Christy, Eric Forsman, Nancy Fredricks, Patricia Greenlee, Richard Holthausen, Robin Lesher, Bruce Marcot, Charles Meslow, Gary Miller, Martin Raphael, Roger Rosentreter, Tom Spies, Ed Starkey, and Cindy Zabel. Jerry Franklin, Grant Gunderson, Joe Lint, and Barry Mulder served as panel members. David Cleaves, Richard Holthausen, and Bruce Marcot organized the expert panel process. Along with Linda Kucera, David Cleaves acted as a facilitator for many of the expert panels. Grant Gunderson provided briefings on the options to each of the expert panels.

Linda Kucera acted as facilitator for many of the innumerable Team meetings and coordinated assembling our reports. Joe Lint supervised and edited the production of tabular data provided by the Spatial Analysis Group. Ken Cushing and Bruce Marcot prepared analyses of expert panel results. Martin Raphael was the chart meister.

Phil Dietrich, Jim Michaels, Barry Mulder, and Teresa Nichols provided oversight of the expert panel process from an Endangered Species Act perspective. Robin Bown reviewed and summarized forest management proposals received from interest groups and individuals. Tom Hamer, Mike Horton, Wayne Logan, Sarah Madsen, Gary Miller, Kim Nelson, and Lynn Roberts participated on the marbled murrelet working team.

Grant Gunderson documented the option development process and provided the description of the Options as they evolved. Eric Forsman, Jerry Franklin, Grant Gunderson, Joe Lint, Teresa Nichols, David Solis, Tom Spies, Ed Starkey, and John Tappeiner produced the standards and guidelines documentation.

Sara Hall, Clair Hibler, Cay Ogden, John Romero, Marilyn Stoll, Molly Sullivan, Kristi Swisher, and Monica Tomosy served as scribes for the panel sessions. Species maps were developed by Martin Raphael, Kevin Peeler, and John Young.

Chapter IV

TERRESTRIAL FOREST ECOSYSTEM ASSESSMENT

Descriptions of Terrestrial Forest Ecosystems

Overview of Biological Communities and Ownership Patterns for Each Physiographic Province

The area addressed in this report is the range of the northern spotted owl within the United States, which includes western Washington, western Oregon, and northwestern California south to Marin County. With the exception of some lowland interior valleys and coastal plains, this area is dominated by mountainous terrain and coniferous forests.

The range of the northern spotted owl within the United states encompasses approximately 57 million acres, of which 24.3 million acres (43 percent) is federal land (table IV-1). Of the federal lands, 19.5 million acres are administered by the U.S. Forest Service, 2.7 million acres are administered by the U.S. Bureau of Land Management, and 2.0 million acres are administered by the U.S. National Park Service (table IV-1). Other federal lands within the range of the owl include military installations and national wildlife refuges.

Table IV-1. Estimated total land acres within the range of the northern spotted owl by agency or ownership and physiographic province.

State/ Physiographic province	Acres by ownership				
	U.S. Forest Service	Bureau of Land Management *	National Park Service	Other federal	Non-federal
Washington					
Eastern Cascades	3,329,000	0	137,200	6,000	2,210,000
Western Cascades	2,957,000	0	760,200	4,400	2,428,300
Western Lowlands	0	0	1,700	124,700	6,343,900
Olympic Peninsula	628,000	0	889,400	1,500	1,512,200
Total:	**6,914,000**	**0**	**1,788,500**	**136,600**	**12,494,900**
Oregon					
Klamath	1,284,800	821,200	200	0	1,894,200
Eastern Cascades	1,431,800	48,400	77,200	100	767,500
Western Cascades	3,724,600	666,300	86,800	500	2,161,700
Coast Range	618,600	776,300	100	1,700	4,374,400
Willamette Valley	0	16,800	0	8,700	2,632,600
Total:	**7,059,800**	**2,329,000**	**164,300**	**11,000**	**11,830,400**
California					
Coast Range	70,100	219,900	77,500	20,600	5,302,300
Klamath	4,358,200	101,600	0	0	1,621,100
Cascades	998,500	10,400	0	0	1,493,300
Total:	**5,426,800**	**331,900**	**77,500**	**20,600**	**8,416,700**
Three-State Total:	**19,400,600**	**2,660,900**	**2,030,300**	**168,200**	**32,742,000**

* No acres tallied for Bureau of Land Management in Washington due to the dispersed nature of the ownership

Lands administered by the U.S. Forest Service are widely distributed within the range of the northern spotted owl. In contrast, Bureau of Land Management lands within the range of the owl are largely concentrated in western Oregon. Because of historical land grants, lands administered by the Bureau of Land Management in western Oregon tend to be distributed in a checkerboard pattern of alternating square-mile sections of federal and private land. In contrast, lands administered by the U.S. Forest Service tend to be more contiguous, with fewer inclusions of private land.

Some portions of the range of the owl contain little federal land. Most notable in this regard are the northern Coast Range Province in Oregon, the western Washington lowlands, and most of the coastal mountains of northern California. Nonfederal lands within the range of the owl include a variety of privately owned lands and areas owned and administered by state governments. Private lands include a multitude of small holdings and extensive areas owned by large timber companies. Indian reservations cover significant portions of the range of the owl, especially in the Olympic Peninsula, Eastern Cascades, and Klamath Provinces.

The Northern Spotted Owl Recovery Team (USDI 1992c) divided the range of the spotted owl into 12 provinces based on differences in vegetation, soils, geologic history, climate, land ownership, and political boundaries (see figure II-5). The physiographic provinces (also referred to as "provinces") incorporate physical, biological and environmental factors that shape broad-scale landscapes. Physiographic provinces reflect differences in geology (e.g., uplift rates, and recent volcanism, tectonic disruption) and climate (e.g., precipitation, temperature, and glaciation). These factors result in broad-scale differences in soil development and natural plant communities. Within each province, variable characteristics of rock stability affect steepness of local slopes, soil texture, soil thickness, drainage patterns, landforms, and erosional processes. Thus, physiographic provinces have utility in the description of both terrestrial and aquatic ecosystems (see Aquatic Ecosystem Assessment Appendix A for more detail). Rates of harvest and natural disturbance have varied tremendously among the 12 different provinces, depending on land ownership patterns, topography, climate, soils, and proximity to centers of human population. As a result, some provinces, such as the Oregon Coast Ranges and Western Washington Lowlands, contain little remaining late-successional/old-growth forest, whereas other provinces, such as the Oregon Cascades, still retain extensive areas of such forests. These patterns have been described in detail elsewhere (e.g., Franklin and Dyrness 1973; Thomas et al. 1990; Ruggiero et al. 1991; USDI 1992) and will only be briefly summarized here.

Olympic Peninsula

The Olympic Peninsula Province in northwestern Washington is a mountainous region bounded on three sides by water and on the fourth side by an extensive region of cutover state and private lands (the Western Washington Lowlands). Vegetation on the peninsula includes temperate rain forests of western hemlock, western red cedar, and Sitka spruce on the western slopes of the Olympic Mountains and forests of Douglas-fir and western hemlock in the rain shadow on the east side of the peninsula (Henderson et al. 1989). This province is occupied by a number of vertebrate species associated with late-successional/old-growth forests, including northern spotted owls, goshawks, American marten, and marbled murrelets. Although only a few nests have been found, large numbers of marbled murrelets are resident offshore and apparently nest on the peninsula. A dark race of the northern goshawk occurs on the peninsula and may represent a unique subspecies.

The Olympic National Park occupies the interior of the Olympic Peninsula. It is surrounded by the Olympic National Forest, which is surrounded by extensive areas of private land, Indian reservations, and state owned lands. Much of the Olympic National Park consists of high-elevation forests and subalpine areas. However, lowland valleys within the park contain significant areas of late-successional/old-growth forest.

The Olympic National Forest is characterized by a fragmented mixture of clearcuts, young plantations, and natural forests ranging from young stands to stands in excess of 2,000 years old. The southern edge of the National Forest includes the Shelton Sustained Yield Unit which was largely clearcut between 1960 and 1985. The National Forest includes several small wilderness areas on the east slope of the Olympic Range adjacent to the National Park. Most private lands, state lands, and Indian reservation lands on the peninsula have been clearcut within the last 80 years. Some of the private lands are now being clearcut for the second time.

Western Washington Lowlands

The Western Washington Lowlands Province includes the Puget Sound area and all of western Washington south of the Olympic Peninsula and west of the Cascades Range. This area is largely in state and private ownership and has been almost entirely clearcut within the last 80 years. It is now dominated by a mixture of recent clearcuts and young stands on cutover areas. Forests on cutover areas are dominated by even-aged mixtures of Douglas-fir, western hemlock, and red alder. This province also includes extensive agricultural and metropolitan areas.

Western Washington and Western Oregon Cascades

The Western Washington and Western Oregon Cascades Provinces include the entire west slope of the Cascades Ranges in Oregon and Washington. This region is dominated by humid forests of Douglas-fir and western hemlock at mid-to-low elevations and forests of silver fir and mountain hemlock at higher elevations. At the southern end of the Western Oregon Cascades, forests of Douglas-fir and western hemlock are largely replaced by mixed conifer forests of Douglas-fir, grand fir, and incense cedar. Land ownerships include a mixture of private and state lands, National Forests, and National Parks. The Bureau of Land Management has extensive holdings in the Western Oregon Cascades Province. Private and state lands within this area are mostly cutover, whereas Forest Service and Bureau of Land Management lands still include significant areas (albeit highly fragmented) of late-successional/old-growth forest. Although some National Parks and wilderness areas within this region include significant areas of mid-elevation late-successional/old-growth forest, most are dominated by high elevation areas of montane and subalpine vegetation. A large proportion of the known spotted owl population in Washington and Oregon occurs in the Western Cascades. In Washington, old forests on federal lands in the Western Cascades are also important nesting habitat for marbled murrelets.

Eastern Washington and Eastern Oregon Cascades

The Eastern Cascades Provinces in Washington and Oregon include the east slope of the Cascades Range from the Okanogan Highlands of northern Washington south to the California border. This region is dominated by mixed-conifer forests and ponderosa pine forests at mid to lower elevations and by true fir forests at higher elevations. Land ownership patterns include a mixture of Forest Service, private, state, Indian, National Park Service and Bureau of Land Management lands. Forests in this region are highly fragmented due to logging and a variety of natural factors (poor soils, high fire frequencies, high elevations).

Before the development of modern methods of fire suppression, wildfire played a major role in shaping the forests of this region. Fire suppression efforts in the last 60 years have resulted in significant fuel accumulations in some areas and shifts in tree species composition. These changes may have made forests more susceptible to catastrophic fires and to epidemic attacks of insects and diseases. Any plan to protect late-successional/old-growth forests in this area must include considerable attention to fire management and to the stability of forest stands.

Oregon Coast Range

The Oregon Coast Range Province includes the coastal mountains of western Oregon from the Columbia River south to the Middle Fork of the Coquille River. This area is dominated by forests of Douglas-fir, western hemlock, and western red cedar, with a narrow band of Sitka spruce along the coastal headlands. The southern half of the province includes a mixture of private, Forest Service, and Bureau of Land Management lands. The northern half is largely in private and state ownership. Heavy logging and a number of extensive wildfires during the last century have eliminated most late-successional/old-growth forests in the northern half of the province. Older forests in the southern half of the province are highly fragmented, especially on Bureau of Land Management lands, which are typically intermixed with cutover private lands in a checkerboard pattern of alternating square-mile sections.

Before the advent of fire suppression, the Coast Range Province was subject to frequent fires caused by lightning. As a result, many of the remaining natural forests consist of a mosaic of mature stands and remnant patches of old-growth trees. Because it is heavily cutover and relatively isolated from other forested areas, the Coast Range Province has been identified as an area of concern for spotted owls, marbled murrelets, and anadromous fish.

Willamette Valley

The Willamette Valley Province includes the lowland valley area between the Coast Range and Cascades Provinces in western Oregon. This area was originally covered by of a mosaic of lowland coniferous and deciduous forests and native prairie grasslands. It was mostly cleared in the 1800's and early 1900's and converted to farmland, residential areas and metropolitan areas. Land ownership is largely private.

Oregon Klamath and California Klamath

The Klamath Provinces of Oregon and California include much of southwestern Oregon and northwestern California. This area is dominated by mixed conifer and mixed conifer/hardwood forests. Land ownerships include a mixture of Forest Service, Bureau of Land Management, private, and state lands. Forests are highly fragmented by natural factors (poor soils, dry climate, wildfires) and timber harvest. Historically, much of the harvest in this area has been selective cutting rather than clearcutting. As a result, many stands that were logged in the early 1900's include a mixture of old trees left after harvest and younger trees that regenerated after harvest.

Much of the area within the Klamath Provinces is characterized by high fire frequencies. Any plan to protect late-successional/old-growth forests in these areas must include careful consideration of the role of fire in management of ecosystems.

California Coast Range

The California Coast Range Province includes the coastal strip that extends from the Oregon border south to Marin County, California. This area is dominated by redwood forests and mixed forests of Douglas-fir and hardwoods. Most of the area is privately owned, but Forest Service lands, Bureau of Land Management lands, and state and federal parks are also present. This area includes the coastal fog belt where the last remaining stands of old-growth redwoods occur. Considerable numbers of spotted owls occur on private lands in the area. This is an important nesting area for marbled murrelets.

California Cascades

The California Cascades Province includes the extreme southern end of the Cascades Range, which extends into California. Forests in this region are dominated by mixed conifer or ponderosa pine associations on relatively dry sites. Ownership is mixed with some areas of consolidated Forest Service lands and some areas of intermixed Forest Service and private lands. Forests are highly fragmented due to natural factors and harvest activities. As in a number of other provinces, fire plays an important role in the California Cascades in maintaining fire-adapted pine communities. Because of fire suppression, mixed conifer communities have increased, gradually replacing stands that were dominated by pine. If the objective is to manage a portion of the landscape in fire-dependent old forests, then management must include understory thinning and understory burning.

Current Forest Conditions

Allocation of Federal Lands

Federal lands within the range of the owl include 20.5 million acres that are considered capable of growing forests (table IV-2). The other 3.8 million acres of federal land includes high elevation nonforest areas and other nonforest types. Of the 20.5 million forest acres on federal lands, 5.7 million (28 percent) are Congressionally Withdrawn Areas, primarily Wilderness and National Parks (table IV-2). Another 3.3 million acres

Table IV-2. Estimated total federal acres and federal forest acres in Congressionally Withdrawn Areas and Administratively Withdrawn Areas in the range of the northern spotted owl, by state and by physiographic province.

State/ Physiographic province	Federal land acres			Federal forest acres *		
	Total	Congressionally Withdrawn areas	Administratively Withdrawn areas	Total	Congressionally Withdrawn areas	Administratively Withdrawn areas
Washington						
Eastern Cascades	3,472,400	1,473,800	586,100	2,498,100	986,800	409,400
Western Cascades	3,721,700	1,749,400	630,300	3,083,200	1,377,900	531,500
Western Lowlands	126,300	1,700	0	1,700	1,700	0
Olympic Peninsula	1,518,800	976,700	45,400	1,440,200	960,100	43,200
Total:	**8,839,200**	**4,201,600**	**1,261,800**	**7,023,200**	**3,326,500**	**984,100**
Oregon						
Klamath	2,106,200	259,100	333,500	1,939,300	223,300	300,500
Eastern Cascades	1,557,400	425,200	320,400	1,444,500	379,300	288,200
Western Cascades	4,478,200	721,800	545,300	4,219,200	661,100	516,200
Coast Range	1,396,800	22,100	73,600	1,331,500	22,100	47,100
Willamette Valley	25,600	0	200	16,000	0	200
Total:	**9,564,200**	**1,428,200**	**1,273,000**	**8,950,500**	**1,285,800**	**1,152,200**
California						
Coast Range	388,200	94,700	96,500	198,500	90,200	45,400
Klamath	4,459,900	1,214,300	1,203,100	3,553,600	955,800	957,700
Cascades	1,009,200	44,300	211,000	732,200	18,200	144,600
Total:	**5,857,300**	**1,353,300**	**1,510,600**	**4,484,300**	**1,064,200**	**1,147,700**
Three-State Total:	**24,260,700**	**6,983,100**	**4,045,400**	**20,458,000**	**5,676,500**	**3,284,000**

* Acre values for Forest Service, Bureau of Land Management , and National Park Service administered lands only.

(16 percent) are Administratively Withdrawn Areas, set aside by the managing agencies. Administrative withdrawals are designated for a variety of reasons, including protection of fragile soils or watersheds, protection of sites unsuited for tree growth, protection of wildlife or fish, recreation values, and scenic values. Administratively Withdrawn Areas are not necessarily off limits to timber harvest, but rates of harvest are frequently greatly reduced in such areas. These administrative withdrawals are subject to modification when agencies revise their current management plans.

Amounts of Late-Successional Conifer Forest on Federal Lands

We categorized vegetation on federal lands within the range of the owl into broad structural classes based on stand inventory data and satellite imagery (see section on Sources For Information on Forest Conditions). These structural classes were:

Small conifer--Stands dominated by small conifer trees ranging from 9 to 21 inches diameter at breast height. Exceptions were in eastern Washington and on the Mendocino National Forest in northern California where this structural class included trees from 9-15.9 inches diameter at breast height. This category also included stands with scattered large overstory trees that provide some old-forest characteristics.

Medium/large single-storied conifer--Stands dominated by conifer trees that were at least 21 inches diameter at breast height, and characterized by only a single canopy layer. Exceptions were in the Eastern Cascades Province of Washington and on the Mendocino National Forest in northern California where this structural class included trees that were at least 16 inches diameter at breast height. Stands in this structural class satisfy the definition of late-successional.

Medium/large multistoried conifer--Stands dominated by conifer trees that were at least 21 inches diameter at breast height, and characterized by a multistoried canopy. Exceptions were in the Eastern Cascades Province of Washington and on the Mendocino National Forest in northern California where this structural class included trees that were at least 16 inches diameter at breast height. Stands in this structural class include the majority of old-growth forests.

Forests on federal lands within the range of the northern spotted owl currently include approximately 4.5 million acres of multistoried, medium/large conifer forest, 4.0 million acres of single-storied medium/large coniferous forest, and 5.8 million acres of small, single story conifers (table IV-3). Over half of the medium/large coniferous forests occur at relatively high altitudes (over 4,000 feet) (table IV-4).

Of the 8.5 million acres of medium/large conifer forest on federal lands within the range of the northern spotted owl, 2.4 million acres (28 percent) are Congressionally Withdrawn Areas, and 1.6 million acres (19 percent) are Administratively Withdrawn Areas (table IV-3). An undetermined proportion of the medium/large conifer forests in both Congressionally Withdrawn and Administratively Withdrawn Areas are high-elevation forests that are not occupied by spotted owls. Although the latter stand types may not be important to spotted owls, they are important habitat for a variety of plants and animals that occupy late-successional high-elevation forests.

Table IV-3. Current estimated late-successional conifer forest on federal lands in the range of the northern spotted owl by total acres, acres in Congressionally Withdrawn Areas, and acres in Administratively Withdrawn Areas by state and physiographic province.

State/ Physiographic province	Total			Portion in Congressionally Withdrawn Areas			Portion in Administratively Withdrawn Areas		
	Small conifer single story *	Medium/large conifer ** Single story	Medium/large conifer ** Multi-story	Small conifer single story *	Medium/large conifer ** Single story	Medium/large conifer ** Multi-story	Small conifer single story *	Medium/large conifer ** Single story	Medium/large conifer ** Multi-story
Washington									
Eastern Cascades	830,100	515,500	432,200	286,000	183,700	217,700	164,400	74,600	68,600
Western Cascades	1,009,000	676,000	515,700	373,000	309,600	209,000	175,500	112,800	143,900
Western Lowlands	0	0	0	0	0	0	0	0	0
Olympic Peninsula	485,800	47,400	446,700	274,300	23,000	327,700	17,800	3,000	16,600
Total:	2,324,900	1,238,900	1,394,600	933,300	516,300	754,400	357,700	190,400	229,100
Oregon									
Klamath	596,200	207,500	489,500	98,100	19,400	50,900	104,400	30,500	75,700
Eastern Cascades	968,900	207,000	81,100	250,700	68,400	22,200	203,100	49,100	16,900
Western Cascades	1,165,100	997,900	921,200	279,400	231,900	102,200	189,900	125,200	122,600
Coast Range	526,100	209,300	140,500	18,900	2,600	400	19,400	9,700	10,900
Willamette Valley	4,300	1,300	800	0	0	0	0	0	100
Total:	3,260,600	1,623,000	1,633,100	647,100	322,300	175,700	516,800	214,500	226,200
California									
Coast range	4,700	25,800	9,800	300	2,700	2,200	2,100	9,600	3,800
Klamath	140,300	963,200	1,303,900	37,100	304,500	368,000	28,800	214,500	462,600
Cascades	38,500	181,500	157,100	1,800	4,700	0	1,400	40,100	34,400
Total:	183,500	1,170,500	1,470,800	39,200	311,900	370,200	32,300	264,200	500,800
Three-State Total:	5,769,000	4,032,400	4,498,500	1,619,600	1,150,500	1,300,300	906,800	669,100	956,100

* Stands generally characterized by trees 9.0 - 20.9 inches in diameter at breast height (dbh) - only a portion of these acres are late-successional forest.

** Stands generally characterized by trees 21.0 inches in diameter at breast height (dbh) or larger

Significant portions of Congressionally and Administratively Withdrawn Areas are covered by relatively young forest. Of the 5.7 million forest acres in Congressionally Withdrawn Areas, for example, 1.6 million acres (28 percent) are in single story stands of small conifers (table IV-3). This does not include additional acres that are covered by forests of trees smaller than 9 inches in diameter. The considerable acreage of small forests within Congressionally Withdrawn Areas reflects a long history of fire and othernatural disturbances as well as factors such as poor soils and high elevations, which tend to suppress tree growth.

Table IV-4. Acres of conifer forest on federal lands within the range of the northern spotted owl, by structural class and 2,000 foot elevation band.

State	Class [a]	*Elevation bands in thousands of feet*					*Grand total*
		0-2	*2-4*	*4-6*	*6-8*	*8-16*	
California	Small Conifer	1,107	53,115	92,635	35,766	830	183,452
	Med/Lrg Single Story Conifer	38,651	373,899	593,551	161,755	2,648	1,170,503
	Med/Lrg Multi Story Conifer	63,074	547,075	612,955	243,996	3,636	1,470,737
Oregon	Small Conifer	594,183	1,060,440	1,124,502	479,338	2,134	3,260,598
	Med/Lrg Single Story Conifer	228,347	665,003	559,959	169,541	40	1,622,889
	Med/Lrg Multi Story Conifer	261,939	784,828	523,403	62,837	40	1,633,045
Washington	Small Conifer	191,079	1,009,064	902,202	222,458	79	2,324,883
	Med/Lrg Single Story Conifer	33,750	435,668	692,746	76,669	0	1,238,833
	Med/Lrg Multi Story Conifer	147,252	593,195	618,172	36,042	0	1,394,661
3 State Total	**Small Conifer**	786,369	2,122,619	2,119,339	737,562	3,043	5,768,932
	Med/Lrg Single Story Conifer	300,747	1,474,570	1,846,256	407,965	2,687	4,032,226
	Med/Lrg Multi Story Conifer	472,264	1,925,098	1,754,530	342,876	3,675	4,498,443

[a] **Small Conifer** - Stands dominated by small conifer trees ranging from 9 to 21 inches diameter at breast height.
Medium/large single storied conifer - Stands dominated by conifer trees that are at least 21 inches in diameter at breast height, and characterized by only a single canopy layer.
Medium/large multistoried conifer - Stands dominated by conifer trees that are at least 21 inches diameter at breast height, and characterized by a multistoried canopy.

Patterns of Spatial Distribution

As described in the earlier descriptions of physiographic provinces, most late-successional and old-growth forests within the range of the northern spotted owl have been harvested from private and state lands. Late-successional/old-growth stands that remain on private and state lands tend to typically occur in small patches surrounded by cutover areas and young stands. In areas where little federal land is present, such as the western Washington lowlands, old-growth forests have been largely eliminated by harvest.

On federal lands, late-successional/old-growth forests are typically highly fragmented by harvested areas and stands of younger trees. Late-successional/old-growth forests in Congressionally Withdrawn Areas tend to occur in larger blocks than in other areas, but even in the Withdrawn areas, there is considerable natural fragmentation of older stands due to historic disturbance patterns and poor growth conditions.

Terrestrial Species of Special Political, Legal, and Biological Interest

Northern Spotted Owl

The northern spotted owl is a medium-sized forest owl that occurs along the Pacific Coast from southwestern British Columbia to central California. Studies of the owl during the last 20 years have shown it to be strongly associated with late-successional/old-growth forests throughout much of its range. In northern California and on the east slope of the Cascades in Washington, the spotted owl also occurs in some types of relatively young forest, especially where those forests are structurally similar to late-successional/old-growth forests.

Northern spotted owls nest in cavities or platforms in trees and feed on a variety of forest mammals, birds, and insects. They are long-lived, territorial birds, often spending their entire adult life in the same territory. In good habitat, pairs are typically spaced about 1-2 miles apart.

Data summarized by the U.S. Department of the Interior Spotted Owl Recovery Team indicated that spotted owls were located at approximately 4,600 sites in the years 1987-1991, including confirmed pairs at 3,602 sites (table IV-5), and single owls at approximately 1,000 sites (Thomas et al. 1993). The actual population is undoubtedly larger than the number of individuals confirmed because a significant portion of the range of the owl has yet to be adequately surveyed (USDI 1992c, Thomas et al. 1993). Although the majority of spotted owls occur on federal lands, significant numbers do occur on nonfederal lands, especially in northwestern California.

Legal status. The northern spotted owl was federally listed as a threatened species in 1990 (USDI 1990). The listing was based primarily on the fact that the preferred habitat of the owl was declining throughout its range. The lack of clear regulatory mechanisms that would ensure the retention of adequate habitat for the owl also figured in the listing. The northern spotted owl is listed as "endangered" by the state of Washington, "threatened" by the state of Oregon, and as a "species of special concern" by the state of California.

Existing recommendations. Early attempts to manage spotted owls focused on protection of habitat for individual pairs or clusters of two to three pairs scattered across the forest landscape on federal lands (Oregon Endangered Species Task Force 1977; Oregon-Washington Interagency Spotted Owl Subcommittee 1981). This approach was abandoned when it became apparent that single pairs or small clusters of two to three pairs occupying widely spaced areas would be unlikely to persist.

An alternative approach, initially published by Thomas et al. (1990) and more recently supported by the U.S. Department of the Interior Spotted Owl Recovery Team (USDI 1992c), was to manage for a network of "Habitat Conservation Areas", each of which was large enough to support 20 or more pairs of owls. Smaller Habitat Conservation Areas were permissible in areas where the 20 pair target was not achievable. To ensure that owls could disperse among Habitat Conservation Areas, Thomas et al. (1990) recommended that distances between Habitat Conservation Areas should not exceed 12

Table IV-5. Known and inferred number of pairs of spotted owls located during a five-year period on all lands in Washington, Oregon, California. These are detected pairs only; numbers do not represent total population size.

Landowner or Agency	Owl pairs: Withdrawn[b]	Non-Withdrawn[c]	Totals
FS, Washington	61	425	486[d]
FS, Oregon	83	1,081	1,164[d]
FS, California	38	433	471[d]
BLM, Oregon	1	607	608[d]
BLM, Washington	0	22	22[d]
NPS, Washington	64	0	64[d]
NPS, Oregon	8	0	8[e]
NPS, California	2	0	2[d]
Indian lands, Washington	0	32	32[e]
Indian lands, Oregon	0	36	36[e]
Indian lands, California	0	37	37[e]
FWS, Washington	0	0	0[e]
FWS, Oregon	0	0	0[e]
WDNR, Washington	0	43	43[e]
WDW, Washington	0	1	1[e]
State parks, Washington	0	0	0[e]
Cities of Seattle, and			
ODF, Oregon	0	24	24[e]
State parks, Oregon	2	0	2[e]
Counties and cities, Oregon	1	0	1[e]
CDF, California	0	4	4[d]
State parks, California	0	10	10[d]
BLM/TNC, California	0	0	0[d]
NAS, California	0	0	0[d]
Private, Washington	0	45	45[d]
Private, Oregon	0	128	128[d]
Private, California	0	414	414[d]
	260	3,342	3,602

a Information obtained from landowners, land managers or state wildlife agencies.

b Withdrawn from timber harvest (e.g., wilderness, national park, research natural area).

c Owl pairs on lands not withdrawn from timber harvest.

d Five year survey period - 1987 to 1991.

e Five year survey period - 1988 to 1992.

FS - U.S. Forest Service
BLM - U.S. Bureau of Land Management
NPS - National Park Service
FWS - U.S. Fish and Wildlife Service
WDNR- Washington Department of Natural Resources
WDW - Washington Department of Wildlife
ODF - Oregon Department of Forestry
CDF - California Department of Forestry and Fire Protection
TNC - The Nature Conservancy
NAS - National Audubon Society

miles. This approach, often referred to as a "metapopulation" approach, has received considerable support from conservation biologists and ecologists as a viable alternative to a "save it all" approach to northern spotted owl management. Although this strategy would allow a considerable decline in the owl population, Thomas et al. (1990) argued that the population within the Habitat Conservation Areas would eventually stabilize as the forest stands regenerated on cutover areas within the Habitat Conservation Areas.

Marbled Murrelet

The marbled murrelet is a small seabird somewhat larger than a robin. The North American subspecies of the marbled murrelet ranges from the Aleutian Archipelago in Alaska south to central California. Marbled murrelets are unique among alcids in their choice of nesting habitat. Except for the treeless tundra portions of their range and possibly a portion of the Prince William Sound area in Alaska, marbled murrelets nest exclusively in trees. Some nest sites are located considerable distances inland from saltwater; marbled murrelets have recently been detected up to 52 miles inland in Washington State (T. Hamer, personal communication).

Many aspects of the life history of marbled murrelets are poorly understood. However, it is believed that they are much like other alcids, which are relatively long-lived and which first breed at about 3 to 4 years of age (Gaston 1992). They may not breed every year. A single egg is laid and incubated by both adults in alternating 24-hour shifts for approximately 28 days. After hatching, the adults leave the chick unattended except for feeding visits. The chick is cryptically colored and remains in the nest approximately 30-35 days before flying to the ocean.

Marbled murrelets are associated with late-successional/old-growth forests throughout most of their range. Although only 54 marbled murrelet nests have been found in North America, 44 of those nests, including all 22 found in Washington, Oregon, and California, are in forests with old-growth characteristics. Nests in trees are typically on top of a large limb or other broad surface, such as thick moss or branch deformations generated by disease or past damage to the nest tree, or on platforms created where two branches come together. Most nests are directly under overhanging branches. It is believed that overhanging branches over nests may reduce detection by predators and provide protection from harsh weather. Because marbled murrelets are seabirds, and thus depend on the ocean for food, nesting habitat must be available within flight distance of a marine environment.

Historical data on the population size of marbled murrelets is largely anecdotal. In the early 1900's marbled murrelets were frequently described in the literature as being common or even abundant in areas that now support low numbers of murrelets. Estimated population sizes in the 1980's were 5,000 individuals in Washington (Speich et al. 1992), 2,000-3,000 individuals in Oregon (Nelson et al. 1992; Strong et al. 1993), and 2,000-3,000 individuals in California (Carter and Erickson 1992). The Oregon, Washington, and California populations are currently being recensused using improved techniques.

Loss of late successional/old-growth forest has reduced the number of nest sites available to marbled murrelets and may be the cause of several gaps in their inland distribution (Carter and Erickson 1992; Sowls et al. 1980; K. Nelson, personal communication 1993).

A major concern is that continued loss of nesting habitat and increasing isolation of the remaining breeding colonies could adversely effect long-term population stability.

High failure rates of marbled murrelet nests in trees has led some to hypothesize that fragmentation of nest stands may cause murrelets to be more susceptible to predation. Predation appears to be the major source of mortality for nestling marbled murrelets. Success rates of nests in trees is only 27 percent, and 54 percent of the nests that fail do so as a result of predation (K. Nelson, personal communication 1993). One theory is that the primary predators on nestling murrelets (jays, ravens, and crows) may be more abundant along forest edges, or may be able to more easily detect nests along edges.

The apparent low reproductive success and recruitment of young birds into the breeding population are major concerns. Surveys in California have shown that only 1-2 percent of marbled murrelets observed on the water each year are newly fledged birds (C. J. Ralph, personal communication 1993). Recent counts of newly fledged birds along the coast of Oregon led to an estimate of 1.1-2.7 percent juvenile birds (Strong et al. 1993); shore-based counts ranged from 1.0-4.5 percent juvenile murrelets over a 5-year period (Nelson and Hardin, in press). Because juvenile birds experience the highest rates of mortality in alcids (Nettleship and Birkhead 1985), rates of recruitment to the breeding population may be substantially lower than inferences drawn from counts of newly fledged birds. Even given the long life expectancy of alcids, newly fledged young: adult ratios appear low. Because of adult longevity, population declines may lag behind declines in reproduction and not be readily detected and not associated with causative factors.

Legal status. The marbled murrelet was federally listed in 1992 as a threatened species in Washington, Oregon, and California (USDI Fish and Wildlife Service 1992). The listing was based on the loss of nesting habitat (late-successional/old-growth forests) and, to a lesser extent, on the threat from gill-net mortality and the potential of catastrophic mortality from oil spills. Under existing state laws, the marbled murrelet is listed as sensitive in Oregon by the Oregon Department of Fish and Wildlife and a candidate for listing by the Washington Department of Wildlife (the candidate category includes species that are currently under review for possible state listing as endangered, threatened, or sensitive). In California, the marbled murrelet was listed as a state endangered species in 1991 by the California Department of Fish and Game.

A Marbled Murrelet Recovery Team was established by the U.S. Fish and Wildlife Service in February 1993 to develop a recovery plan for the species. A draft recovery plan is anticipated in late 1993 or early 1994, with a final plan due 6-12 months later. The recovery plan will address all aspects of the life history of the marbled murrelet, including the nesting habitat conditions throughout the range (regardless of ownership) and potential impacts in the marine environment (e.g., gill-net mortality, oil spills).

Existing recommendations. In 1990, prior to the listing of the marbled murrelet, an interagency team, with both research and management expertise, developed a set of interim management guidelines for marbled murrelet conservation in Washington, Oregon, and California. The latest draft was completed in August 1991. To date, there has been no adoption or recognition of these interim guidelines.

Thomas et al. (1993) recommended interim protection of all habitat that was suitable for nesting by marbled murrelets on federal lands within 35 miles of the coast in California and southern Oregon, and 50 miles of the coast in Washington and northern Oregon.

They further recommended that additional "recruitment habitat" be protected, equal to 50 percent of the amount of suitable habitat outside of Category 1 and 2 Habitat Conservation Areas (as described in Thomas et al. 1990). These guidelines were intended to be interim, pending completion of a recovery plan for the marbled murrelet. The Thomas et al. (1993) guidelines have not been formally accepted by any federal agencies.

Both the U.S. Forest Service and Bureau of Land Management require that proposed timber sales in suitable murrelet habitat be surveyed for marbled murrelets and that consultation with the U.S. Fish and Wildlife Service be initiated for all actions that may affect marbled murrelets. Beyond that, neither agency has adopted specific management guidelines for protection of marbled murrelets.

Other Threatened or Endangered Species

The Final Draft Recovery Plan for the Northern Spotted Owl (USDI 1992c) reviewed other species that might be influenced by the plan. This review included threatened or endangered species, candidates for federal listing, sensitive species or species of special concern in any one of the three states, and species associated with late-successional forests. Of 668 species that were considered in the recovery plan, eight are listed federally as threatened or endangered, 162 are candidates for federal listing, 27 are listed as threatened or endangered by one or more of three states within the range of the northern spotted owl, and 144 are sensitive species or species of special concern in at least one state. Of the species considered, 482 are associated with late-successional forests. In addition, the list of 28 fish species includes numerous stocks that are at risk and may become candidates for listing in the future. The large number of candidates for federal listing, species of special concern, and those associated with late-successional forests emphasizes the need for an ecosystem-based strategy to conserve biological diversity. In addition, the large number of riparian associates and the many fish stocks that are considered at risk emphasize the importance of protecting and restoring riparian areas in any such strategy.

The eight threatened or endangered species include four birds, two mammals, one stock of chinook salmon, and one plant found in coniferous forests in the Pacific Northwest. Other species within the range of the northern spotted owl are federally listed but are not included here because they are principally associated with habitats other than coniferous forests. The species included on the list of threatened or endangered species found in coniferous forests are the grizzly bear, gray wolf, bald eagle, marbled murrelet, peregrine falcon, northern spotted owl, Sacramento River winter chinook salmon, and McDonald's rock-cress. A brief description of the legal status, existing management recommendations (i.e., recovery plans), and important biological considerations of six of these species is presented below. Similar information was presented for northern spotted owls and marbled murrelets in previous sections.

Grizzly Bear

The grizzly bear is federally listed as threatened and state listed as endangered in Washington. It has been extirpated in Oregon and California and is found only in the northern Cascade Mountains of Washington. This population of grizzly bears was not included in the original listing of the grizzly bears in the Intermountain States, so there is currently no recovery plan for the population in Washington. Recovery planning by the Fish and Wildlife Service for the population of the species in the North Cascades of Washington is currently under way.

Grizzly bears are not closely associated with late-successional forests, but inhabit vast, diverse, and remote mountainous areas away from human disturbance. They use a variety of vegetation types and forest successional stages for foraging and other life functions. These habitats include open areas such as lowland wet meadows and marshes, shrub fields, high-elevation sedge or heath meadows, and stream floodplains. Forested areas are used for resting and hiding cover as well as for foraging.

Gray Wolf

The gray wolf is federally listed as endangered and is listed as endangered by the state of Washington. It has been extirpated from Oregon and California and is found only in the northern Cascade Mountains of Washington. The North Cascades population of gray wolves was not included in the initial federal listing of the species in the Intermountain States. Therefore, there is no recovery plan for the species in Washington. The recovery plan for gray wolves is being revised by the Fish and Wildlife Service to include the population in Washington.

Like the grizzly bear, the gray wolf is not closely associated with late-successional forests within the range of the northern spotted owl. Forested and open habitats supporting ungulate populations, their major prey, are the primary requirements of the gray wolf. Areas that support small-mammal populations are important seasonally. Human-induced mortality is the major limiting factor to the survival of the species throughout its range. Wolf predation on livestock can cause conflicts with humans, and misconceptions about wolves have led to indiscriminate shooting.

Bald Eagle

The bald eagle is listed federally as threatened in Washington and Oregon and endangered in California. Breeding and wintering populations occur in all three states. The Pacific Bald Eagle Recovery Plan (USDI 1986) covers the management recommendations for the species in the Pacific Northwest.

Prey of the bald eagle consists primarily of fish during the breeding season and waterfowl or carrion during the fall and winter. As a result, the species forages over water for most of its prey items. However, bald eagles nest (and roost communally – usually during winter) in forested habitats, and these areas are in old-growth forests or forests that possess components of old-growth forests. Nesting and roosting areas are considered essential habitat features for the species. The Pacific Bald Eagle Recovery Plan recognizes the importance of older forests for nesting and roosting, and timber harvest is restricted in such areas.

Peregrine Falcon

The peregrine falcon is listed federally as endangered in all three states. Both breeding and wintering populations occur in all three states. The Pacific States Recovery Plan for the Peregrine covers the recommendations for management for the species.
The peregrine falcon is not closely associated with late- successional forests, but it often nests on cliffs that are situated among coniferous forests in the Pacific Northwest. It

also forages in and around coniferous forests, and its prey base is quite diverse, with most of the prey associated with openings around forested areas. Pesticides, particularly DDT, were a major factor in the initial decline of this species. Populations of the species have increased in some areas of North America since DDT was banned and a large scale reintroduction program was initiated. However, populations in the Pacific Northwest have not reached recovery levels.

Sacramento River Winter Chinook Salmon

This stock of chinook salmon is listed as threatened throughout this river system. A recovery plan for this stock of fish has been completed and is under the jurisdiction of the National Marine Fisheries Service.

The major spawning areas for this species occur outside of coniferous forests. Before the construction of Shasta Reservoir, this stock of salmon spawned throughout the upper tributaries of the Sacramento River. Forest management practices along the tributaries to the west of the mainstem below the reservoir could have an influence on the species. The major factors that affect the stock are probably the allocation of water flows on the river, withdrawal of water for irrigation, and harvesting of the fish at sea.

MacDonald's Rock-Cress

MacDonald's rock-cress was listed federally as endangered in 1978 (USDI 1978), and a recovery plan was completed in 1984 (USDI 1984). Specimens from Oregon, which were previously considered MacDonald's rock-cress, have been determined to be a separate and undescribed species. Therefore, both taxa are significantly more rare than originally considered (J. Nelson May 11, 1993, U.S. Forest Service, personal communication).

MacDonald's rock-cress occurs on barren or shrub-covered, rocky, and serpentine soils associated with Jeffrey pine woodlands, which range from 3,500 to 4,000 feet in elevation in Del Norte and Mendocino Counties, California (Matthews et al. 1990). These soils do not typically produce stands of commercial timber due to the sparse tree cover and low site productivity. However, salvage sales and related activities plus development of rock quarries for roads present potential threats to this species (Foster 1992). Mining of nickel-rich soils has posed the greatest threat to the species and was the primary concern cited in the original listing (USDI 1978).

Other Species Associated with Late-Successional and Old-Growth Forests

Literally thousands of species occupy late-successional and old-growth forests of the Pacific Northwest. Several previous efforts attempted to account for the effects of various forest management plans on these species. The Final Draft of the Recovery Plan for the Northern Spotted Owl (USDI 1992c) discussed 640 terrestrial species within the range of the northern spotted owl that were old-forest associates or threatened, endangered, or candidate species. The Scientific Analysis Team (Thomas et al. 1993) assessed the effects of various forest management options on 667 species, including 555 terrestrial species and 112 at risk fish stocks or species.

In the current assessment, we reviewed and updated the list of species associated with old forests. Criteria based on those developed by Thomas et al. (1993) were used for this effort (see section on identification of species closely-associated with late-successional forests). The number of species identified is greater than that shown by Thomas et al. because of new information and because this report focuses on all federal late-successional forests within the range of the northern spotted owl rather than just the old-growth component on National Forests. A total of 1,098 terrestrial species (not counting arthropods) are identified as closely associated with late-successional forests on federal lands. The number of species in each species group follows:

Fungi	527
Bryophytes	106
Lichens	157
Vascular plants	124
Mollusks	102
Amphibians	18
Birds	38
Mammals	26
Total species	1,098

In addition to this list of species, we recognized and reviewed 15 functional groups of arthropods that may include as many as 7,000 individual species closely associated with late-successional forests. Information on all these species and groups, and the effects of proposed management plans on them, is presented in the section on the effects of options on terrestrial ecosystems. (No reptile species was identified as closely associated with late-successional forests.)

Development of Terrestrial Options

Terrestrial Reserves: Late-Successional Reserves and Managed Late-Successional Areas

Habitat areas -- often referred to as "conservation areas" or, for this report, Late-Successional Reserves -- have been key components of most spotted owl and late-successional forest management strategies developed in the Pacific Northwest in the last decade. Thomas et al. (1990), the Final Draft Recovery Plan for the Northern Spotted Owl (USDI 1992c), Johnson et al. (1991), and Thomas et al. (1993) all recommended large blocks of federal land that encompass late-successional forests to serve as habitat areas. Although habitat areas from these plans were variously named, the objective of each plan was to provide areas where habitat would occur in amounts and arrangements capable of supporting multiple, reproductive pairs of spotted owls and other species associated with old-growth forests.

We used the conservation areas or Reserves from the above mentioned works to develop options. We briefly describe the biological rationale for, and criteria used to delineate the Reserves and Managed Late-Successional Areas of each of the plans.

Conservation areas of the Interagency Scientific Committee's Strategy and the Final Draft Recovery Plan for the Northern Spotted Owl

Conservation areas recommended by Thomas et al. (1990) and the Final Draft Recovery Plan (USDI 1992c) were designed to support multiple pairs of northern spotted owls. Empirical data from studies of other bird species and modeling results indicate that habitat patches or areas capable of supporting fewer than 15 breeding pairs have a low probability of successfully supporting the expected numbers of pairs through time. Fluctuations in birth and death rates or stochastic events are more likely to cause populations in such areas to "wink out," causing local extirpations. This information led the Interagency Scientific Committee (Thomas et al. 1990), and later the Northern Spotted Owl Recovery Team (USDI 1992c), to prescribe conservation areas large enough to support at least 20 pairs of spotted owls. Where lack of federal land or limitations in the amount of spotted owl habitat made it impossible to delineate 20-pair conservation areas, smaller areas were prescribed.

Principles of conservation biology and common sense also indicate that conservation areas should be located in a network system so that individuals of the species can successfully move (disperse) among such areas. Successful dispersal is necessary for recolonization of areas where habitat may be temporarily lost and it provides for maintenance of genetic diversity. The conservation areas of Thomas et al. (1990) and the Final Draft Recovery Plan (USDI 1992c) were spaced so as to accommodate dispersal of spotted owls. The conservation areas capable of supporting at least 20 pairs of spotted owls were to be no more than 12 miles apart, and those capable of supporting fewer than 20 pairs were to be no more than 7 miles apart. The 12-mile distance was within the dispersal radius of about two-thirds of the spotted owls observed in studies.

Thomas et al. (1990) and the Final Draft Recovery Plan (USDI 1992c) suggested that the successful movement by spotted owls would be increased if federal lands between the conservation areas (known as the forest Matrix) provided spotted owls with forage areas and cover from predation. To facilitate successful movement, the plans prescribed the 50-11-40 rule. This rule is described in the discussion on standards and guidelines. The 50-11-40 prescription is intended to provide a forested condition in the Matrix sufficient to sustain dispersing owls between conservation areas.

The following criteria were used to delineate the conservation areas:

- Conservation areas are to include 20 known pairs of spotted owls when possible.

- Conservation areas are to be widely distributed throughout the range of the northern spotted owl to provide redundancy in the network.

- Each conservation area is to be within the prescribed dispersal distance of at least two other conservation areas--again to provide redundancy in the network, and to increase the probability of successful movement by owls among the areas.

- Conservation areas are to be as circular as possible because this shape minimizes edge and maximizes interior forest conditions. Forest interior conditions are believed to be important to spotted owl survival. Because ownership patterns and actual terrain within the northern spotted owl range make it impossible to delineate circular conservation areas, the plans delineated large blocky conservation areas that mostly tended to be square or rectangular shaped.

- As much as possible, conservation areas are to be identified using wilderness areas and other land allocations where no timber harvest is planned.

- Conservation areas are to be distributed so forests at various elevations and in various ecological zones are included. The plans placed particular emphasis on delineated conservation areas in the lower elevational forest lands, which are generally more biologically productive than forests at higher elevations.

- In the Final Draft Recovery Plan (USDI 1992c), the conservation areas were adjusted to include known locations of other species associated with late-successional forests.

Reserves from Johnson et al. 1991

The report of the Scientific Panel on Late-Successional Forest Ecosystems (Johnson et al. 1991) identified large geographic areas the panel called "reserves." These Reserves were analogous to our Late-Successional Reserves and were identified primarily on the basis of locations of late-successional forests. Late-successional forests include mature forest stands greater than 80 years old, stands of mixed age (mature and old-growth forests), and old-growth forests.

The areas mapped as Reserves were aggregations of late-successional and old-growth forest stands that were categorized into three groups based on ecological significance. These categories were (1) most significant (LS/OG1), (2) significant (LS/OG2), and (3) remaining late-successional/old-growth forests (LS/OG3). The following characteristics of an area gave it ecological significance:

- Large contiguous blocks of forest that maximize the area of forest with interior forest conditions.

- A location that is key to the design of an interconnected system or network of late-successional conservation areas.

- Presence of classic old-growth forest as defined in Forest Service Research Note PNW-447 (Old-Growth Definition Task Force 1986).

- Areas of late-successional forests on lands with higher site productivity (generally lower elevation) that are believed to have greater biological diversity than late-successional forests at higher elevations.

- Areas with known or likely occurrence of spotted owls, marbled murrelets, or other species associated with late-successional forests.

In addition to the late-successional forest areas (LS/OG), Johnson et al. (1991) identified areas known as "owl additions" that, in combination with the LS/OG1s, would meet the criteria for spotted owl conservation areas from Thomas et al. (1990). The owl additions in combination with the LS/OG1 areas formed Reserves under some alternatives identified by Johnson et al. (1991).

Conservation Areas from the Scientific Analysis Team Report

Thomas et al. (1993) identified conservation areas beginning with either those of the Interagency Scientific Committee (Thomas et al. 1990) or the Final Draft Recovery Plan for the Northern Spotted Owl (USDI 1992c). The biological rationale for these areas was described above. Other terrestrial conservation areas that result from the application of mitigation steps offered in Thomas et al. (1993) are:

- Conservation areas resulting from protection of forest stands occupied by rare and locally endemic species closely associated with old-growth forests (at least 17 species).
- Conservation areas resulting from the protection of other species found in the upland forest Matrix (Del Norte salamander and great gray owl).

The small conservation areas that would result from protection of rare and locally endemic species and the Del Norte salamander and great gray owl are needed because significant numbers in such species, within the range of the northern spotted owl, occur outside the other larger conservation areas.

Recommendations of the Marbled Murrelet Working Team

The current effort incorporates recommendations from a marbled murrelet working team which were used in most options. The marbled murrelet working team assessed the network of Reserves from each of the three plans described above. The working team identified a minimum Late-Successional Reserve network on federal forest land they believed was necessary for an option to have a high probability of providing marbled murrelet nesting habitat in adequate amounts and arrangements to support viable populations. The working team identified two zones based on observed use and expected occupancy by marbled murrelets. Zone 1 extends 10 to 40 miles inland from the marine environments, depending on geographic area. The majority of murrelet occupied sites and sightings occur in this zone. Distances vary by geographic region, as follows:

Washington - Marine environments to 40 miles inland.

Oregon - Marine environments to 35 miles inland.

California at the Oregon border - Marine environments to 35 miles inland; thence southward maintaining a distance of 35 miles inland to a point of intersection with the Klamath River. The eastern boundary of zone 1 then follows the Klamath River southward to a point where it is 25 miles from the marine environments (near the town of Orleans, California); from that point, zone 1 extends southward with the eastern boundary remaining 25 miles inland until a point near the town of Ukiah, California. From Ukiah the eastern boundary of zone 1 then follows Route 253 to a point where it is 10 miles from marine environments; thence the eastern boundary of zone 1 extends southward, remaining 10 miles inland, to the southern end of the range of the northern spotted owl.

Zone 2 includes areas further inland from the eastern boundary of zone 1, and is characterized by relatively low numbers of murrelet sightings, partially a function of few inventories. Specific distances for zone 2 by geographic area are as follows:

Washington - from the eastern boundary of zone 1 (40 miles inland) to 55 miles inland from marine environments.

Oregon - from the eastern boundary of zone 1 (35 miles inland) to 50 miles inland from marine environments.

California - from the eastern boundary of zone 1 to 45 miles inland from marine environments to a point where the eastern boundary of zone 2 intersects with California Highway 175. At this point the southern boundary of zone 2 follows Highway 175 until it intersects with zone 1, where it ends.

In zone 1, the working team determined that a Late-Successional Reserve network should consist of the most significant late-successional forest areas (LS/OG1s), the significant late-successional forest areas (LS/OG2s), and the owl additions (or equivalent area) from Johnson et al. (1991). In addition to the network of Late-Successional Reserves, the murrelet team recommended surveys (to an accepted protocol) and protection of all sites occupied by murrelets in zones 1 and 2, regardless of whether they were in a Reserve or not. Occupied forest stands are to be protected as follows:

1. The contiguous stand within 0.5 mile of the occupied site will be protected from cutting.

2. Forest stands within 0.5 mile of the occupied site that are currently not suitable as nesting habitat, but will likely develop into such habitat within 25 years (100 years old) and are contiguous to the occupied forest stand, will be protected from cutting.

Protection of forest stands occupied by marbled murrelets in both zones 1 and 2 creates additional small Late-Successional Reserves including younger forests that will grow and develop into suitable nesting habitat for marbled murrelets.

Standards and Guidelines for Vegetation Management

In addition to standards and guidelines we developed for this report, we used other standards and guidelines derived from earlier plans proposed for the management of federal forest lands. Brief descriptions of four sets of standards and guidelines for vegetation management that we used follow:

The first set, standards and guidelines from the Scientific Panel on Late-Successional Forest Ecosystems (Johnson et al. 1991), provided for management of the late-successional/old-growth forest areas (LS/OG), called "reserves" in that report, and for areas between the reserves, or the forest Matrix. Standards and guidelines for the

Reserve restricted the cutting of trees to precommercial silvicultural treatments of young stands. Timber sales that had already been awarded were exempted from this prohibition.

Johnson et al. (1991) also proposed options for the management of the forest Matrix. In this report, the Forest Ecosystem Management Assessment Team used two of the Matrix options from Johnson et al. (1991):

- Forest Matrix Management Option A -- This option was designed to augment the standards and guidelines that were in effect under forest plans of the federal agencies. The 50-11-40 rule developed by Thomas et al. (1990) was included with an additional provision to increase the retention of old-growth structural components left after logging to provide structure in the forested environments. The 50-11-40 rule called for at least 50 percent of the forest stands on federal lands in a quarter-township to be at least 11 inches in diameter at breast height and for such stands to have a canopy closure of at least 40 percent. The intent of the 50-11-40 rule was to provide for conditions that would facilitate successful movement of spotted owls among reserves. The prescription for retention of old-growth forest structural components consisted of leaving six large green trees, two large snags (standing dead trees), and two large logs per acre after logging.

- Forest Matrix Management Option C -- This option is identical to option A but further stipulates that at least 10 percent of the forest outside Wilderness Areas and the proposed Reserves was to be older than 180 years. The remaining forest stands in the Matrix were to be managed using an area-control timber harvest strategy to achieve 180-year timber harvest rotations. At most, 1/18th of the area remaining in the Matrix would be cut per decade.

Standards and guidelines proposed by Johnson et al. (1991: 26) for the protection of watersheds and fish habitat include: (1) 180-year timber harvest rotations in "Key Watersheds" identified for their high water quality and the presence of species and stocks of fish considered to be at risk, and (2) riparian buffer zones. Riparian buffers of varying width were prescribed depending on the type of stream or wetland. There was to be no cutting of timber in the buffers and livestock grazing was to be curtailed to promote the reestablishment of riparian vegetation. A road improvement and reduction program was also to be implemented.

A second set of standards and guidelines we used was contained in the Final Draft Recovery Plan for the Northern Spotted Owl (USDI 1992c). This plan provided direction for the management of vegetation in the recommended conservation areas and the intervening federal forest lands -- the Matrix. Several categories of conservation areas were proposed, with variations in the standards and guidelines for each type. Descriptions of the standards and guidelines follow:

- Designated conservation areas -- Standards and guidelines for these areas have several key objectives (USDI 1992c: 64-75). They allow natural successional processes to continue in areas currently suitable as spotted owl habitat, and they focus silvicultural activities on developing suitable habitat for spotted owls in areas that are currently unsuitable. Salvage of dead trees is allowed where it will not retard development of suitable habitat. Standards and guidelines also provide for treatment of some forest stands within some of the conservation areas to reduce risk of large-scale disturbances. In some situations, these may include stands that are currently suitable owl habitat. The Recovery Plan indicates that a management plan for each designated conservation area should be completed prior to implementation of silvicultural activity in that conservation area.

- Reserved pair areas -- Standards and guidelines for management of vegetation within this category of conservation area are the same as those for the designated conservation areas (USDI 1992c: 86).

- Managed pair areas -- In this category of conservation area, the objective of the standards and guidelines is to always maintain an acreage of suitable habitat equal to the median amount observed in home ranges of pairs of spotted owls in each physiographic province (USDI 1992c: 86). A wider application of silvicultural activities designed to reduce the risk of large-scale disturbances is permitted in managed pair areas.

- Residual habitat areas - These conservation areas incorporate 100 acres of suitable spotted owl habitat as close as possible to the nest site or activity center of a pair of spotted owls or a single, territorial spotted owl. Timber management is not appropriate in the residual habitat areas, and adjacent management should be designed to reduce risk of natural disturbance.

- Matrix management -- The Draft Final Recovery Plan for spotted owls prescribed the 50-11-40 rule as a standard and guideline for management of vegetation outside the conservation areas.

The third set we drew from, the report of the Scientific Analysis Team (Thomas et al. 1993), provided standards and guidelines associated with several major components of a strategy that was developed to provide for species associated with old-growth forests within the range of the northern spotted owl using a step-wise approach. The standards and guidelines used within this report follow:

- Standards and guidelines for riparian habitat conservation areas (Thomas et al. 1993: 447-458) include the establishment of interim riparian buffers of varying widths for different categories of streams, lakes, and wetlands. Buffers for riparian areas vary from a minimum of 300 feet (on each side of the stream) for fish-bearing streams and lakes, to a minimum of 150 feet on each side of perennial streams without fish, and around ponds, reservoirs, and wetlands greater than 1 acre, to at least 100 feet on seasonally flowing streams or wetlands less than 1 acre. The riparian buffers are interim until watershed analyses are completed that may reduce or increase the widths of the buffers in some areas (see chapter V, Aquatic Ecosystem Assessment, for a description of watershed analysis). Vegetation management in the buffers would be limited to removal of hazard trees, silvicultural activities that create conditions needed to attain riparian objectives, and some limited salvage of dead trees following large catastrophic events. "Key Watersheds" identified by Thomas et al. (1993: 449) are delineated using the same criteria as those used by Johnson et al. (1991). However, under the standards and guidelines of the Scientific Analysis Team, Key Watersheds are used to establish priority areas for completing watershed analyses and restoration work rather than as areas where there would be extended timber harvest rotation as under Johnson et al. (1991).

- Standards and guidelines for protection of rare and locally endemic species (Thomas et al. 1993: 291-295) include inventories in areas where activities are planned that could disturb or destroy habitat occupied by such species. Sites occupied by rare and locally endemic species would be protected when located.

- Standards and guidelines for the protection of habitat for other species in the upland Matrix (Thomas et al. 1993: 295-299) consist of (1) conducting surveys and protecting sites occupied by Del Norte salamanders; (2) retaining a greater numbers of snags and green trees within the range of the white-headed woodpecker, black-backed woodpecker, pygmy nuthatch, and flammulated owl; (3) providing buffers around meadows and natural openings within the range of the great gray owl; (4) completing the habitat capability model for fisher and American marten by the National Forests in California and retaining all management requirement areas for martens on National Forests and in Oregon and Washington; (5) regulatory closure of kill trapping of martens in Oregon and Washington where the range of the American marten overlaps with that of the fisher (to avoid accidental kill trapping of fishers); (6) developing site-specific timber harvest, roading, and fire management plans in the range of the lynx to improve conditions for lynx.

The Forest Ecosystem Management Assessment Team developed additional standards and guidelines for some options. The bases for these standards and guidelines are presented in the section on Ecological Principles for Management of Late-Successional Forests.

Ecological Principles For Management of Late-Successional Forests: The Basis For Standards And Guidelines

In this section we provide the rationale for management of Late-Successional Reserves and Matrix lands, and the development of terrestrial standards and guidelines. A similar discussion of the aquatic/riparian system is found in Chapter V. Specific terrestrial standards and guidelines used to develop the options are presented in Chapter III.

Standards and guidelines provide objectives and rules for management under different options evaluated by the Forest Ecosystem Management Assessment Team. All of the options have the same general goal: maintain late-successional species and ecosystems on federal lands while providing for social and economic needs. Late-successional forests are those forest seral stages that include mature and old-growth age classes (Thomas et al. 1993:510). The options differ in means used to reach that goal and the degree of certainty that the goal will be met.

For all options, standards and guidelines are intended to provide guidance during the early phase of implementation. However, forest ecosystems are quite variable throughout the Pacific Northwest and site-specific knowledge of ecosystems is best interpreted and applied by resource specialists familiar with local conditions. These specialists will aid in refining the standards and guidelines over time to adapt to specific planning areas and incorporate new information and improved understanding of ecosystems. A process by which standards and guidelines could be modified is described in Chapter VIII. Oversight groups would be responsible for interpretation of guidelines provided by any selected option, as well as review and approval of proposed modifications.

An important goal of forest management on the federal lands is to maintain biological diversity associated with native species and ecosystems in accordance with environmental laws and regulations. To meet this goal, the federal lands are viewed as an ecologically interdependent mosaic of ecosystems that is stratified into Congressionally Withdrawn Areas, Late-Successional Reserves, and Matrix.

In Late-Successional Reserves, standards and guidelines are designed to maintain late-successional forest ecosystems and protect them from loss to large-scale fire, insect and disease epidemics, and major human impacts. The intent is to maintain natural ecosystem processes such as gap dynamics, natural regeneration, pathogenic fungal activity, insect herbivore, and low-intensity fire. In some options, standards and guidelines encourage the use of silvicultural practices to accelerate the development of overstocked young plantations into stands with old forest characteristics, and to reduce the risk that Late-Successional Reserves will be severely impacted by large-scale disturbances and unacceptable loss of habitat.

The Matrix is an integral part of the conservation strategy included in all options. Production of timber and other commodities is an important objective for the Matrix. However, management must ensure that the forests in the Matrix provide for connectivity between Late-Successional Reserves and provide habitat for a variety of organisms associated with both late-successional and younger forests, and that ecosystem productivity is maintained. Standards and guidelines for the Matrix are designed to provide for important ecological functions such as dispersal of organisms, carryover of some species from one stand to the next, and maintenance of ecologically valuable structural components such as down logs, snags, and large trees. The Matrix will also provide for ecologically diverse early-successional conditions.

General Ecological Basis For Forest Management

Most options contain provisions to manage young forests to maintain or accelerate the development of attributes that are characteristic of late-successional forests, namely: (1) structure and composition, (2) ecological processes, and (3) ecosystem functions.

Structure and Composition

The structure and composition of late-successional and old-growth forest ecosystems has been detailed in numerous publications (e.g., Franklin et al. 1981; Spies and Franklin 1988; Spies and Franklin 1991). Franklin et al. (1981) identified four major structural attributes of old-growth Douglas-fir forests: live old-growth trees, standing dead trees (snags), fallen trees or logs on land, and logs in streams. Additional important elements typically include multiple canopy layers, smaller understory trees, canopy gaps, and patchy understory (Spies et al. 1990). Structural characteristics of old forests vary with vegetation type, disturbance regime, and developmental stage. For example, in many Douglas-fir stands in western Oregon and Washington the mature phase of stand development begins around 80 years with relatively large live and dead trees (Spies and Franklin in press), although multiple canopy layers may not yet be well developed. In some forest types subject to frequent, low-intensity fire, such as ponderosa pine, the late-successional and old-growth stages typically have relatively open understories and relatively few large fallen trees in comparison with more moist Douglas-fir/western hemlock types. We recognize that as structural and compositional characteristics of old forests vary among physiographic provinces, so necessarily will standards and guidelines intended to promote the desired conditions.

Ecological Processes

Ecological processes include those natural changes that are central to the development and maintenance of late-successional and old-growth forest ecosystems. Although the processes that created the current late-successional and old-growth ecosystems are not completely understood, we do know that they include: (1) tree growth and maturation, (2) death and decay of large trees, (3) low to moderate intensity disturbances (e.g., fire, wind, insects, and disease) that create canopy openings or gaps in the various strata of vegetation, (4) establishment of trees beneath the maturing overstory trees either in gaps or under the canopy, and (5) closing of canopy gaps by lateral canopy growth or growth of understory trees. These processes result in forests moving through different stages of late-successional/old-growth conditions that may span 80 to 1,000 years for forests dominated by long-lived species.

Several authors have described these stages (Bormann and Likens 1979; Oliver 1981; Peet and Christensen 1987) and Spies and Franklin (in press) have expanded the descriptions to include the protracted nature of stand development in forests dominated by long-lived trees such as Douglas-fir. Following stand-replacement disturbance, these stages can be described as (1) establishment, (2) thinning, (3) maturation, (4) transition, and (5) shifting-gap.

The maturation stage (3) is characterized by a slowed rate of height growth and crown expansion. Heavy limbs begin to form and gaps between crowns become larger and more stable or expand from insect and pathogen mortality. Large dead and fallen trees begin to accumulate, and the understory may be characterized by seedlings and saplings of shade-tolerant tree species. In Douglas-fir stands west of the Cascades, this stage typically begins between 80 and 140 years, depending on site conditions and stand history.

During the transition stage (4), the original cohort of overstory trees approaches its maximum height and diameter and growth is slow. Tree crowns become more open and irregular in shape and contain heavy limbs, Broken, dead, and decaying portions of tree crowns are common. Old trees become relatively resistant to low to moderate intensity fire, and depending on species, crown bases are high above the understory and bark is relatively thick. During this stage, understory trees form multiple canopy layers, coarse woody debris accumulates to relatively high levels, and low to moderate intensity disturbances from insects, disease, wind, and fire create patchy openings and accumulations of standing dead trees. These disturbances also frequently promote establishment or advancement of understory trees that eventually fill the holes in the canopy. In Douglas-fir stands west of the Cascades, this stage begins between 150 to 250 years and may last for an additional 300 to 600 years depending on site conditions and species.

The shifting-gap stage begins when the last of the original cohort of overstory old-growth trees dies and all trees in the canopy have established following smaller gap-type disturbances of various types. Forests in the last two stages (4 and 5) of development actually contain all of the stand developmental stages in a relatively fine-grained mosaic of smaller stands. The later three stages (3, 4, and 5) embody the late-successional/old-growth conditions that are the focus of this report.

Some of the stand developmental processes, such as tree growth and mortality, and understory establishment, can be accelerated through silvicultural manipulations. Most options provide for the acceleration of these processes in younger stands. Other processes such as maturation of tree crowns, thickening of bark, and decay of tree boles are not readily accelerated through silviculture. Because of our limited knowledge of late-successional and old-growth processes and lack of silvicultural experience in old stands, it is by no means certain that we can create old-growth ecosystem conditions.

Most of the current late-successional and old-growth stands developed from natural regeneration following wildfire that occurred during the last 500 to 600 years and covered large areas--frequently many thousands of acres. Although these fires were large, they were patchy and left many areas of unburned or lightly burned forest. The natural regime of patchy fires that leave an abundance of large dead trees and lesser amounts of scattered live trees, as individuals and in patches, is the basis for silvicultural methods such as retention of green trees as individuals and in patches.

In some cases, however, natural reburns occurred, resulting in relatively little carryover of live trees as a legacy from the old-growth condition. Where considerable live and dead material was left following fires, young stands contained many old-growth structures and presumably old-growth-associated organisms, including organisms associated with coarse woody debris on the forest floor.

Large fires and relatively long fire return intervals in the moist northern and western physiographic provinces resulted in periods during which landscapes contained large areas of relatively unbroken forest cover. In the warmer, drier physiographic provinces (e.g., Eastern Cascades and Klamath Provinces), fire is more frequent, less intense, and more a part of the internal dynamics of what is typically considered a stand (e.g., tens to hundreds of acres). In the drier provinces, fire control and timber harvest have decreased the abundance of some types of old-growth, such as ponderosa pine, that are dependent on frequent, low-intensity fires. Other types of late-successional forest that are less fire resistant or are less desirable for harvest have become more widely distributed. In these areas, the potential for stand replacement wildfires has increased, resulting in a higher risk to the stability of current stands reserved for late-successional species.

At a landscape-scale and over long periods, stand replacing wildfires have an important role in resetting successional processes and developing new areas of late-successional forests to replace those lost through succession or disturbance. Silvicultural practices, designed to imitate natural processes may be able to reset succession to achieve stand and landscape level goals. This type of silviculture holds promise to meet a variety of ecosystem objectives, however we have very little experience in applying silviculture for late-successional objectives. Until we gain more experience and knowledge about active management to produce late-successional ecosystems, sustaining late-successional ecosystems in the landscape will be best accomplished through retention of existing areas of late-successional forest. Given the relatively low remaining proportion of late-successional ecosystem in the landscape at the present time, these older forests should be protected from fire and other "resetting" disturbances.

Ecosystem Functions

Late-successional ecosystems perform several ecological functions that appear to be lacking, or less well developed, in younger natural forests and managed plantations. These functions include buffering of microclimate during seasonal climatic extremes (Chen et al. 1993), producing food for those consumer organisms which occupy late-successional forests (Ure and Maser 1982; Huff et al. 1991), storing carbon (Harmon et al. 1990), nutrient and hydrological cycling (Franklin and Spies 1991), and providing sources of arthropod predators and organisms beneficial to other ecosystems or successional stages (Schowalter 1989). Old-growth ecosystems appear to be highly retentive of nutrients (Sollins et al. 1980) and low in soil erosion potential (Swanson et al. 1982) although differences in these functions between stand developmental stages may not be large when canopy closure has occurred. Tall, deep canopies of late-successional forests can intercept more moisture from clouds and fog than young plantations (Harr 1982).

Categories of Late-Successional Forest Conservation Areas

Any plan that does not maintain a strong network of existing old-forest ecosystems risks losing known and unknown biodiversity associated with old forests. Therefore, all management options include Reserves designed to maintain and enhance late-successional forests. Although their size, distribution, and management varies among options, these Reserves include two general categories, as follows.

Late-Successional Reserves

These Reserves represent a strong network of existing old forests that are retained in their natural condition, with natural processes such as fire allowed to function to the extent possible. These Reserves are designed to serve several functions. First, they provide a distribution, quantity, and quality of old-forest habitat sufficient to avoid foreclosure of future management options. Second, they provide habitat for viable, well-distributed populations of species including the northern spotted owl and marbled murrelet that are associated with late-successional forests. Third, they will help ensure that the full range of late-successional biodiversity will be conserved. Currently, Reserves contain significant areas dominated by early successional communities. However, late-successional communities and associated species will become more abundant as younger stands mature.

Late-successional forest communities are the result of a unique interaction of disturbance, regeneration, succession, and climate that probably can never be created with management. At present, we do not even fully understand the structure, species composition, and function of these forests. The best we can hope to accomplish through silviculture is to at least partially restore or accelerate the development of some of the structural and compositional features of such forests. Because they will be regenerated by different processes during a different period from that of the existing late-successional forests, it is highly likely that silviculturally created stands will look and function differently from current old stands that developed over the last 1,000 years. Consequently, conserving a network of natural old-growth stands is imperative for preserving biodiversity into the future.

Most options allow management of stands within Late-Successional Reserves to maintain, or accelerate the development of, late-successional forest conditions. In general, management would be limited to young stands, removal of hazard trees, and salvage of limited amounts of dead trees after fires, windstorms, or insect-caused mortality.

A variety of areas currently remaining unmapped would be managed as Late-Successional Reserves. These areas include LS/OG3s (Johnson et al. 1991) and murrelet sites within the Matrix. Options 1-6, 9 and 10 included protection for murrelets and assumed that sites occupied by murrelets would be retained as Late-Successional Reserves once they were identified and mapped. LS/OG3s were retained as Late-Successional Reserves under option 1, were at least partially retained under options 3 and 4, and were released for harvest under other options. Where the LS/OG3 areas were retained as Late-Successional Reserves, the intent was to further strengthen the network and diversity of late-successional forest. We assumed that all of these areas would be mapped during the planning and implementation process for the selected option.

Managed Late-Successional Areas

We assume that all late-successional forests will, at one time or another in the future, be subjected to ecological disturbance such as fire, wind, insects, or disease. Given this assumption, we believe it is reasonable to initiate silvicultural experiments that are likely to produce stands that are similar in structure to existing old stands. While these replacement stands may never be duplicates of existing old stands, we hypothesize that they will provide for most of the species and processes that occur in natural stands and will be adapted to current and future climate.

We proposed some options that allow management in some Reserves so that managers and researchers will experiment and gain experience with a more dynamic approach to maintenance of older forests on the landscape, while at the same time extracting some wood products. Research, monitoring, and adaptive management will have to occur simultaneously if we are going to understand how well we can expect to duplicate late-successional forest conditions within managed forest landscapes.

Some options examined by the Forest Ecosystem Management Assessment Team contained provisions for timber harvest through the use of long rotations in some Late-Successional Reserves. The objective of long rotations is to re-create, to the extent possible, the structural and compositional features of late-successional forests. Some of these features include: (1) multispecies and multilayered assemblages of trees, (2) moderate to high accumulations of large logs and snags, (3) moderate to high canopy closure, (4) moderate to high numbers of trees with physical imperfections such as cavities, broken tops, and large deformed limbs, and (5) moderate to high accumulations of fungi, lichens, and bryophytes. Although they may not be duplicates of existing old forests, we do believe that in the long term these stands could provide adequate habitat for some species.

Role of Silviculture

Silviculture is the art and science of managing forest stands to provide or maintain structures, species composition, and growth rates that contribute to forest management goals. Silvicultural practices will vary considerably throughout the Pacific Northwest because of the broad variety of forest species and ecosystems in this region. The ecosystems range from coastal temperate rain forests where fire occurs infrequently but where wind may have a major impact, to forests on dry interior sites where disturbance by natural fire and insects is common. Within specific locales the silvicultural practices will be strongly influenced by such factors as nearby residential areas, local wildlife habitat requirements, and fire management constraints.

To develop silvicultural systems, it is important to have clear objectives for stand structure and species composition. Under most options, silviculture systems proposed for Late-Successional Reserves have two principle objectives (Tappeiner et al. 1992): (1) development of old-forest characteristics including snags, logs on the forest floor, large trees, and canopy gaps that enable establishment of multiple tree layers and diverse species composition; and (2) prevention of large-scale disturbances by fire, wind, insects, and diseases that would destroy or limit the ability of the Reserves to sustain viable forest species populations. Small-scale disturbances by these agents should continue.

Matrix objectives for silviculture should include: (1) production of commercial yields of wood, including those species such as Pacific yew and western red cedar that require extended rotations, (2) retention of moderate levels of ecologically valuable old-growth components such as snags, logs, and relatively large green trees, and (3) provision of ecologically diverse early-successional conditions.

Stand Management

Forests within Late-Successional Reserves are composed of managed stands from 2 to over 50 years of age as well as unmanaged, late-successional, and old-growth stands. The younger stands were usually established following fire or timber harvest. Some of these stands will develop old-growth characteristics without silvicultural intervention. However, current stocking and structure of some of these stands were established to produce high yields of timber, not to provide for old-growth-like forests. Consequently, silviculture can accelerate the development of young stands into multilayered stands with large trees and diverse plant species and structures that may in turn maintain or enhance species diversity.

Under most options, stand management in Late-Successional Reserves is proposed to focus on stands that have been regenerated (by clearcutting, shelterwood, and group or single tree selection methods) following timber harvest or on stands that have been thinned. These include stands that will acquire old-growth-like characteristics more rapidly with treatment, or are prone to fire, insects, disease, wind, or other variables that would jeopardize the reserve. Depending upon stand conditions, treatments could include, but not be limited to: (1) thinning or managing the overstory to produce large trees, release advanced regeneration of conifers, hardwoods, or other plants, or to reduce risk from fire, insects, disease, or other environmental variables; (2) underplanting and limited understory vegetation control to begin development of multistory stands; (3) killing trees to make snags and logs on the forest floor; (4) reforestation; and (5) use of prescribed fire.

Tappeiner et al. (1992) discussed management of forest stands for northern spotted owl habitat, including examples of silvicultural systems and treatments that resemble natural forest disturbances. Their discussion can provide initial guidance for silvicultural treatment of young stands in Late-Successional Reserves.

Stands in the Matrix can be managed for timber and other commodity production, but they also have an important role in maintaining biodiversity. Silviculture systems for stands in the Matrix should provide for retention of old-growth ecosystem components such as large green trees, snags and down logs, and depending upon site and forest type, a diversity of species.

All options evaluated provide for retention of varying numbers of green trees following timber harvest in the Matrix, to provide a legacy bridging past and future forests. Retained green trees serve several important functions including snag recruitment, promoting multi-storied canopies, and providing shade and suitable habitat for many organisms in the Matrix.

Options 3 and 9 call for retention of green trees in well-distributed patches as well as dispersed individuals. Patches of green trees of various sizes, ages, and species will promote species diversity and may act as refugia or centers of dispersal for many organisms including plants, fungi, lichens (Esseen et al. 1992), small vertebrates, and arthropods.

Patches of trees may also provide protection for special microsites such as seeps, wetlands, or rocky outcrops. Trees retained within riparian protection areas can contribute to retention objectives but will generally not be sufficiently dispersed across the landscape to fully satisfy these objectives.

Diversity of tree structure should be considered when selecting trees for retention. Complex canopy structure and especially leaning boles are beneficial for some lichens (Esseen et al. 1992). Trees that are asymmetrical provide a diversity of habitat substrates and often have more lichen and moss epiphytes on large lateral limbs than symmetrical trees. Location of green trees is also important (e.g., ridgelines are optimum locations for lichen dispersal).

Large logs of a variety of decay classes should be left. All down logs in advanced stages of decay (class 3-5) and significant quantities of less decayed logs (class 1-2) should be retained. Down log guidelines will differ between forests west of the Cascades and those in the Eastern Cascade or Klamath Provinces primarily because of fundamental differences in ecosystems (e.g., climate, vegetation, fire frequency and severity).

Coarse woody debris is essential for many species of vascular plants, fungi, liverworts, mosses, and lichens, arthropods, salamanders, reptiles and small mammals. Because of drier microclimates, logs in the Matrix may be occupied by species different from those found on coarse woody debris in late-successional forests. However, these logs may provide transitional islands in successional time for the maintenance and eventual recovery of some late-successional organisms in the Matrix.

In the Matrix, levels of snags should be retained that are adequate to support viable populations of cavity nesters. Management for 40 percent of potential populations of cavity nesters may be the minimum required for viability of these species within the Matrix (Thomas et al. 1979). However, considerable research and monitoring will be required to determine actual levels of snags required to support viable populations of various species in different provinces. Snags could be created in Matrix stands if they are lacking, but there is much uncertainty concerning the efficacy of killing trees to provide snags.

Adequate numbers of large snags and green trees are especially critical for bats because they are used for maternity roosts, temporary night roosts, day roosts, and hibernacula. Large snags and green trees should be well distributed throughout the Matrix because bats compete with primary excavators and other species that use cavities. Day and night roosts are often located at different sites, and migrating bats may roost under bark in small groups. Thermal stability within a roost site is important for bats, and large snags and green trees provide that stability. Individual bat colonies may use several roosts during a season as temperature and weather conditions change. Large, down logs with loose bark may also be used by some bats for roosting.

Local information should be used to refine requirements for quantity, size, spacing, and distribution of snags and down logs. Guides for the retention of snags and down logs must be responsive to safety considerations during logging and other forest operations.

Thinning prescriptions should encourage development of diverse stands with large trees and a variety of species in the overstory and understory. Prescriptions should vary within and among stands.

Management of Disturbance Risks

Natural disturbance is an important process within late-successional forest ecosystems but humans have altered disturbance regimes. Management may be required to re-introduce natural disturbance such as fire or to minimize socially unacceptable impacts.

Fire suppression has resulted in significant increases in accumulated fuels within some forests, particularly in the Eastern Cascades Province of Washington and Oregon and in the Klamath Province of southern Oregon and northern California (Agee 1990; Deeming 1990; Kauffman 1990). At the same time, these forests may have become much more vulnerable to insects and diseases (Mitchell 1990; Wickman 1992; Mutch et al. 1993).

In Late-Successional Reserves in the Western Cascades and coastal areas of Oregon and Washington, manipulation of natural stands to reduce fire hazard is generally not necessary (Agee and Edmonds 1992). However, fuel management may be desirable in plantations. An aggressive fire control strategy should be implemented, with emphasis on fire detection and initial attack (Agee and Edmonds 1992). In the future, fires may be allowed to burn, at least under some conditions. However, until we have fire management plans, all fires in west-side Late-Successional Reserves should be suppressed.

In Late-Successional Reserves in the Eastern Cascades or Klamath Provinces, silviculture aimed at reducing the risk of stand-replacing fires may be appropriate. Treatments may include thinning, underburning, and establishment of fuelbreaks. With fire suppression, some forests have become quite dense and multistoried, primarily from the invasion of shade tolerant species (Tappeiner et al. 1992). Reduction in mid-level canopy layers by thinning may reduce the probability of crown fires. Also, underburning can be used to reduce fuel loads and vertical fuel continuity. Wildfires entering underburned stands generally are less severe and direct control is often possible. To be effective, underburning should be implemented over large areas (Agee and Edmonds 1992).

Fuelbreaks compartmentalize management units by creating zones of reduced fuel, which allow safe access for fire suppression crews and provide a reasonable location for control. Fuelbreaks are generally located along ridgelines with continuous fuels. Stands are manipulated to reduce continuity of canopies, boles are pruned on residual trees, and significant quantities of understory fuels are removed (Agee and Edmonds 1992). Many of these treatments may reduce the quality of habitat for late-successional organisms. Thus, managers need to seek balance in an approach that reduces risk of fire while at the same time protects large areas of fire-prone late-successional forest.

Silvicultural systems within the Matrix contribute to management of the Late-Successional Reserves. Matrix management should reduce the risk of fire and other large-scale disturbances that would jeopardize the reserves. For example, fire and fuels management in the Matrix are compatible with management objectives for Late-Successional Reserves when they reduce the risk of fire entering the Reserves from adjacent managed lands.

Harvesting trees immediately adjacent to Late-Successional Reserves may result in increased wind damage along boundaries. In such cases, "feathering" stands within harvest units may be appropriate to reduce this risk. Local expertise will be essential in designing meaningful strategies for wind protection (Agee and Edmonds 1992).

Management After Natural Disturbance

Fire, wind, insects, and disease have greatly influenced the development of Pacific Northwest forests (Agee 1990, 1991; Kauffman 1990; Agee and Edmonds 1992). Fine-scale disturbances, generally insects or disease, include deaths of single trees or small groups of trees which result in small patches of early successional vegetation embedded in a larger portion of older forest. Coarse-scale disturbances, such as fire and wind, result in more extensive areas of early seral vegetation. Many native forest organisms have adapted to these cycles and scales of disturbance and regrowth.

Most options have provisions for management following natural disturbances in Late-Successional Reserves. Management objectives should focus on either simulating natural succession or allowing it to occur unimpeded. Direct silvicultural management will usually be more appropriate following coarse-scale disturbances such as extensive, hot fires that kill most or all trees within a large area. Fine-scale disturbances will generally not require such management. In fact, insects, disease, and wind create small gaps in the overstory that characterize the transition and shifting-gap stages of old-growth forest development (Spies and Franklin 1989; Spies et al. 1990). The processes leading to formation of these gaps should not be impeded.

Tree mortality is an important and natural process within a forest ecosystem. Diseased and damaged trees and logs are key structural components of late-successional and old-growth forests (Franklin and Spies 1991; Spies and Franklin 1991). Accordingly, management planning for Late-Successional Reserves must acknowledge the considerable value of retaining dead and dying trees in the forest.

Salvage of dead trees has significant effects on the development of future stands and their suitability as habitat for a number of organisms. Snag removal results in long-term impacts on the forest community because large snags are not produced by the new stand until trees become large and begin to die from natural mortality (often a period of 50-100 years). Snags are used extensively by cavity nesting birds and mammals such as woodpeckers, nuthatches, chickadees, squirrels, red tree voles, and American marten (Carey et al. 1991; Gilbert and Allwine 1991a, b; Lundquist and Mariani 1991; Thomas et al. 1993). Removal of snags following disturbance can significantly reduce the carrying capacity for these species for many years.

Down logs are important components of forest ecosystems. They provide habitat for a broad array of vertebrates, invertebrates, fungi, mosses, vascular plants, and micro-organisms. Arthropods, salamanders, reptiles, and small mammals live in or under logs; woodpeckers forage on them; vascular plants and fungi grow on rotting logs (Harmon et al. 1986, Thomas et al. 1993).

Because of the important role of dead wood in late successional and old-growth forest ecosystems, and because there is much to learn about the role of dead wood in the development of forests, only limited salvage is appropriate in Late-Successional Reserves. Salvage policies of options generally ranged from no salvage to limited salvage as permitted by the Final Draft Recovery Plan for the Northern Spotted Owl (USDI 1992c). This plan would allow removal of small-diameter snags and logs but would also require retention of snags and logs likely to persist until the new stand begins to contribute significant quantities of coarse woody debris.

Many natural disturbances do not result in complete mortality of stands. For example, recent fires in the Western Cascades of Oregon killed only 25-50 percent of trees within the areas burned (USDA 1988, 1989, 1992). The surviving trees are important elements of the new stand. They provide structural diversity and a potential source of additional large snags during the development of new stands. Furthermore, trees injured by disturbance may develop cavities, deformed crowns, and limbs that are important habitat components for a variety of wildlife. Therefore, no removal of green trees should be allowed within Late-Successional Reserves unless significant human safety hazards (e.g., unstable trees adjacent to campgrounds or trails) are involved.

In many options, more extensive salvage would be allowed where fire, insects, or disease are likely to result in a significant risk to the future development of late-successional and old-growth forests (e.g., Eastern Cascades and Klamath Provinces). The Final Draft Recovery Plan for the Northern Spotted Owl (USDI 1992c) provides for a process by which salvage guidelines can be adapted to specific conditions. A similar process should be adopted to provide guidance for management of salvage in Late-Successional Reserves.

In Matrix areas, objectives for post-disturbance management will generally be different from that for Late-Successional Reserves. Economic benefits of timber production will receive greater consideration. For example, the commercial salvage of dead trees will be less constrained, and replanting of disturbed areas will be a high priority. However, because the Matrix provides habitat and connectivity for many organisms, post-disturbance management must achieve a balance between economic and ecosystem objectives. Standards and guidelines for post-disturbance management were generally similar to those for timber harvest management, but restoration planning must consider local conditions and site-specific information.

Methods for Assessing Effects of Options

Sources of Information

Information for the assessment of the effects of the options on terrestrial species and their habitats included data on forest cover types, species' geographic ranges, northern spotted owl and marbled murrelet habitat, and specific locations occupied by these two species.

Information on general forest cover types on Forest Service and National Park Service lands in Oregon and Washington was obtained through a contract with Pacific Meridian Resources Company. The cover type data were produced using a combination of 1988 and 1991 Landsat imagery and were classified into vegetation categories based on tree size and stand structure. For Forest Service lands in California, vegetation data from each of the National Forests were used to develop the forest cover type data set. No data were available for National Park Service lands in California.

Vegetation information for Bureau of Land Management lands in Oregon was compiled from forest stand description data on tree diameter classes of the dominant overstory trees. This data was developed from aerial photo interpretation and field surveys. Forest cover type data for Bureau of Land Management lands in California were derived from the agency's Wildlife Habitat Relationships Geographic Information System theme.

To combine data from different agencies, the data were generalized to a geographic information system-based grid with a resolution of 400 by 400 meters square. Data were then reorganized to conform to the cover type categories of the Pacific Meridian Resources classification.

We obtained specific data sets for northern spotted owl and marbled murrelet habitat for lands administered by the Forest Service in the three states; the Bureau of Land Management lands in Oregon; and the National Park Service lands in Oregon and Washington. Agency field offices had previously completed the classification of spotted owl habitat for the Forest Service and Bureau of Land Management. Information on spotted owl habitat for National Parks in Oregon and Washington was derived from the Pacific Meridian Resources Landsat cover type data by the Forest Ecosystem Management Assessment Team. All medium and large conifer acres from the Landsat data that occurred under 4,000 feet elevation in Washington and under 5,500 feet in Oregon were tallied as spotted owl habitat.

The spotted owl habitat data were also used to identify marbled murrelet habitat on Forest Service lands within the range of the murrelet in Oregon and California; data specific to marbled murrelet habitat were not available for those lands. In Washington, marbled murrelet habitat was identified for National Forests and National Parks using updated 1989 Landsat data classified by Eby and Snyder (1990). Data for a portion of land in the Puget Sound not covered by the Eby and Snyder data were supplied by the Washington Department of Natural Resources from work by Green et al. (1993). On Bureau of Land Management lands in Oregon, the team used field office classifications of forest stand data designating probable murrelet habitat. No data were available for either northern spotted owl or marbled murrelet habitat on lands administered by the Bureau of Land Management or the National Park Service in California.

Species range maps developed by Thomas et al. (1993) were refined for this effort by personnel from the Forest Service's Pacific Northwest Research Station in Olympia, Washington, for the mammal, bird, and amphibian species closely associated with late-successional forest. They were based on information derived from field guides, scientific literature, Natural Heritage Database files, state agency records and review by species authorities.

Specific location information was plotted for northern spotted owls and marbled murrelets from data compiled by the state wildlife agencies of Washington, Oregon, and California. The spotted owl location data identified points on the landscape where survey data documented nesting by a pair of owls, or continued occupancy of a location by either a pair of owls or a territorial single owl. Data were tallied for owl pairs and territorial single owls that had been verified from 1987 to 1991 for all federal lands, and from 1988 to 1992 for other ownerships where earlier surveys were incomplete or significant new data were available. The marbled murrelet location data identified sites where surveys documented murrelet activity in the canopy of a given forest stand. Data coverage included all federal lands. Occupied stands verified from 1986 through 1992 were included.

Identification of Species Closely Associated with Late-Successional Forests

To identify plant and animal species closely associated with late-successional forests and components, we relied on (1) existing assessments and publications and (2) the advice of experts who reviewed those lists for completeness for all federal lands within the range of the northern spotted owl.

Existing assessments and publications included the Scientific Analysis Team Report of Thomas et al. (1993), who identified old-growth forest species and evaluated their likely future under planning alternatives presented in the Forest Service's Final Environmental Impact Statement on the Northern Spotted Owl (USDA Forest Service 1992). Thomas et al. (1993) identified species closely associated with old-growth forests and components of old-growth forests on National Forests within the range of the northern spotted owl. In their analysis, 667 species, species in parts of their range, and at-risk fish stocks were found to be closely associated with old-growth forests.

We adopted the process used by Thomas et al. (1993) for identifying species of plants and animals closely associated with late-successional, including old-growth, forests within the range of the northern spotted owl. In their process, Thomas et al. (1993) listed ecological information on each species and determined the association of each species with late-successional and old-growth forests by applying specific criteria. (See table IV-6). With help from species experts (see appendix IV-B and later sections on species groups), we expanded this list to account for new information and for additional plants and animals found on other federal lands within the northern spotted owl's range, particularly on National Parks and on Bureau of Land Management Districts. In this process our working definition of late-successional, including old-growth forests included all forests in which the dominant overstory trees were at least 80 years old. This included old-growth forests as described by Spies and Franklin (1991) and Franklin and Spies (1991).

Table IV-6. Criteria for developing the list of species closely associated with late-successional and old-growth forests. Adapted from Thomas et al. (1993). A species is included in the list of species closely associated with late-successional and old-growth forests or components if it meets at least one of the following four criteria:

Criterion 1:	The species is significantly more abundant (based on field study or collective professional judgment of the Forest Ecosystem Management Assessment Team) in late-successional and old-growth forest than in young forest, in any part of its range.
Criterion 2:	The species shows association with late-successional and old-growth forest (may reach highest abundance there, but not necessarily statistically so), and the species requires habitat components that are contributed by late-successional and old-growth forest (based on field study or collective professional judgment of the Forest Ecosystem Management Assessment Team).
Criterion 3:	The species is associated with late-successional and old-growth forest (based on field study) and is on a federal (Fish and Wildlife Service) or state threatened and endangered list, on the Fish and Wildlife Service candidate species list, Forest Service Regions 5 or 6 sensitive species list, or listed by Washington, Oregon, or California as species of special concern or sensitive species.
Criterion 4:	Field data are inadequate to measure strength of association with late-successional and old-growth forest, and the species is listed as a federal (Fish and Wildlife Service) threatened and endangered, and the Forest Ecosystem Management Assessment Team suspects that it is associated with late-successional and old-growth forest.

Methods for Assessing Effects of Options on Species

We assessed the potential effect of seven of the options on species habitat and viability in two separate rounds of expert panels. We viewed evaluations not as precise analyses of likelihoods of habitat and population conditions, but rather as judgements of knowledgeable experts.

The first panel assessment was conducted April 21 to 30, 1993, involving 67 panelists in 12 panels covering all major plant and animal taxa associated with late-successional and old-growth forest ecosystems in the Pacific Northwest.

For the first panel assessment, the rating was an assessment of the likelihood of maintaining species viability, defined as the continued persistence of the species population, well distributed throughout its historical range on federal lands within the range of the northern spotted owl over the next 100 years.

Panelists were selected from universities, the private sector, and agency management and research branches. Results from the panels were advisory to the Forest Ecosystem Management Assessment Team who made final judgments about viability effects. Other information considered in the assessment included contract reports, notes from panel discussions, panel leader's impressions from the panel discussions, published scientific reports, empirical experience of the panel leaders, and follow-up discussions with panel members and additional experts. Results from the first panel sessions were reviewed during the first 2 weeks in May 1993. A second round of panel evaluations was conducted in June because new options were developed, existing options were revised, and some key problems needed corrections.

The panel process was structured to elicit high quality judgments about future outcomes. We judged most of the structure of the first round of panels to be sound, so it was repeated. This included selection of species, species groupings protocols, panelist selection criteria, and information bases for Team evaluation. Major changes were made in the response scale and in emphasizing habitat as opposed to population viability.

A second round of panel evaluations was conducted in June. The Team convened this second round of panels for several reasons:

1. The option set had changed substantially in response to initial biological, economic, and sociological assessments. New options were added, and existing options had been substantially modified.

2. Panel procedures were revised to improve the interpretability of the results and to better capture the panelists' professional opinions. The scale used in the first round of panels, although biologically well founded, was a difficult instrument for interpreting option differences. In the second set of panels it was refined to allow a clear distinction between population and habitat factors; habitat was the element of concern and most directly influenced by the options.

3. The reassessment allowed a cleaner separation of biological judgments from legal or political contexts. The redesigned process focused judgment on biological events without predisposing panelists to layers of complex and possibly confusing legal and political interpretations.

4. The final reason for repaneling was to develop a response format that allowed panelists to express levels of uncertainty across options and species as a component of their likelihood judgements.

The second round of panels, consisting of three to nine biological experts, were held during June 3 to 14, 1993. Most panelists in this round had participated in the first round (appendix IV-B). All panelists who had participated in the first round were asked to participate in the second round, but some were unavailable. Panels considered differing numbers of species, ranging from one in the case of the northern spotted owl and marbled murrelet panels to more than 8,000 in the arthropod panel. Some panels with large numbers of species rated them in groups. Other panels considered geographical segments of individual species that had unique habitat requirements sensitive to the options. Seven of the 10 options were assessed by these panels. These were options 1, 3, 4, 5, 7, 8 and 9.

Panelist Selection

Panelists were selected using several criteria including technical expertise with the taxa, ecological understanding of habitat requirements, availability to attend panel sessions, and representative of a range of technical expertise across species and throughout the geographic range. Biologists were selected who could set interest group values aside to focus on the biological assessment task. We gathered a mixture of research and management biologists, providing they met qualifications, and we tried to develop a mixture of habitat and population perspectives.

Assessment Process - Overview

The basic assessment process generally followed those described in Merkhofer (1987), McNamee and Celona (1989), Spetzler and Stael von Holstein (1975), and Cleaves (in prep) for making probabilistic judgments. The process was adapted for use in a panel setting. Our process led panelists through several generally accepted stages, including motivating panelists toward probabilistic assessment, task structuring, conditioning of assumption and background information, encoding the actual numerical judgments, and verifying the assessment results.

Motivation and structuring were handled in a 2-hour orientation that covered assessment rationale, description of the task, explanation of scale, and description of the options (see below). Conditioning occurred in a facilitated discussion of specific conditions that describe each of the four outcomes in the scale. This usually involved group agreement about the meaning of terms such as well distributed, habitat, and population, and about assumptions adopted to clarify the assessment task.

The actual rating of likelihoods was individual, followed by group display and discussion. Verification was also handled in the discussion step, as panelists explained reasons for their ratings. Final individual assessments were panelists' choices. We did not attempt to achieve a consensus rating; group interaction was used to clarify knowledge and exchange individual reasoning.

Response Scale: Outcome Component

Panelists used an outcome-based scale to assess the likelihood that habitat would support populations. We developed this scale to represent the range of possible trends and future condition of habitat on federal lands (table IV-7). Each of four outcomes, labeled A through D, describes a biological condition that is observable and mutually exclusive of the other three outcomes. Value-laden references such as "high," "good," or "preferred" were avoided in the outcome descriptions. Panels discussed and refined the scale. In some panels, the outcome scale worked well without adjustment, while in others considerable discussion was necessary to clarify how the scale applied to a particular taxon.

We also instructed panelists to consider the ability of the options to buffer natural disturbances such as fire, insects, disease, and windstorms, at their historic frequencies and severities. We could not provide data on rates of natural disturbance, but we encouraged discussion of these factors during the sessions.

We feel the scale improved on the earlier scale, but it was not a panacea. The following areas were subject to different interpretations by different panels:

1. Treatment for rare and locally endemic species. Many of these species had small and restricted ranges or existed in refugia even before habitat alteration by harvesting and other activities. Some panelists tended to rate these species in outcome B or C under even the most protective options.

2. qHabitat versus population outcomes. We defined the outcomes in terms of habitat "quality, distribution, and abundance", but some panelists found it difficult to separate the habitat and population elements.

3. Definition of "well distributed." Panelists were not uniformly clear about what "well distributed" meant for each taxon, although they concentrated their thinking on biological functions, particularly interaction. This issue was particularly confusing between outcomes A (well distributed) and B (distributed with gaps). Distinctions between B and C (occurrence in refugia) and between C and D (extirpation) were more explicit.

Table IV-7. Description of the outcomes used for rating the level of habitat support for populations.

<u>Outcome A</u>. Habitat is of sufficient quality, distribution, and abundance to allow the species population to stabilize, well distributed across federal lands. (Note that the concept of well distributed must be based on knowledge of the species distribution, range, and life history).

<u>Outcome B</u>. Habitat is of sufficient quality, distribution, and abundance to allow the species population to stabilize, but with significant gaps in the historic species distribution on federal land. These gaps cause some limitation in interactions among local populations. (Note that the significance of gaps must be judged relative to the species distribution, range, and life history, and the concept of metapopulations).

<u>Outcome C</u>. Habitat only allows continued species existence in refugia, with strong limitations on interactions among local populations.

<u>Outcome D</u>. Habitat conditions result in species extirpation from federal land.

4. Historic versus current species distribution. Reference in our scale to "historic species distribution" in outcome A was difficult for species groups for which information is limited to the current distribution. Taken literally, the reference to historic distribution held the ratings to a high standard of requiring habitat reestablishment throughout the historic range.

5. It was difficult for panelists to project changes in bio-physical conditions over the 100 year timeframe specified.

6. Some panelists said that the 100-year period was not long enough for the options to express "equilibrium" conditions. These panelists considered 100 years to be an interim checkpoint and preferred 200 years or longer as an assessment frame.

Response Scale: Likelihood Component

We asked panelists to assign 100 "likelihood votes" (or points) across the four outcomes in the scale. A panelist could express complete certainty in a single outcome for a species/option combination by allocating all 100 points to a single outcome. The panelist could express uncertainty by spreading votes across the outcomes. An individual panelist could refrain from assessing a species because they simply had too little understanding to venture an informed opinion. The entire panel could also choose not to rate a species if they thought there was inadequate scientific knowledge about the species. These species were marked "not rated" on the assessment forms, but they were of no less concern than rated species. Discussions about the need to study and provide for these species was captured in the panel transcripts and panel leaders' reports.

We adopted the likelihood voting methodology in an effort to quantify scientific and personal uncertainty (Finkel 1990). We felt that honest expressions of how little or how much was known about species/option interactions could help us and decisionmakers better understand the issues and make more informed tradeoffs. We emphasized to panelists that the likelihoods are not probabilities in the classical notion of frequencies. They represented degrees of belief in future outcomes, expressed in a probability-like scale that could be mathematically aggregated and compared across options and species. This use of the "judgmental probabilities" is consistent with the theory and practice of decision analysis and decision science (von Winterfeldt and Edwards 1986; Howard and Matheson 1983).

Panel facilitators and leaders encouraged panelists to be candid and protected panelists' ratings from domineering personalities. The pattern of likelihood votes across the options reflected the panelist's rationale, knowledge base, and assumptions. It allowed panel leaders and panelists to detect and clarify key uncertainties and ambiguities in the option descriptions or panelist's interpretation of them.

Panel Process Mechanics

All panel assessments followed the same process flow. Panels lasted one to two days depending on the number of species being assessed. Two panels were usually combined for orientation to help standardize the process and to stimulate questions.

Each orientation consisted of the following:

1. *Welcoming statement.* We reviewed the purposes of the overall Forest Ecosystem Management Assessment Team assessment and reasons for reconvening the panels. Some panelists were suspicious that the second round of assessments was politically motivated to obtain "new" results. Introductory remarks responded to these concerns.

2. *Orientation to the rating scale.* We presented and explained the rating scale. We defined terms and encouraged panelists to discuss their understanding of the scale. The points received particular consideration. The first was the definition of "well-distributed". The second was the separation of federal habitat from other influences on species viability. This was discussed with reference to figure IV-1.

   This diagram displays six factors that could influence species populations. These are habitat conditions on federal lands; life history characteristics of the species; "bottleneck" periods of low habitat and population; landownership patterns and habitat conditions on nonfederal lands; habitat conditions outside the range of the northern spotted owl; and other environmental conditions caused by activities off federal lands.

For the purposes of the rating, panelists were asked to focus their assessment on habitat conditions on federal lands; life history characteristics of the species; and any bottlenecks in habitat (and population) that would occur under the option. For this assessment, they were asked to assume that the other three factors would be adequate to support a stable, well-distributed population of the species if habitat on federal land was adequate to support such a population. These assumptions were relaxed later in the process when the likelihood rating had been completed. Panelists were then asked to describe the actual influence that these last three factors might have on overall population viability.

3. *Orientation to the assignment (likelihood) scale component.* We presented the likelihood scheme, its methodological rationale, and examples. The purpose of the group discussion was information exchange not consensus, and it was important to spend time in calibrating judgments, customizing the outcome definitions, and discussing the concept of likelihood points.

4. *Orientation to process flow.* We described the roles of the facilitator, panel leader, panelists, scribe and observers.

   The facilitator's role was to clarify the task and the use of materials, keep the process moving and the discussions relevant to the task, stimulate thinking and interchange about the assessments, probe for consistency, biases, and misunderstandings and identify opportunities for improving the assessment process.

   The scribe captured the discourse during the session, displaying the transcripts to the panel with an overhead projection from the computer screen. These transcripts were useful in clarifying and tracking points cited by panelists and supporting the later interpretations.

   At times, panels were visited by members of the Supplemental Environmental Impact Statement Team and other observers. These observers were asked to limit their involvement to occasional clarifying questions; their primary role was passive observation.

Description of the Options

We presented the seven options in a 1-hour briefing with opportunities for panelists to ask questions. In order to make the panel process workable, we assessed only seven of the 10 options (1, 3, 4, 5, 7, 8 and 9). In an attempt to emphasize the biological nature of the judgment task, only information relative to the bio-physical aspects were presented; no economic, harvest level (allowable sale quantity), or community assessment information was provided. The briefing was supplemented with visual materials provided to the panelists and displayed in the panel work area. In addition, an option expert was available to answer questions at any time during the panel assessments. Materials provided for the seven options included:

- Maps of options, color-keyed to depict spatial allocations of reserves. These 1:500,000 maps, one for each state for each option, were displayed on walls around the work area.

- Overlay maps of Key Watersheds.

- For vertebrates and vascular plants, overlay maps were available showing species ranges.

- Package of written descriptions of option components. Each option was described in a two-page summary, including details about Late-Successional Reserves, Managed Late-Successional Reserves, Riparian Reserves, Matrix management, and other standards and guidelines. For some options this included supplementary guidelines for marbled murrelet management, and for Option 9 a two-page description of the Adaptive Management Areas. A pie chart of acreage allocations was also presented for each option except Options 8 and 9.

- Summary table of options, comparing them across the components. This table served as a bridge between the detailed descriptions and the maps and was referred to repeatedly by the panelists.

- In addition to the materials provided to describe the options, we also provided overlay maps of the ranges of vertebrates and vascular plants. For many of the other species groups, panelists supplied maps of species locations or ranges.

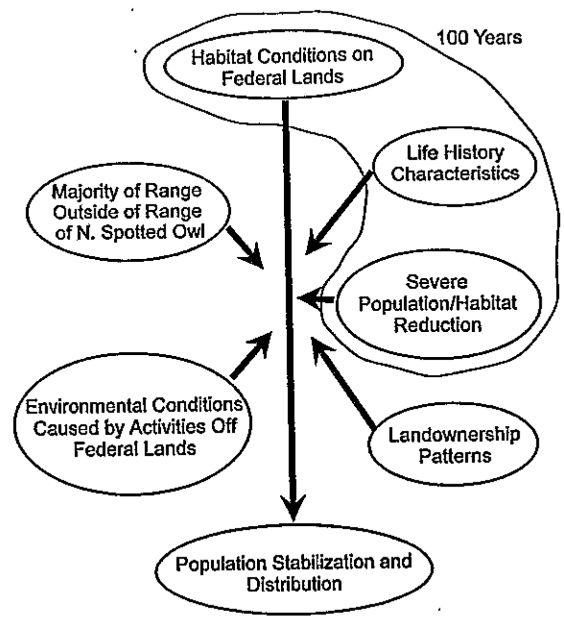

Figure IV-1. Factors that can affect a species' population trend and distribution. Factors that are circled were the focus of the species' habitat assessments.

The assessment for each species or group of species proceeded according to the following steps:

1. *Present species profile.* Panelists contributed to a set of facts and assumptions that could be important in assessing the species or species group.

The assessment for each species or group of species proceeded according to the following steps:

1. *Present species profile.* Panelists contributed to a set of facts and assumptions that could be important in assessing the species or species group.

2. *Individuals assess species for all options.* Panelists were provided with rating forms and allocated 100 likelihood points to outcomes for each option.

3. *Display and discuss assessments.* The facilitator recorded individual assessments on the overhead projector, and encouraged the panel to review patterns across options and across panel members. Each panelist briefly explained his/her reasoning for the rating. The facilitator encouraged discussion among panel members.

4. *Individuals review their ratings and modify as appropriate.* These final ratings were not displayed but were turned in to the panel leader.

5. *Record judgment factors.* The facilitator led the group through a prepared list of option elements (table IV-8) ("factors influencing judgment"), asking for a listing of factors that were most important in arriving at a final rating. In most cases these factors had already been introduced in the discussion.

6. *Suggest mitigation measures.* The panels to recommended mitigation for species and options that did not provide an average of at least 80 percent likelihood of achieving outcome A. Mitigation meant relatively minor modifications that might enhance habitat conditions provided in the option. These measures did not include major changes that would have made the option more similar to another option. They could conceivably be written into standards and guidelines. Mitigations were suggested that might achieve the 80 percent level, but no attempt was made to re-evaluate the options with the measures applied.

7. *Record other influences on population viability.* The primary assessment was based on the adequacy of habitat provided on federal land. The final step was intended to look at the influence of population-level and nonfederal habitat factors on the overall success of the species. This assessment was not specific to any option. The panelists were asked to indicate which, if any, of the following factors were important: landownership patterns, species range outside the range of the spotted owl, and environmental conditions outside federal lands affecting the population. Panelists described how these factors might influence the overall species population. These discussions generally indicated that other factors would cause negative effects on populations. The discussions are captured in the sections of this chapter describing each species or group of species.

Summary and Evaluation of Panel Results

Ratings were averaged across panelists for each outcome under each option for each species. The panel leader then made the final assessment for each species, generally accepting the outcomes of the panel. However, before accepting these as the final assessment, he or she evaluated the results to look for any obvious errors or apparent misunderstandings that might have led to illogical results. If any problems were suspected, further evaluations were done based on comparisons of panel results with

Table IV-8. Components of the options considered by the expert panels in their evaluation of habitat outcomes.

<u>Riparian Reserves proposed for the option</u>
- Specific distances protected for different stream classes
- Overall acreage of the reserves
- Distribution of the reserves across the landscape
- Management proposed for the reserves
- Quality of habitat within the reserves

<u>Other reserves proposed for the option</u>
- Overall acreage of the reserves
- Size of the individual reserves
- Location of specific reserves
- Spacing of the reserves
- Distribution of the reserves across the landscape
- Management proposed for the reserves
- Quality of habitat within the reserves

<u>Forests in the Matrix</u>
- Overall amount of forest in the Matrix
- Distribution of Matrix lands across the landscape
- Proposed management provisions of the Matrix forests

transcripts from the panel discussions, primarily to determine if results were consistent with the discussion. Panel leaders, in conjunction with other team members, could make a final assessment different from the panel results if they determined that errors or misinterpretations had occurred.

To summarize results across species among options, several different data summaries were prepared from the individual species assessments. The first summary is the total number of species that achieved each of the four outcomes with a cumulative likelihood of 80 percent or better. For each species, we calculated the cumulative score for each successive outcome from A through D. We determined the outcome where the cumulative score equalled 80 or more. For example, if a species' scores were 60, 25, 10, and 5 for outcomes A, B, C, and D, respectively, the species would have been tallied as achieving outcome B or better; scores of 50, 20, 20, and 10 would have been tallied as outcome C or better. We then summed the number of species that reached the 80 percent cumulative likelihood level at each of the four outcomes.

Second, we determined the likelihood that each species would reach outcome A. We classified this into five equal intervals of likelihood (0-19, 20-39, 40-59, 60-79, and 80-100). We made this determination for each species under each option and summarized the options for that group of species by counting the total number of species that fell into each level.

We compared outcomes of options by using these two kinds of summaries. The first summary -- assessing 80 percent likelihood or greater of achieving outcome A was used because it represents a relatively secure level of providing habitat, and thus a stringent criterion for comparison of options. However, there is no single such level that represents a viable population for all species and cirumstances. The 80 percent level was chosen here as a point of comparison only; other levels could also be chosen for comparing options. The information on likelihoods is available and is amenable for such additional comparisons, if desired.

Methods for Assessing the Likelihood of Maintaining a Functional, Interconnected Late-Successional Ecosystem

We assessed the potential effect of seven of the options on the late-successional ecosystem in two separate rounds of expert panels. The general process used follows that described for the species assessments in the section "Methods for Assessing Effects of Options on Species".

Assessments of likelihood of maintaining a functional interconnected late-successional ecosystem were performed by a panel of five experts (see previous section for the general expert panel process). The set of outcomes used in the ecosystem assessment panel differed from the set of outcomes defined for the species panels -- an ecosystem perspective requires different evaluation criteria than a species perspective. The species assessments were based on habitats of specific organisms, while the ecosystem assessment was broader, focusing on the diversity, function, dynamics, and spatial patterns of the late-successional/old-growth ecosystem as a whole system. The ecosystem assessment emphasized the primary producers of the late-successional ecosystem (i.e., the vegetation) and the processes and functions associated with the quantity, quality, and dynamics of those primary producers (i.e., physical, chemical, and biological environment, including disturbances).

The rating of late-successional ecosystems is based on three attributes that characterize the quantity and quality of the ecosystem. The attributes, which are described in detail later in this chapter, are:

1. Abundance and ecological diversity - the acreage and variety of plant communities and environments.

2. Processes and functions - the ecological actions that lead to the development and maintenance of the ecosystem and the values of the ecosystem for species and populations.

3. Connectivity - the extent to which the landscape pattern of the ecosystem provides for biological flows that sustain animal and plant populations.

Abundance and Ecological Diversity

Abundance of late-successional/old-growth communities and ecosystems refers to the total acreage of forest meeting structural, functional, or minimum age criteria based on sub-regional ecological conditions and definitions. These standards define forests corresponding to the maturation, transition, and shifting, small gap stages of late-successional/old-growth forest development (see section on Ecological Principles for Management of Late-Successional Forests for a description of these forest development stages). In the central western Cascades these conditions are typically found in stands over 80 years of age.

Ecological diversity of late-successional forest ecosystems includes the occurrence of the full range of late-successional and old-growth stages (maturation, transition, and shifting, small gap and variants of these) that can develop following severe disturbance. Ecological diversity also includes the distribution represented in late-successional and old-growth communities (geographic, climatic, elevation, topographic, edaphic).

Outcome 1: Late-successional and old-growth ecosystem abundance and ecological diversity on federal lands is at least as high as the long-term average (see below for discussion) prior to logging and extensive fire suppression.

Long-term is defined as a period of at least 200 to 1,000 years or the time over which the full potential range of late-successional and old-growth communities and ecosystems can develop following severe disturbance. Relatively large areas (e.g., 50,000 to 100,000 acres) would still occur in which the abundance and distribution of late-successional forests are well below the regional average for long periods. However, within each physiographic province, the abundance would be at least as high as province-level long-term averages, which might be higher or lower than the regional long-term average.

Outcome 2: Late-successional and old-growth ecosystem abundance and ecological diversity on federal lands is less than the long-term average conditions (prior to logging and extensive fire-suppression) but within the typical range of conditions that occurred during previous centuries.

Abundance and distribution would be at least as high as the long-term average of the centurial-low values (see discussion below). Ecological diversity is characterized by presence of a wide range of late-successional stages. Distribution is characterized by presence in all physiographic provinces and elevations but with larger gaps in distribution than in outcome 1.

Outcome 3: Late-successional and old-growth ecosystem abundance and ecological diversity on federal lands is considerably below the typical range of conditions that have occurred during the previous centuries but some provinces are within the range of variability.

The ecological diversity (age class diversity) may be limited to just the younger stages of late-successional ecosystems. Late-successional and old-growth communities and ecosystems may be absent from some physiographic provinces or elevations within physiographic provinces and/or occur as scattered remnant patches within provinces.

Outcome 4: Late-successional and old-growth ecosystems are very low in abundance and may be restricted to a few physiographic provinces or elevational bands or localities within provinces.

Late-successional and old-growth communities and ecosystems are absent from most physiographic provinces or occur only as small remnant forest patches.

Long-term Averages and Long-term Average Lows

The long-term average regional abundance of late-successional and old-growth communities can only be approximated from a few local studies of fire history. If we assume that the average regional natural fire rotation was about 250 years for severe fires (those removing 70 percent or more of the basal area), then 60 to 70 percent of the forest area of the region was typically dominated by late-successional and old-growth forests, depending on the age at which "mature" forest conditions develop (assume a range of 80 to 100 years). Converting this range to a single number, 65 percent, provides an estimate of the long-term average percentage of the regional landscape covered by late-successional forest. This average percentage would certainly vary by physiographic province, with moist, northerly provinces having higher averages than drier provinces with higher fire frequencies.

Our estimate of the natural fire rotation and average coverage by late-successional forest is close to values reported in the literature (Franklin and Spies 1984; USDI 1992c). The total percentage would apply to a wide range of patch sizes, from less than 1 acre to 100,000's of acres. Most of the total percentage (perhaps 80 percent or more) would probably have occurred as relatively large (greater than 1,000 acres) areas of connected forest.

The average of centurial-low (average of the lows that occur in 100-year periods) coverage by late-successional forest is defined as setting the lower bound of the "typical" range. There is no data from which we could estimate the average low for the preceding 10 centuries. Consequently, this value was estimated based on the subjective opinions of the ecosystem experts. We hypothesized that the average of low amounts might be about 40 percent coverage by late-successional forests, with lower values expected for individual provinces.

Processes and Function

Processes refer to ecological changes or actions that lead to the development and maintenance of late-successional and old-growth ecosystems at all spatial and temporal scales. Examples include: (1) tree establishment, maturation, and death, (2) gap formation and filling, (3) understory development, (4) small and large scale disturbances such as fire and wind, (5) decomposition, (6) nitrogen fixation, (7) canopy interception of energy and matter, and (8) energy and matter transfers between the forest and atmosphere.

Functions, in this case, refer to ecological values of the late-successional ecosystem or its components that (1) are of value to maintenance of populations of species that use these ecosystems and (2) contribute to the diversity and productivity of other ecosystems (e.g. carryover of large dead trees to early successional ecosystems, and storage of carbon in the global ecosystem). Examples include habitat for organisms, climatic buffering, soil development and maintenance of soil productivity through inputs of large woody debris, nitrogen fixation, spread of biotic and abiotic disturbance through landscapes, and source-sink in landscapes for organisms and structures.

Outcome 1: Full range of natural disturbance and vegetative development processes and ecological functions are present at all spatial scales, from microsite to large landscapes.

Outcome 2: Natural disturbance and vegetative development processes and ecological functions occur across a moderately wide range of scales but are limited at large landscape scales through fire suppression and limitation of areas where late-successional ecosystems can develop.

Outcome 3: Natural disturbance and vegetative development processes are limited in occurrence to stand and microsite scales. Many stands may be too small or not well-developed enough to sustain the full range of ecological processes and functions associated with late-successional and old-growth ecosystems.

Outcome 4: Natural disturbance and vegetative development processes associated with late-successional and old-growth ecosystems are extremely restricted or absent from most stands and landscapes. Most late-successional and old-growth stands are too small or not well-developed enough to sustain the full range of processes and ecological functions associated with late-successional/old-growth ecosystems.

Connectivity

Connectivity is a measure of the extent to which the landscape pattern of the late-successional/old-growth ecosystem provides for biological and ecological flows that sustain late-successional/old growth animal and plant species across the region. Connectivity does not necessarily mean that the late-successional/old-growth areas have to be physically joined in space -- many late-successional species can move (or be carried) across areas that are not in late-successional ecosystems conditions. Landscape features affecting connectivity of late-successional ecosystems are (1) distance between late-successional/old-growth areas and (2) forest conditions in areas between late-successional/old growth areas.

Outcome 1: Connectivity is very strong, characterized by relatively short distances (less than 6 miles on average) between late-successional/old-growth areas. Smaller patches of late-successional/old-growth frequently occur. "Small patches" consist of riparian buffers, green tree retention patches, individual live and dead old-growth trees. The proportion of the landscape covered by late-successional/old-growth conditions of all patch sizes exceeds 0.6, a threshold when many measures of connectivity increase rapidly. At regional scales, physiographic provinces are connected by presence of landscapes containing areas of late-successional/old growth forests.

Outcome 2: Connectivity is strong, characterized by moderate distances (less than 12 miles on average) between large late-successional/old growth areas. Smaller patches of late-successional forest occur as described in outcome 1. At regional scales, physiographic provinces are connected by presence of landscapes containing areas of late-successional/old-growth forest. Total proportion of landscape in late-successional/old-growth conditions, including smaller patches is at least 0.5, so that the late-successional condition is still the dominant cover type.

Outcome 3. Connectivity is moderate, characterized by distances of 12-24 miles between large old-growth areas and limited occurrence of smaller patches of late-successional forest in the Matrix. The late-successional forest is at least 25 percent of the landscape, and the Matrix contains some smaller areas for dispersal habitat.

Outcome 4. Connectivity is weak, characterized by wide distances (greater than 24 miles) between old-growth areas and a Matrix in which late-successional/old-growth conditions occur as scattered remnants or are completely absent.

Overall outcome descriptions were obtained by combining the individual attribute outcomes into four overall outcomes for the ecosystem as a whole. The likelihoods of achieving overall outcomes were computed by averaging the likelihoods of individual attribute outcomes.

Effects of Options on Terrestrial Ecosystems

Amounts of Late-Successional and Old-Growth Forests

The amounts of current late successional and old-growth forests in different land allocations were estimated for the options from various sources (see also section Sources of Information). In Washington and Oregon, the abundance and distribution of late successional forests (forests older than 80 years) were estimated from digital maps derived from satellite imagery classified by Pacific Meridian Resources under contract with the Forest Service. In this data set late-successional forests were defined as stands dominated by conifers at least 21 inches in diameter ("medium" and "large" classes in tables IV-9, IV-10, IV-11) including single and multistoried stands. A "small conifer" class (9-20.9 inches in diameter) (tables IV-10, IV-11) contains some natural forests over 80 years old but is dominated by younger natural stands and older plantations in low to mid-elevations. On Bureau of Land Management lands in Oregon and on all lands in California, maps of forest conditions derived from air photo interpretation were used to estimate the abundance and distribution of forests dominated by conifers at least 21 inches in diameter. The estimates of late-successional forest acreages derived from these data sets have not been subjected to error analysis and ground-truthing by the Forest Ecosystem Management Assessment Team. Consequently, the estimates should be viewed only as approximations with unknown error. Some spot-checking was done by comparing maps with air photos, and no systematic error was observed.

The options are estimated to protect between 5.9 and 8.5 million acres of late-successional forests in several categories of reserves: Congressionally Withdrawn, Administratively Withdrawn, Late-Successional Reserves, and Riparian Reserves (tables IV-10, IV-11). This represents 69 to 100 percent of the current late-successional and old-growth forests on federal lands. The degree of protection varies by state and physiographic province and elevation, with highest percentages protected in the state of Washington and the lowest percentages protected in Oregon.

About 42 to 53 percent of the Late-Successional Reserves are currently covered by late-successional forests depending on the option (table IV-9). This illustrates that the Late-Successional Reserves were drawn around large areas containing a mixture of age classes. Option 1 has a higher percentage of late-successional forest in Late-Successional Reserves than the other options because many of its Reserves were created by drawing boundaries around small concentrations of late-successional forest (LS/OG3s of Johnson et al. 1991). The remaining area of the Reserves is covered by smaller, naturally regenerated conifers, conifer plantations, deciduous forests, younger successional stages following logging, and nonforested areas. The Late-Successional Reserves have a higher percentage of late-successional forest in them than the federal landscape as whole (table IV-9) and the Matrix lands.

Table IV-9. Acreages and percentages of forests dominated by medium and large conifer in different federal land allocations. ("Total Reserve" includes Congressionally Withdrawn Areas)

Option	Total federal lands	Late-Successional Reserve	Admin. Withdrawn	Riparian Reserve	Total Reserve	Adaptive Mgt/LS Mgt.	Matrix
1	8,530,900	6,060,800	0	7,100	8,518,800	0	12,100
	(35%)	(53%)	-	(4%)	(40%)	-	(1%)
2	8,530,900	3,777,800	431,500	561,100	7,281,800	0	1,249,100
	(35%)	(42%)	(28%)	(28%)	(38%)	-	(26%)
3	8,530,900	3,336,000	518,100	602,000	7,310,100	396,100	1,220,800
	(35%)	(42%)	(31%)	(28%)	(37%)	(47%)	(27%)
4	8,530,900	3,553,700	453,800	851,700	7,310,400	0	1,220,500
	(35%)	(42%)	(27%)	(30%)	(37%)	-	(28%)
5	8,530,900	2,982,000	610,700	838,400	6,830,500	0	1,700,400
	(35%)	(43%)	(29%)	(32%)	(37%)	-	(30%)
6	8,530,900	3,220,500	550,900	682,500	6,904,600	0	1,626,300
	(35%)	(43%)	(30%)	(30%)	(37%)	-	(29%)
7	8,530,900	2,559,000	691,700	194,000	5,915,800	0	2,615,100
	(35%)	(43%)	(30%)	(31%)	(37%)	-	(31%)
8	8,530,900	3,220,500	550,900	451,100	6,673,200	0	1,857,700
	(35%)	(43%)	(30%)	(30%)	(37%)	-	(29%)
9	8,530,900	2,975,100	586,600	696,600	6,623,200	457,000	1,450,700
	(35%)	(42%)	(35%)	(31%)	(37%)	(31%)	(30%)
10	8,530,900	3,220,500	550,900	682,500	6,904,600	0	1,626,300
	(35%)	(43%)	(30%)	(30%)	(37%)	-	(29%)

Projections Over Time in Reserves

The proportion of late-successional forest in the Reserves is expected to increase over time under all options. The Reserves currently contain 47 to 58 percent (depending on the option) of younger natural forests and plantation forests. Over time most of these areas probably will develop late-successional characteristics through stand development processes. The future amount of late-successional/old-growth forest will depend on the frequency of large severe disturbances and the occurrence of "typical" stand developmental processes. We are unable to model future amounts of late-successional forests in the Reserves except under the simplest of assumptions (see below).

Analysis of Change for Oregon and Washington

A simulation of forest development in the Reserves was conducted starting with current conditions estimated from satellite imagery classified for the Forest Service by Pacific Meridian Resources. The simulation was applied to the following land allocations in western Oregon and Washington: Congressionally Withdrawn, Administratively Withdrawn, and Late-Successional Reserves (see fig. IV-2). The simulation was based on simple assumptions about growth from one forest cover size class into another and did not include disturbance. It did not take into account that many dense young plantations within the Reserves would probably take longer to develop late-successional conditions, or perhaps not ever develop them. A disturbance correction was applied to the growth output by assuming that 12.5 percent of the reserved areas would be subject to severe disturbance over 50 years. This translates to a 400-year natural disturbance rotation. The simulation assumed that partial fire suppression would occur, driving the natural disturbance rotation longer than the presettlement regional average of about 250 years. Under these assumptions, about 80 percent of the Reserves on average would eventually be covered by forests older than 80 years.

Effects ofOptions on Ecosystems

The effects of the options on the late successional ecosystem were evaluated in terms of degrees (outcomes 1-4) of ecosystem quantity and quality (abundance, diversity, processes, functions and connectivity). The outcomes were characterized in part in terms of how they compare to hypothesized long-term averages and typical ranges (See Methods for Assessment of Late Successional Ecosystem for further information). Long-term past (last 1000 years) conditions are not the only, or necessarily the best standard by which to evaluate the future late successional ecosystem. However past conditions provide a reference point for current and future conditions and an opportunity for understanding processes that lead to the development and maintenance of the current late successional ecosystem.

None of the options provides for higher than 60 percent likelihood of reaching an outcome in 100 years in which the quality and quantity (as defined by the three attributes) of the overall late successional ecosystem is as at least as high as the hypothesized long-term average condition (Outcome 1) (table IV-12). However, two of the options (3 and 4 in moist provinces) attained at least 80 percent likelihood of reaching an outcome in which the quantity and quality of the overall late-successional ecosystem falls within the hypothesized, typical long-term range of conditions (Outcomes 1 and 2) (fig. IV-3, table IV-13). The other options had a 62-77 percent likelihood or reaching outcomes 1 and 2 combined in moist provinces. No options achieved an 80 percent or higher likelihood of reaching outcome 2 or better in the dry provinces (fig. IV-3, table IV-13).

For individual attributes, none of the options achieved a likelihood of 80 percent or better for outcome 1 for any of the individual attributes (table IV-12). However, Options 1, 3, 4, 5, and 9 had at least one attribute that had an 80 percent or better likelihood of achieving outcomes 1 and 2 combined (table IV-13). For the "process and function" attribute, none of the options achieved an 80 percent or better likelihood for outcome 1 and 2 combined (table IV-13). This occurred primarily because outcomes 1 and 2 under this attribute describe a condition in which larger scale landscape disturbance processes, such as fire, follow long-term natural behavior, which we felt was

Table IV-10. Current late-successional conifer forest on federal lands in the range of the northern spotted owl by option, by state, and by physiographic province.

State/ Physiographic province	Total: Small conifer single story *	Total: Medium/large conifer ** Single story	Total: Medium/large conifer ** Multi-story	Portion in Late-Successional Reserves: Small conifer single story *	Portion in Late-Successional Reserves: Medium/large conifer ** Single story	Portion in Late-Successional Reserves: Medium/large conifer ** Multi-story
Option 1						
Washington						
Eastern Cascades	830,100	515,500	432,200	296,800	331,800	214,600
Western Cascades	1,009,000	676,000	515,700	381,100	366,400	306,700
Western Lowlands	0	0	0	0	0	0
Olympic Peninsula	485,800	47,400	446,700	143,600	24,400	119,000
Total:	**2,324,900**	**1,238,900**	**1,394,600**	**821,500**	**722,600**	**640,300**
Oregon						
Klamath	596,200	207,500	489,500	337,900	187,800	430,500
Eastern Cascades	968,900	207,000	81,100	370,700	138,600	56,800
Western Cascades	1,165,100	997,900	921,200	457,200	765,500	814,400
Coast Range	526,100	209,300	140,500	331,500	206,600	136,900
Willamette Valley	4,300	1,300	800	1,000	1,300	600
Total:	**3,260,600**	**1,623,000**	**1,633,100**	**1,498,300**	**1,299,800**	**1,439,200**
California						
Coast	4,700	25,800	9,800	3,000	23,100	7,600
Klamath	140,300	963,200	1,303,900	49,600	658,600	935,800
Cascades	38,500	181,500	157,100	5,500	176,700	157,100
Total:	**183,500**	**1,170,500**	**1,470,800**	**58,100**	**858,400**	**1,100,500**
Three-State Total:	**5,769,000**	**4,032,400**	**4,498,500**	**2,377,900**	**2,880,800**	**3,180,000**
Option 2						
Washington						
Eastern Cascades	830,100	515,500	432,200	296,800	196,700	151,000
Western Cascades	1,009,000	676,000	515,700	379,500	253,000	235,800
Western Lowlands	0	0	0	0	0	0
Olympic Peninsula	485,800	47,400	446,700	142,500	21,500	112,400
Total:	**2,324,900**	**1,238,900**	**1,394,600**	**818,800**	**471,200**	**499,200**
Oregon						
Klamath	596,200	207,500	489,500	279,300	116,100	294,100
Eastern Cascades	968,900	207,000	81,100	368,100	76,600	45,000
Western Cascades	1,165,100	997,900	921,200	427,100	483,200	580,200
Coast Range	526,100	209,300	140,500	301,200	157,200	112,200
Willamette Valley	4,300	1,300	800	600	600	400
Total:	**3,260,600**	**1,623,000**	**1,633,100**	**1,376,300**	**833,700**	**1,031,900**
California						
Coast	4,700	25,800	9,800	3,000	16,100	3,000
Klamath	140,300	963,200	1,303,900	49,600	342,300	455,900
Cascades	38,500	181,500	157,100	5,400	84,300	40,200
Total:	**183,500**	**1,170,500**	**1,470,800**	**58,000**	**442,700**	**499,100**
Three-State Total:	**5,769,000**	**4,032,400**	**4,498,500**	**2,253,100**	**1,747,600**	**2,030,200**

* Stands generally characterized by trees 9.0 - 29.0 inches in diameter at breast height (dbh)

** Stands generally characterized by trees 21.0 inches in diameter at breast height (dbh) or larger

Portion in Administratively Withdrawn Areas			Portion in Riparian Reserves			Portion in Matrix		
Small	Medium/large conifer **		Small	Medium/large conifer **		Small	Medium/large conifer **	
conifer single story *	Single story	Multi-story	conifer single story *	Single story	Multi-story	conifer single story *	Single story	Multi-story
55,700	0	0	68,900	0	0	122,800	0	0
76,100	0	0	73,200	0	0	105,600	0	0
0	0	0	0	0	0	0	0	0
1,500	0	0	33,600	0	0	32,800	0	0
133,300	0	0	175,700	0	0	261,200	0	0
23,600	0	0	58,200	100	2,600	78,500	300	5,400
75,300	0	0	75,300	0	700	197,000	0	1,500
87,700	0	0	142,000	300	1,800	198,900	300	2,800
8,100	0	0	91,000	0	1,500	76,700	0	1,700
0	0	0	1,500	0	100	1,700	0	100
194,700	0	0	368,000	400	6,700	552,800	600	11,500
100	0	0	600	0	0	700	0	0
4,500	0	0	23,500	0	0	25,600	0	0
900	0	0	12,800	0	0	17,600	0	0
5,500	0	0	36,900	0	0	43,900	0	0
333,500	0	0	580,600	400	6,700	857,900	600	11,500

55,700	21,800	17,600	50,400	28,300	11,500	141,200	85,100	34,400
76,300	37,000	36,000	56,200	25,300	9,300	124,000	51,000	25,600
0	0	0	0	0	0	0	0	0
1,500	100	200	28,000	1,100	2,700	39,500	1,600	3,700
133,500	58,900	53,800	134,600	54,700	23,500	304,700	137,700	63,700
24,600	4,500	6,600	66,400	19,500	39,800	127,700	48,000	98,000
75,300	18,100	2,600	54,200	6,500	2,300	220,600	37,500	9,100
88,100	45,200	16,100	109,700	70,400	61,700	260,900	167,200	161,000
8,200	1,400	200	83,100	17,300	9,900	114,700	30,700	17,800
0	0	0	1,400	200	100	2,300	400	200
196,200	69,200	25,500	314,800	113,900	113,800	726,200	283,800	286,100
100	1,000	1,200	400	1,600	1,000	900	4,400	2,400
4,500	48,400	153,700	16,700	84,200	107,700	32,400	183,800	218,500
900	12,300	7,500	9,000	23,600	37,100	21,500	56,500	72,200
5,500	61,700	162,400	26,100	109,400	145,800	54,800	244,700	293,100
335,200	189,800	241,700	475,500	278,000	283,100	1,085,700	666,200	642,900

Table IV-10. (continued)

State/ Physiographic province	Total: Small conifer single story *	Total: Medium/large conifer ** Single story	Total: Medium/large conifer ** Multi-story	Portion in Late-Successional Reserves: Small conifer single story *	Portion in Late-Successional Reserves: Medium/large conifer ** Single story	Portion in Late-Successional Reserves: Medium/large conifer ** Multi-story	Portion in Managed Late-successional Areas: Small conifer single story *	Portion in Managed Late-successional Areas: Medium/large conifer ** Single story	Portion in Managed Late-successional Areas: Medium/large conifer ** Multi-story
Option 3									
Washington									
Eastern Cascades	830,100	515,500	432,200	323,600	216,600	160,200	0	0	0
Western Cascades	1,009,000	676,000	515,700	344,500	224,000	217,800	28,700	20,000	7,200
Western Lowlands	0	0	0	0	0	0	0	0	0
Olympic Peninsula	485,800	47,400	446,700	143,600	21,700	113,000	0	0	0
Total:	2,324,900	1,238,900	1,394,600	811,700	462,300	491,000	28,700	20,000	7,200
Oregon									
Klamath	596,200	207,500	489,500	228,500	96,100	249,100	43,100	16,800	40,900
Eastern Cascades	968,900	207,000	81,100	374,500	81,200	45,300	0	0	0
Western Cascades	1,165,100	997,900	921,200	303,800	345,400	438,800	104,900	120,200	128,900
Coast Range	526,100	209,300	140,500	325,400	159,300	112,900	600	300	400
Willamette Valley	4,300	1,300	800	500	600	400	0	100	0
Total:	3,260,600	1,623,000	1,633,100	1,232,700	682,600	846,500	148,600	137,400	170,200
California									
Coast	4,700	25,800	9,800	3,000	16,100	3,700	0	0	0
Klamath	140,300	963,200	1,303,900	43,800	311,100	394,300	4,500	21,500	39,800
Cascades	38,500	181,500	157,100	5,400	84,300	44,100	0	0	0
Total:	183,500	1,170,500	1,470,800	52,200	411,500	442,100	4,500	21,500	39,800
Three-State Total:	5,769,000	4,032,400	4,498,500	2,096,600	1,556,400	1,779,600	181,800	178,900	217,200
Option 4									
Washington									
Eastern Cascades	830,100	515,500	432,200	312,600	206,200	158,800	0	0	0
Western Cascades	1,009,000	676,000	515,700	371,700	251,000	239,100	0	0	0
Western Lowlands	0	0	0	0	0	0	0	0	0
Olympic Peninsula	485,800	47,400	446,700	151,000	22,100	115,100	0	0	0
Total:	2,324,900	1,238,900	1,394,600	835,300	479,300	513,000	0	0	0
Oregon									
Klamath	596,200	207,500	489,500	248,800	109,500	274,400	0	0	0
Eastern Cascades	968,900	207,000	81,100	288,600	68,800	39,400	0	0	0
Western Cascades	1,165,100	997,900	921,200	338,900	387,800	477,200	0	0	0
Coast Range	526,100	209,300	140,500	332,600	170,500	119,600	0	0	0
Willamette Valley	4,300	1,300	800	500	600	400	0	0	0
Total:	3,260,600	1,623,000	1,633,100	1,209,400	737,200	911,000	0	0	0
California									
Coast	4,700	25,800	9,800	3,000	17,100	4,100	0	0	0
Klamath	140,300	963,200	1,303,900	48,200	335,200	424,100	0	0	0
Cascades	38,500	181,500	157,100	6,300	88,700	44,000	0	0	0
Total:	183,500	1,170,500	1,470,800	57,500	441,000	472,200	0	0	0
Three-State Total:	5,769,000	4,032,400	4,498,500	2,102,200	1,657,500	1,896,200	0	0	0

* Stands generally characterized by trees 9.0 - 29.0 inches in diameter at breast height (dbh)

** Stands generally characterized by trees 21.0 inches in diameter at breast height (dbh) or larger

Portion in Administratively Withdrawn Areas			Portion in Riparian Reserves			Portion in Matrix		
Small	Medium/large conifer **		Small	Medium/large conifer **		Small	Medium/large conifer **	
conifer single story *	Single story	Multi-story	conifer single story *	Single story	Multi-story	conifer single story *	Single story	Multi-story
54,200	20,100	16,200	49,900	27,200	11,600	116,400	67,800	26,500
84,100	46,600	47,900	62,900	27,900	10,300	115,900	47,900	23,500
0	0	0	0	0	0	0	0	0
1,500	100	200	29,100	1,200	2,600	37,400	1,400	3,300
139,800	66,800	64,300	141,900	56,300	24,500	269,700	117,100	53,300
33,500	8,100	11,400	66,800	20,300	40,700	126,100	47,000	96,400
73,600	16,800	2,500	57,400	6,300	2,400	212,700	34,300	8,800
106,400	62,800	28,600	120,200	77,500	71,100	250,400	160,100	151,600
8,200	1,700	200	74,100	17,200	9,900	98,900	28,100	16,800
0	0	0	1,400	200	100	2,300	400	200
221,700	89,400	42,700	319,900	121,500	124,200	690,400	269,900	273,800
100	1,000	500	500	1,900	1,300	900	4,200	2,100
5,800	58,000	175,600	18,100	97,100	122,800	31,000	170,900	203,300
900	12,300	7,500	9,000	23,600	35,800	21,500	56,500	69,700
6,800	71,300	183,600	27,600	122,600	159,900	53,400	231,600	275,100
368,300	227,500	290,600	489,400	300,400	308,600	1,013,500	618,600	602,200

61,800	21,200	16,800	58,200	34,900	13,400	111,500	69,500	25,600
76,600	37,500	34,900	81,300	35,300	12,600	106,500	42,500	20,200
0	0	0	0	0	0	0	0	0
1,200	100	0	30,000	1,100	2,000	29,300	1,100	1,900
139,600	58,800	51,700	169,500	71,300	28,000	247,300	113,100	47,700
32,100	5,800	9,900	84,500	26,700	56,500	132,600	46,200	97,800
110,400	22,200	5,600	91,200	9,800	4,100	228,100	37,800	9,900
102,900	53,000	24,800	182,800	134,500	124,300	261,100	190,700	192,600
8,100	1,700	200	90,200	15,700	9,300	76,300	18,700	10,900
0	0	0	1,800	300	200	2,000	400	200
253,500	82,700	40,500	450,500	187,000	194,400	700,100	293,800	311,400
200	1,300	200	600	1,900	1,300	500	2,700	1,900
5,200	46,900	151,100	23,600	123,000	163,800	26,300	153,500	196,900
700	12,900	7,700	12,500	31,500	49,500	17,300	43,600	55,900
6,100	61,100	159,000	36,700	156,400	214,600	44,100	199,800	254,700
399,200	202,600	251,200	656,700	414,700	437,000	991,500	606,700	613,800

Table IV-10. (continued)

State/ Physiographic province	Total: Small conifer single story *	Total: Medium/large conifer ** Single story	Total: Medium/large conifer ** Multi-story	Portion in Late-Successional Reserves: Small conifer single story *	Portion in Late-Successional Reserves: Medium/large conifer ** Single story	Portion in Late-Successional Reserves: Medium/large conifer ** Multi-story
Option 5						
Washington						
Eastern Cascades	830,100	515,500	432,200	220,500	174,800	129,900
Western Cascades	1,009,000	676,000	515,700	323,100	215,600	221,200
Western Lowlands	0	0	0	0	0	0
Olympic Peninsula	485,800	47,400	446,700	151,000	22,100	115,100
Total:	**2,324,900**	**1,238,900**	**1,394,600**	**694,600**	**412,500**	**466,200**
Oregon						
Klamath	596,200	207,500	489,500	225,600	96,300	245,800
Eastern Cascades	968,900	207,000	81,100	140,800	30,500	20,900
Western Cascades	1,165,100	997,900	921,200	214,900	250,600	320,300
Coast Range	526,100	209,300	140,500	331,700	170,300	119,400
Willamette Valley	4,300	1,300	800	200	400	200
Total:	**3,260,600**	**1,623,000**	**1,633,100**	**913,200**	**548,100**	**706,600**
California						
Coast	4,700	25,800	9,800	3,000	17,100	4,100
Klamath	140,300	963,200	1,303,900	36,000	267,500	384,900
Cascades	38,500	181,500	157,100	4,500	85,500	37,700
Total:	**183,500**	**1,170,500**	**1,470,800**	**43,500**	**370,100**	**426,700**
Three-State Total:	**5,769,000**	**4,032,400**	**4,498,500**	**1,651,300**	**1,330,700**	**1,599,500**

State/ Physiographic province	Total: Small conifer single story *	Total: Medium/large conifer ** Single story	Total: Medium/large conifer ** Multi-story	Portion in Late-Successional Reserves: Small conifer single story *	Portion in Late-Successional Reserves: Medium/large conifer ** Single story	Portion in Late-Successional Reserves: Medium/large conifer ** Multi-story
Options 6 and 10						
Washington						
Eastern Cascades	830,100	515,500	432,200	249,500	168,100	135,200
Western Cascades	1,009,000	676,000	515,700	344,500	224,000	217,800
Western Lowlands	0	0	0	0	0	0
Olympic Peninsula	485,800	47,400	446,700	143,600	21,700	113,000
Total:	**2,324,900**	**1,238,900**	**1,394,600**	**737,600**	**413,800**	**466,000**
Oregon						
Klamath	596,200	207,500	489,500	228,500	96,100	249,100
Eastern Cascades	968,900	207,000	81,100	260,300	61,100	36,400
Western Cascades	1,165,100	997,900	921,200	303,800	345,400	438,800
Coast Range	526,100	209,300	140,500	325,400	159,300	112,900
Willamette Valley	4,300	1,300	800	500	600	400
Total:	**3,260,600**	**1,623,000**	**1,633,100**	**1,118,500**	**662,500**	**837,600**
California						
Coast	4,700	25,800	9,800	3,000	16,100	3,700
Klamath	140,300	963,200	1,303,900	43,800	311,100	394,300
Cascades	38,500	181,500	157,100	5,000	76,300	39,100
Total:	**183,500**	**1,170,500**	**1,470,800**	**51,800**	**403,500**	**437,100**
Three-State Total:	**5,769,000**	**4,032,400**	**4,498,500**	**1,907,900**	**1,479,800**	**1,740,700**

* Stands generally characterized by trees 9.0 - 29.0 inches in diameter at breast height (dbh)

** Stands generally characterized by trees 21.0 inches in diameter at breast height (dbh) or larger

Portion in Administratively Withdrawn Areas			Portion in Riparian Reserves			Portion in Matrix		
Small conifer single story *	Medium/large conifer **		Small conifer single story *	Medium/large conifer **		Small conifer single story *	Medium/large conifer **	
	Single story	Multi-story		Single story	Multi-story		Single story	Multi-story
106,400	37,200	36,400	61,600	33,500	14,500	155,500	86,200	33,700
89,600	47,800	40,800	84,000	40,000	15,300	139,200	63,000	29,400
0	0	0	0	0	0	0	0	0
1,200	100	0	26,000	1,000	1,700	33,300	1,200	2,100
197,200	85,100	77,200	171,600	74,500	31,500	328,000	150,400	65,200
36,200	8,300	14,700	80,600	25,300	54,500	155,700	58,200	123,600
159,900	41,500	10,300	90,900	10,500	5,500	326,500	56,100	22,300
127,900	72,300	52,100	176,200	147,100	141,100	366,700	296,000	305,500
8,100	1,700	200	71,300	13,100	7,700	96,100	21,600	12,900
0	0	100	1,500	300	200	2,600	600	300
332,100	123,800	77,400	420,500	196,300	209,000	947,600	432,500	464,600
200	1,300	200	400	1,500	1,200	700	3,100	2,000
8,200	62,500	161,500	21,200	118,800	144,900	37,800	209,800	244,600
800	13,200	8,500	9,300	23,000	37,700	22,200	55,000	73,200
9,200	77,000	170,200	30,900	143,300	183,800	60,700	267,900	319,800
538,500	285,900	324,800	623,000	414,100	424,300	1,336,300	850,800	849,600

73,300	29,400	21,600	57,500	33,300	14,400	163,800	101,000	43,400
84,100	46,600	47,900	67,200	32,700	11,700	140,200	63,100	29,300
0	0	0	0	0	0	0	0	0
1,500	100	200	27,600	1,100	2,400	38,900	1,500	3,400
158,900	76,100	69,700	152,300	67,100	28,500	342,900	165,600	76,100
33,500	8,100	11,400	78,000	23,700	50,200	158,100	60,300	127,900
118,700	25,700	7,300	69,000	7,600	3,000	270,200	44,200	12,400
106,400	62,800	28,600	139,600	105,400	95,500	335,800	252,500	256,100
8,200	1,700	200	72,000	16,300	9,600	101,700	29,300	17,400
0	0	0	1,400	200	100	2,400	500	200
266,800	98,300	47,500	360,000	153,200	158,400	868,200	386,800	414,000
100	1,000	500	400	1,600	1,000	900	4,400	2,400
5,800	58,000	175,600	18,000	90,800	119,900	35,600	198,800	246,100
900	16,400	7,800	9,100	24,800	37,400	21,800	59,300	72,800
6,800	75,400	183,900	27,500	117,200	158,300	58,300	262,500	321,300
432,500	249,800	301,100	539,800	337,500	345,200	1,269,400	814,900	811,400

Table IV-10. (continued)

Physiographic province	Total: Small conifer single story *	Total: Medium/large conifer ** Single story	Total: Medium/large conifer ** Multi-story	Portion in Late-Successional Reserves: Small conifer single story *	Portion in Late-Successional Reserves: Medium/large conifer ** Single story	Portion in Late-Successional Reserves: Medium/large conifer ** Multi-story
Option 7						
Washington						
Eastern Cascades	830,100	515,500	432,200	220,500	174,800	129,900
Western Cascades	1,009,000	676,000	515,700	299,400	200,800	199,700
Western Lowlands	0	0	0	0	0	0
Olympic Peninsula	485,800	47,400	446,700	127,100	19,100	104,300
Total:	**2,324,900**	**1,238,900**	**1,394,600**	**647,000**	**394,700**	**433,900**
Oregon						
Klamath	596,200	207,500	489,500	107,100	69,600	151,600
Eastern Cascades	968,900	207,000	81,100	140,700	30,500	19,800
Western Cascades	1,165,100	997,900	921,200	211,900	245,700	316,800
Coast Range	526,100	209,300	140,500	236,100	133,200	94,500
Willamette Valley	4,300	1,300	800	200	100	0
Total:	**3,260,600**	**1,623,000**	**1,633,100**	**696,000**	**479,100**	**582,700**
California						
Coast	4,700	25,800	9,800	3,000	16,800	4,000
Klamath	140,300	963,200	1,303,900	33,700	244,400	300,200
Cascades	38,500	181,500	157,100	4,500	85,500	37,700
Total:	**183,500**	**1,170,500**	**1,470,800**	**41,200**	**346,700**	**341,900**
Three-State Total:	**5,769,000**	**4,032,400**	**4,498,500**	**1,384,200**	**1,220,500**	**1,358,500**
Option 8						
Washington						
Eastern Cascades	830,100	515,500	432,200	249,500	168,100	135,200
Western Cascades	1,009,000	676,000	515,700	344,500	224,000	217,800
Western Lowlands	0	0	0	0	0	0
Olympic Peninsula	485,800	47,400	446,700	143,600	21,700	113,000
Total:	**2,324,900**	**1,238,900**	**1,394,600**	**737,600**	**413,800**	**466,000**
Oregon						
Klamath	596,200	207,500	489,500	228,500	96,100	249,100
Eastern Cascades	968,900	207,000	81,100	260,300	61,100	36,400
Western Cascades	1,165,100	997,900	921,200	303,800	345,400	438,800
Coast Range	526,100	209,300	140,500	325,400	159,300	112,900
Willamette Valley	4,300	1,300	800	500	600	400
Total:	**3,260,600**	**1,623,000**	**1,633,100**	**1,118,500**	**662,500**	**837,600**
California						
Coast	4,700	25,800	9,800	3,000	16,100	3,700
Klamath	140,300	963,200	1,303,900	43,800	311,100	394,300
Cascades	38,500	181,500	157,100	5,000	76,300	39,100
Total:	**183,500**	**1,170,500**	**1,470,800**	**51,800**	**403,500**	**437,100**
Three-State Total:	**5,769,000**	**4,032,400**	**4,498,500**	**1,907,900**	**1,479,800**	**1,740,700**

* Stands generally characterized by trees 9.0 - 29.0 inches in diameter at breast height (dbh)

** Stands generally characterized by trees 21.0 inches in diameter at breast height (dbh) or larger

Portion in Administratively Withdrawn Areas			Portion in Riparian Reserves			Portion in Matrix		
Small	Medium/large conifer **		Small	Medium/large conifer **		Small	Medium/large conifer **	
conifer single story *	Single story	Multi-story	conifer single story *	Single story	Multi-story	conifer single story *	Single story	Multi-story
106,400	37,200	36,400	14,200	7,700	3,100	203,000	112,000	45,000
97,600	54,700	52,600	19,400	9,400	3,900	219,600	101,500	50,500
0	0	0	0	0	0	0	0	0
3,400	100	500	6,800	400	1,200	74,200	4,700	13,000
207,400	92,000	89,500	40,400	17,500	8,200	496,800	218,200	108,500
73,300	13,500	35,500	21,300	6,700	16,400	296,300	98,400	235,000
159,900	41,500	10,300	19,700	2,200	1,400	397,900	64,400	27,600
127,900	72,400	52,200	37,000	31,000	28,800	508,900	416,900	421,200
9,100	2,800	800	20,900	5,700	3,600	241,100	65,000	41,200
0	0	100	300	100	0	3,800	1,100	600
370,200	130,200	98,900	99,200	45,700	50,200	1,448,000	645,800	725,600
200	1,500	300	100	300	200	1,000	4,600	3,100
8,900	68,300	189,300	4,800	25,700	32,200	55,900	320,200	414,200
800	13,200	8,500	2,300	5,600	8,400	29,200	72,400	102,500
9,900	83,000	198,100	7,200	31,600	40,800	86,100	397,200	519,800
587,500	305,200	386,500	146,800	94,800	99,200	2,030,900	1,261,200	1,353,900

73,300	29,400	21,600	37,600	21,600	9,200	183,700	112,700	48,500
84,100	46,600	47,900	46,500	22,700	8,100	161,000	73,200	33,000
0	0	0	0	0	0	0	0	0
1,500	100	200	21,900	800	1,900	44,500	1,700	3,900
158,900	76,100	69,700	106,000	45,100	19,200	389,200	187,600	85,400
33,500	8,100	11,400	46,000	15,100	31,300	190,100	68,900	146,700
118,700	25,700	7,300	41,800	4,500	1,900	297,500	47,300	13,400
106,400	62,800	28,600	88,700	65,600	59,800	386,700	292,300	291,800
8,200	1,700	200	49,000	11,400	6,500	124,600	34,100	20,500
0	0	0	900	200	100	2,900	500	300
266,800	98,300	47,500	226,400	96,800	99,600	1,001,800	443,100	472,700
100	1,000	500	300	1,000	600	1,100	5,000	2,800
5,800	58,000	175,600	11,100	56,500	87,700	42,500	233,100	278,300
900	16,400	7,800	5,900	16,000	28,600	25,000	68,100	81,600
6,800	75,400	183,900	17,300	73,500	116,900	68,600	306,200	362,700
432,500	249,800	301,100	349,700	215,400	235,700	1,459,600	936,900	920,800

Table IV-10. (continued)

Physiographic province	Total: Small conifer single story *	Total: Medium/large conifer ** Single story	Total: Medium/large conifer ** Multi-story	Portion in Late-Successional Reserves: Small conifer single story *	Portion in Late-Successional Reserves: Medium/large conifer ** Single story	Portion in Late-Successional Reserves: Medium/large conifer ** Multi-story	Portion in Adaptive Management Areas: Small conifer single story *	Portion in Adaptive Management Areas: Medium/large conifer ** Single story	Portion in Adaptive Management Areas: Medium/large conifer ** Multi-story
Option 9									
Washington									
Eastern Cascades	830,100	515,500	432,200	266,700	172,100	116,300	5,600	14,000	19,000
Western Cascades	1,009,000	676,000	515,700	291,500	193,700	208,200	81,100	44,500	39,600
Western Lowlands	0	0	0	0	0	0	0	0	0
Olympic Peninsula	485,800	47,400	446,700	130,300	21,700	114,400	81,000	2,600	4,600
Total:	2,324,900	1,238,900	1,394,600	688,500	387,500	438,900	167,700	61,100	63,200
Oregon									
Klamath	596,200	207,500	489,500	186,800	86,500	214,200	99,000	24,700	35,300
Eastern Cascades	968,900	207,000	81,100	238,000	59,000	25,600	0	0	0
Western Cascades	1,165,100	997,900	921,200	257,100	291,900	387,500	31,600	54,800	55,000
Coast Range	526,100	209,300	140,500	300,200	129,800	90,800	69,400	33,500	17,300
Willamette Valley	4,300	1,300	800	200	200	0	0	0	0
Total:	3,260,600	1,623,000	1,633,100	982,300	567,400	718,100	200,000	113,000	107,600
California									
Coast	4,700	25,800	9,800	3,000	17,100	3,800	0	0	0
Klamath	140,300	963,200	1,303,900	45,200	307,700	397,600	12,300	84,500	27,600
Cascades	38,500	181,500	157,100	6,700	91,300	45,700	0	0	0
Total:	183,500	1,170,500	1,470,800	54,900	416,100	447,100	12,300	84,500	27,600
Three-State Total:	5,769,000	4,032,400	4,498,500	1,725,700	1,371,000	1,604,100	380,000	258,600	198,400

* Stands generally characterized by trees 9.0 - 29.0 inches in diameter at breast height (dbh)

** Stands generally characterized by trees 21.0 inches in diameter at breast height (dbh) or larger

Portion in Administratively Withdrawn Areas			Portion in Riparian Reserve Areas			Portion in Matrix Areas		
Small conifer single story *	Medium/large conifer **		Small conifer single story *	Medium/large conifer **		Small conifer single story *	Medium/large conifer **	
	Single story	Multi-story		Single story	Multi-story		Single story	Multi-story
69,000	25,000	29,800	64,300	35,300	15,500	138,500	85,400	34,000
68,000	34,400	23,900	70,600	35,000	11,500	124,700	58,800	23,500
0	0	0	0	0	0	0	0	0
0	0	0	100	0	0	100	0	0
137,000	59,400	53,700	135,000	70,300	27,000	263,300	144,200	57,500
26,300	3,400	13,400	73,600	23,400	56,600	112,300	50,200	119,100
122,000	25,100	9,100	80,400	8,800	4,900	277,800	45,700	19,300
117,300	66,200	37,500	149,300	111,300	95,000	330,500	241,800	244,100
6,500	1,700	200	53,800	14,800	11,200	77,300	26,800	20,600
0	0	100	1,500	400	200	2,500	700	400
272,100	96,400	60,300	358,600	158,700	167,900	800,400	365,200	403,500
200	1,400	600	400	1,500	1,200	700	3,100	2,000
3,400	47,500	159,900	16,500	83,000	130,600	25,900	136,000	220,200
1,000	14,000	7,500	8,500	21,100	35,300	20,500	50,400	68,600
4,600	62,900	168,000	25,400	105,600	167,100	47,100	189,500	290,800
413,700	218,700	282,000	519,000	334,600	362,000	1,110,800	698,900	751,800

Table IV-11. Existing acres of federal forest by cover type by land allocation for each option by state within the range of the northern spotted owl.

Option/allocation/state	Grass/ shrub	Conifer dominated: Seedling, sapling, poles	Conifer dominated: Small conifer single story	Conifer dominated: Medium/large conifer Single story	Conifer dominated: Medium/large conifer Multi story	Hardwood dominated: Small	Hardwood dominated: Medium	Hardwood dominated: Large
Congressionally Withdrawn Areas								
Washington	31,200	257,300	933,300	516,300	754,400	13,600	0	0
Oregon	4,100	55,200	647,000	322,200	175,700	8,900	0	0
California	28,100	16,200	39,100	312,000	370,200	3,700	10,000	6,100
Total:	**63,400**	**328,700**	**1,619,400**	**1,150,500**	**1,300,300**	**26,200**	**10,000**	**6,100**
Option 1								
Late-Successional Reserves								
Washington	180,600	384,500	821,500	722,500	640,300	3,100	600	0
Oregon	116,500	947,600	1,498,200	1,299,700	1,439,300	44,500	200	0
California	71,300	149,400	58,000	858,500	1,100,500	31,100	27,300	15,800
Total:	**368,400**	**1,481,500**	**2,377,700**	**2,880,700**	**3,180,100**	**78,700**	**28,100**	**15,800**
Administratively Withdrawn Areas								
Washington	23,800	79,600	133,200	0	0	500	0	0
Oregon	6,700	36,000	194,600	0	0	1,000	0	0
California	28,100	27,600	5,400	0	0	3,600	8,100	5,200
Total:	**58,600**	**143,200**	**333,200**	**0**	**0**	**5,100**	**8,100**	**5,200**
Option 2								
Late-Successional Reserves								
Washington	180,300	382,600	818,700	471,200	499,300	3,000	600	0
Oregon	114,700	932,900	1,376,300	833,700	1,031,800	42,000	100	0
California	71,300	149,400	58,000	442,700	499,100	31,100	27,300	15,800
Total:	**366,300**	**1,464,900**	**2,253,000**	**1,747,600**	**2,030,200**	**76,100**	**28,000**	**15,800**
Administratively Withdrawn Areas								
Washington	23,800	79,700	133,400	58,900	53,800	500	0	0
Oregon	6,800	36,200	196,200	69,200	25,500	1,100	0	0
California	28,100	27,600	5,400	61,700	162,400	3,600	8,100	5,200
Total:	**58,700**	**143,500**	**335,000**	**189,800**	**241,700**	**5,200**	**8,100**	**5,200**
Option 3								
Late-Successional Reserves								
Washington	179,000	371,100	811,700	462,300	491,000	3,100	600	0
Oregon	92,800	771,300	1,232,700	682,500	846,500	43,100	100	0
California	64,500	137,300	52,100	411,500	442,000	30,700	26,000	14,700
Total:	**336,300**	**1,279,700**	**2,096,500**	**1,556,300**	**1,779,500**	**76,900**	**26,700**	**14,700**
Managed Late-successional Areas								
Washington	5,300	17,900	28,700	20,000	7,200	0	0	0
Oregon	20,600	155,100	148,700	137,300	170,100	600	0	0
California	3,200	10,300	4,500	21,500	39,800	200	900	600
Total:	**29,100**	**183,300**	**181,900**	**178,800**	**217,100**	**800**	**900**	**600**
Administratively Withdrawn Areas								
Washington	25,900	83,700	139,700	66,700	64,200	500	0	0
Oregon	9,100	47,700	221,800	89,400	42,600	1,100	0	0
California	31,700	29,700	6,800	71,300	183,600	3,800	8,500	5,700
Total:	**66,700**	**161,100**	**368,300**	**227,400**	**290,400**	**5,400**	**8,500**	**5,700**

Diameter at breast height (dbh) for each size class:

Oregon, Western Washington		Eastern Washington		California
seedling	< 0.9 inches	seedling	< 0.9 inches	Definitions vary - see text.
sapling	1.0-4.9 inches	sapling	1.0-4.9 inches	
pole	5.0-8.9 inches	pole	5.0-8.9 inches	
small	9.0-20.9 inches	small	9.0-15.9 inches	
medium	21.0-31.9 inches	medium	16.0-23.9 inches	
large	> 31.9 inches	large	> 23.9 inches	

Table IV-11. (continued)

Option/allocation/state	Grass/ shrub	Conifer dominated: Seedling, sapling, poles	Conifer dominated: Small conifer single story	Conifer dominated: Medium/large conifer Single story	Conifer dominated: Medium/large conifer Multi story	Hardwood dominated: Small	Hardwood dominated: Medium	Hardwood dominated: Large
Congressionally Withdrawn Areas								
Washington	31,200	257,300	933,300	516,300	754,400	13,600	0	0
Oregon	4,100	55,200	647,000	322,200	175,700	8,900	0	0
California	28,100	16,200	39,100	312,000	370,200	3,700	10,000	6,100
Total:	63,400	328,700	1,619,400	1,150,500	1,300,300	26,200	10,000	6,100
Option 4								
Late-Successional Reserves*								
Washington	190,300	400,500	835,300	479,300	512,900	3,000	600	0
Oregon	95,700	862,000	1,209,400	737,200	911,100	43,700	100	0
California	62,500	145,800	57,500	441,100	472,300	32,800	15,300	13,200
Total:	348,500	1,408,300	2,102,200	1,657,600	1,896,300	79,500	16,000	13,200
Administratively Withdrawn Areas								
Washington	16,800	75,200	139,500	58,800	51,700	400	0	0
Oregon	10,200	41,900	253,600	82,700	40,400	1,100	0	0
California	37,100	24,900	6,100	61,200	159,000	4,900	11,000	7,600
Total:	64,100	142,000	399,200	202,700	251,100	6,400	11,000	7,600
Option 5								
Late-Successional Reserves*								
Washington	169,300	345,200	694,600	412,600	466,300	2,600	500	0
Oregon	72,000	700,400	913,300	548,000	706,500	43,200	100	0
California	59,500	130,100	43,600	370,100	426,700	32,200	13,500	11,700
Total:	300,800	1,175,700	1,651,500	1,330,700	1,599,500	78,000	14,100	11,700
Administratively Withdrawn Areas								
Washington	21,200	89,700	197,200	85,100	77,300	500	0	0
Oregon	13,600	56,500	332,100	123,900	77,300	1,100	0	0
California	38,500	27,700	9,200	77,000	170,300	5,200	11,100	8,500
Total:	73,300	173,900	538,500	286,000	324,900	6,800	11,100	8,500
Option 6 and 10**								
Late-Successional Reserves								
Washington	166,500	348,300	737,500	413,800	466,000	3,100	600	0
Oregon	89,600	762,000	1,118,500	662,400	837,500	43,000	100	0
California	64,500	135,700	51,700	403,500	437,100	30,700	13,500	14,700
Total:	320,600	1,246,000	1,907,700	1,479,700	1,740,600	76,800	14,200	14,700
Administratively Withdrawn Areas								
Washington	26,600	86,900	158,900	76,100	69,600	500	0	0
Oregon	10,700	48,100	266,900	98,300	47,400	1,100	0	0
California	31,700	29,700	6,800	75,300	183,900	3,800	11,200	5,700
Total:	69,000	164,700	432,600	249,700	300,900	5,400	11,200	5,700

Diameter at breast height (dbh) for each size class:

Oregon, Western Washington

seedling	< 0.9 inches
sapling	1.0-4.9 inches
pole	5.0-8.9 inches
small	9.0-20.9 inches
medium	21.0-31.9 inches
large	> 31.9 inches

Eastern Washington

seedling	< 0.9 inches
sapling	1.0-4.9 inches
pole	5.0-8.9 inches
small	9.0-15.9 inches
medium	16.0-23.9 inches
large	> 23.9 inches

California
Definitions vary - see text.

* Includes 147,000 acres of Managed Late-Successional Areas

** Table information the same for Option 6 and Option 10

Table IV-11. (continued)

Option/allocation/state	Grass/ shrub	Seedling, sapling, poles	Small conifer single story	Medium/large conifer Single story	Medium/large conifer Multi story	Hardwood Small	Hardwood Medium	Hardwood Large
		Conifer dominated				Hardwood dominated		
Congressionally Withdrawn Areas								
Washington	31,200	257,300	933,300	516,300	754,400	13,600	0	0
Oregon	4,100	55,200	647,000	322,200	175,700	8,900	0	0
California	28,100	16,200	39,100	312,000	370,200	3,700	10,000	6,100
Total:	**63,400**	**328,700**	**1,619,400**	**1,150,500**	**1,300,300**	**26,200**	**10,000**	**6,100**
Option 7								
Late-Successional Reserves*								
Washington	157,200	313,100	647,000	394,800	434,000	1,500	500	0
Oregon	55,200	559,800	696,000	479,000	582,800	17,000	100	0
California	58,800	110,300	41,200	346,700	341,800	32,100	12,200	11,700
Total:	**271,200**	**983,200**	**1,384,200**	**1,220,500**	**1,358,600**	**50,600**	**12,800**	**11,700**
Administratively Withdrawn Areas								
Washington	22,100	96,700	207,400	92,000	89,500	700	0	0
Oregon	16,400	79,100	370,300	130,200	98,800	5,000	0	0
California	38,700	33,100	9,900	82,900	198,200	5,400	11,400	8,500
Total:	**77,200**	**208,900**	**587,600**	**305,100**	**386,500**	**11,100**	**11,400**	**8,500**
Option 8								
Late-Successional Reserves								
Washington	166,500	348,300	737,500	413,800	466,000	3,100	600	0
Oregon	89,600	762,000	1,118,500	662,400	837,500	43,000	100	0
California	64,500	135,700	51,700	403,500	437,100	30,700	13,500	14,700
Total:	**320,600**	**1,246,000**	**1,907,700**	**1,479,700**	**1,740,600**	**76,800**	**14,200**	**14,700**
Administratively Withdrawn Areas								
Washington	26,600	86,900	158,900	76,100	69,600	500	0	0
Oregon	10,700	48,100	266,900	98,300	47,400	1,100	0	0
California	31,700	29,700	6,800	75,300	183,900	3,800	11,200	5,700
Total:	**69,000**	**164,700**	**432,600**	**249,700**	**300,900**	**5,400**	**11,200**	**5,700**
Option 9								
Late-Successional Reserves								
Washington	155,600	313,900	688,600	387,500	438,900	2,500	700	0
Oregon	69,800	658,500	982,300	567,400	718,100	20,000	100	0
California	65,200	142,200	55,000	416,000	447,100	32,200	14,100	12,100
Total:	**290,600**	**1,114,600**	**1,725,900**	**1,370,900**	**1,604,100**	**54,700**	**14,900**	**12,100**
Adaptive Management Areas								
Washington	44,600	113,000	167,700	61,100	63,200	800	0	0
Oregon	23,900	180,900	200,100	113,000	107,600	38,800	0	0
California	200	22,200	12,300	84,500	27,600	300	2,200	0
Total:	**68,700**	**316,100**	**380,100**	**258,600**	**198,400**	**39,900**	**2,200**	**0**
Administratively Withdrawn Areas								
Washington	15,800	65,400	137,100	59,400	53,700	200	0	0
Oregon	11,300	45,400	272,100	96,400	60,200	1,200	0	0
California	36,100	26,500	4,600	62,900	168,000	5,100	11,200	8,000
Total:	**63,200**	**137,300**	**413,800**	**218,700**	**281,900**	**6,500**	**11,200**	**8,000**

Diameter at breast height (dbh) for each size class:

Oregon, Western Washington

seedling	< 0.9 inches
sapling	1.0-4.9 inches
pole	5.0-8.9 inches
small	9.0-20.9 inches
medium	21.0-31.9 inches
large	> 31.9 inches

Eastern Washington

seedling	< 0.9 inches
sapling	1.0-4.9 inches
pole	5.0-8.9 inches
small	9.0-15.9 inches
medium	16.0-23.9 inches
large	> 23.9 inches

California

Definitions vary - see text.

* Includes 147,000 acres of Managed Late-Successional Areas

Table IV-12. Projected future likelihoods for ecosytem outcomes under land management options

Ecosystem Outcomes	Option 1				Option 3				Option 4			
	1	2	3	4	1	2	3	4	1	2	3	4
Overall Ecosystem												
Dry Provinces	23	36	31	10	25	44	27	4	22	43	30	5
Moist Provinces	46	31	18	5	39	46	14	1	39	43	16	2
Abundance and Diversity												
Dry Provinces	28	38	18	16	35	40	19	6	32	43	19	6
Moist Provinces	53	33	12	2	44	48	6	2	49	44	5	2
Process and Function												
Dry Provinces	2	32	56	10	4	49	43	4	2	44	50	4
Moist Provinces	12	40	36	12	8	63	27	2	8	54	36	2
Connectivity												
Dry Provinces	38	38	18	6	36	42	20	2	33	43	22	2
Moist Provinces	72	20	6	2	64	26	8	2	59	31	8	2

Ecosystem Outcomes	Option 5				Option 7				Option 8				Option 9			
	1	2	3	4	1	2	3	4	1	2	3	4	1	2	3	4
Overall Ecosystem																
Dry Provinces	18	42	34	6	12	40	42	6	13	38	44	5	18	45	32	5
Moist Provinces	30	43	23	4	24	38	32	6	27	41	27	5	33	44	20	3
Abundance and Diversity																
Dry Provinces	24	45	25	6	20	44	26	10	26	38	30	6	24	45	25	6
Moist Provinces	36	44	18	2	30	36	24	10	31	38	23	8	42	34	22	2
Process and Function																
Dry Provinces	6	41	49	4	4	36	56	4	2	36	56	6	4	49	43	4
Moist Provinces	8	51	39	2	6	46	46	2	8	51	38	3	8	67	23	2
Connectivity																
Dry Provinces	25	41	27	7	12	39	43	6	12	41	45	2	25	41	27	7
Moist Provinces	47	33	13	7	37	31	26	6	41	33	20	6	48	32	16	4

Interpretation of outcomes under each option is explained in the text. Overall Ecosystem rating is an average of the likelihoods of three attributes

Likelihood values are expressed as percentages that total to 100 for a given attribute within an option. Numbers displayed may vary due to rounding errors. See text for fuller explanation and discussion of the rating scale and outcomes.

Table IV-13. Likelihood of achieving outcomes 1 and 2 combined for different ecosystem attributes and average of attributes. Numbers in bold are at least 80 percent likelihood. Attributes: A = Abundance and Diversity; P = Process and Function; C = Connectivity.

	Moist Provinces				Dry Provinces			
Option	A	P	C	Average	A	P	C	Average
1	**86**	52	**92**	77	66	34	76	59
3	**92**	71	**90**	**85**	75	53	78	69
4	**93**	62	**90**	**82**	75	46	76	65
5	**80**	59	**80**	73	69	47	66	60
7	66	50	68	62	64	41	51	52
8	69	59	74	68	64	38	53	51
9	76	75	80	77	69	53	66	63

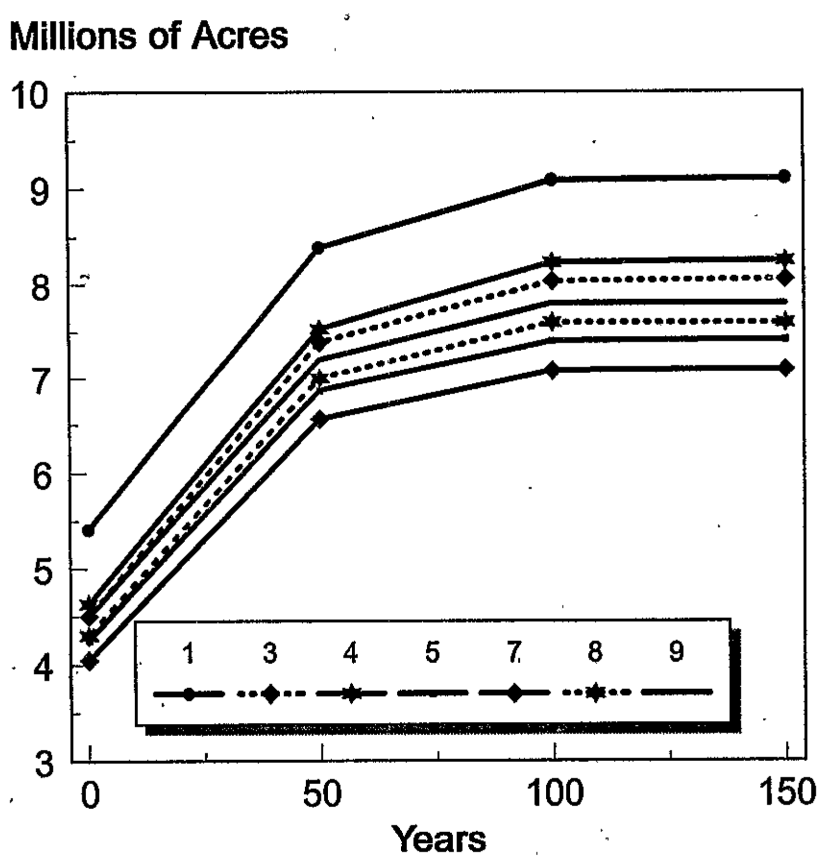

Figure IV-2. Projected acreage of late-successional forest (stands with dominant trees at least 21 inches in diameter) on Congressionally and Administratively Withdrawn Areas and in Late-successional Reserves in Oregon and Washington over the next 150 years.

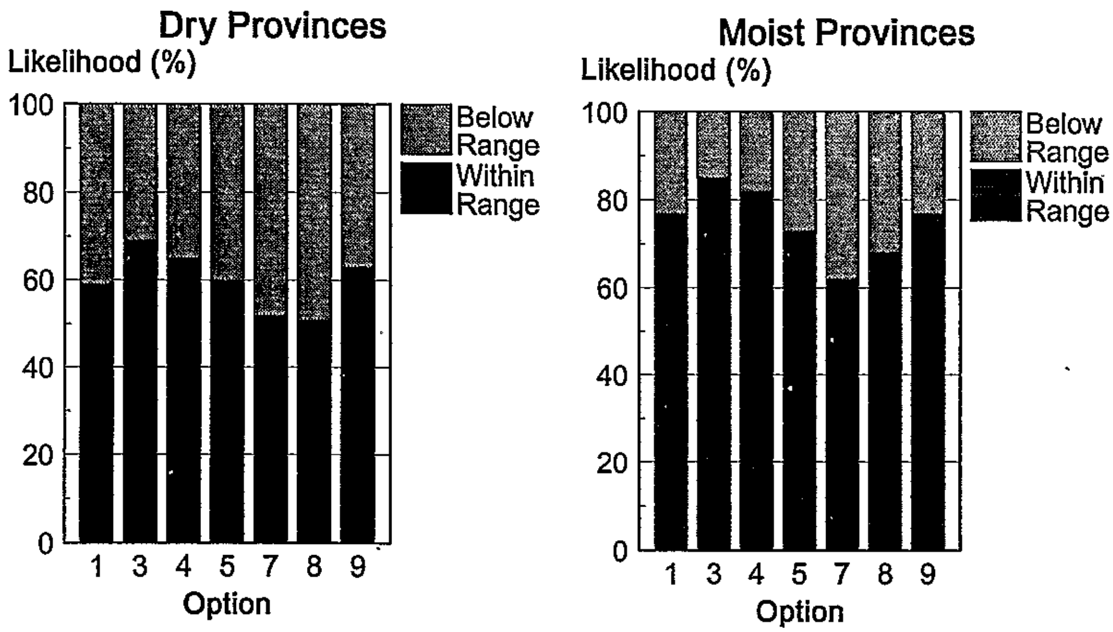

Figure IV-3. Likelihood of achieving outcomes in which most attributes of the late successional ecosystem fall within the typical range of variability (Outcomes 1 and 2) and in which most attributes of the late successional ecosystem fall below the typical range of variability (Outcomes 3 and 4) by dry and moist provinces.

unlikely. In the dry provinces, no options achieved an 80 percent or greater likelihood for outcome 1 and 2 combined for any attribute (table IV-13). In the moist provinces Options 3, 4, and 9 achieved 62-93 percent likelihood ratings for outcomes 1 and 2 combined under all three attributes (table IV-13). In the dry provinces, no options achieved a 60 percent or greater likelihood rating for outcomes 1 and 2 under all attributes (table IV-13).

The results indicate that none of the options had a 60 percent or greater likelihood of producing a late-successional/old-growth ecosystem with attributes that approximate at least long-term average conditions (outcome 1). This occurs primarily because 100 years is not long enough for the cutover landscapes to return to late-successional conditions that approximate prelogging conditions. Many late-successional attributes require 200 to 500 years to develop. In addition, many larger scale disturbance processes will probably not occur under any of the options, at least not to the extent that they would in an environment that was not influenced by humans.

Some options do have an 80 percent or greater likelihood of achieving an overall ecosystem condition at 100 years that is hypothesized to fall within the typical range of conditions that have occurred over previous centuries (outcomes 1 and 2 combined) . This does not mean, however, that all attributes and stands would meet this condition. Many young forest plantations within Reserves are not developing along typical pathways, and fire suppression has and will alter the stand and landscape-level processes that have been typical of these ecosystems. In general, high rates of logging, forest plantations, fire suppression, ownership patterns, and human population and environmental influences have altered the regional ecosystem on federal lands to the extent that none of the options can provide for a return to conditions that closely match those of previous centuries. However, all of the options reverse the trend of the last 50 years on federal lands, which, if continued, would result in a steep decline in the quantity and quality of the late-successional ecosystem and its eventual loss in many federal planning areas.

Some of the options provide greater likelihoods than others of maintaining and enhancing the late-successional ecosystem at levels that approach typical long-term conditions. Options 3, 4, 1, and 9 received the highest ratings (fig. IV-3). Options 3 and 4 provide for relatively high amounts of late-successional forest and strong connectivity through presence of riparian Reserves and retention of old-growth components in managed forest Matrix. Options 3 and 4 also provide relatively high acreage of low elevation (0 to 4000 feet) (tables IV-14, IV-15, IV-16) late successional ecosystems, which are relatively rare in the entire region. Although Option 1 provides for the highest acreage of Late-Successional Reserves, it did not achieve an 80 percent or greater likelihood because it lacks restoration silviculture in the reserves. We assumed that without restoration silviculture, late-successional conditions would be retarded in development. However, such use of silviculture remains largely untested in the Pacific Northwest, and is to be treated as a working hypothesis to be assessed by studies in an adaptive management framework. Option 9 achieved a 60 to 80 percent or greater likelihood rating for the overall ecosystem for outcomes 1 and 2 combined in moist provinces (table IV-13). Option 9 might have achieved a higher overall ranking if it provided for more acreage of late-successional ecosystems in the low elevations of Oregon (table IV-14). We felt that the opportunities to increase knowledge about ecosystem function and management in the adaptive management areas of Option 9, actually increased the likelihood that this option would provide late-successional characteristics in the future, given our poor understanding of ecosystem function and the likelihood of future environmental change.
Other reasons for not achieving 80 percent or greater likelihoods for outcome 1 alone or outcomes 1 and 2 combined include:

1. *Inherent dynamics of the ecosystems and environment.* The probabilities of large-scale disturbances and other environmental changes during the next 100 years are high. The region has historically been subjected to large fires and in coastal areas to wind disturbances that could substantially reduce the area and character of late-successional/old-growth forest ecosystems in reserves. Although fire suppression will be practiced, it may not be sufficient to prevent loss of large portions of late-successional/old-growth forests. The risk of large-scale change in Reserves is particularly high in the eastern Cascade provinces and drier portions of the Oregon and California Klamath provinces. The higher risk of large-scale change in these provinces is the primary reason that none of the options achieved an 80 percent or greater likelihood of outcome 1 and 2 combined in the eastern Cascades and Klamath area (table IV-13). In addition to disturbances such as fire and wind, climate change, projected to occur under increasing carbon dioxide levels in the atmosphere during the next century, could have widespread direct and indirect effects on ecosystem processes, functions, and stability (Franklin et al. 1991).

   Potential mitigations:

   Northern and Western provinces: None

   Eastern Cascades and Klamath Provinces: Use active fire management, including thinning and prescribed fire to reduce risk of large-scale loss of late-successional/old

Table IV-14. Acres of Large Reserves[a] by elevation bands, and percent (in parentheses) of total federal land represented by those reserves in each elevation band.

		Elevation bands in thousands of feet.					Totals
		0-2	*2-4*	*4-6*	*6-8*	*8-16*	
Acres of Federal Land							
Washington		693,220 (8)	2,951,156 (33)	3,735,628 (42)	1,379,564 (16)	79,514 (1)	8,839,083 (100)
Oregon		1,719,436 (18)	3,844,861 (40)	3,061,812 (32)	910,027 (10)	28,415 (0)	9,564,551 (100)
California		379,471 (6)	2,275,601 (39)	2,380,724 (41)	780,599 (13)	40,587 (1)	5,856,983 (100)
Three State Total		2,792,128 (12)	9,071,618 (37)	9,178,164 (38)	3,070,190 (13)	148,516 (1)	24,260,617 (100)
Acres of Large Reserves							
	Option						
Washington	1	548,814 (79)	2,369,145 (80)	3,335,765 (89)	1,345,182 (98)	78,921 (99)	7,677,827 (87)
	2	439,028 (63)	2,234,856 (76)	3,208,629 (86)	1,340,795 (97)	78,921 (99)	7,302,229 (83)
	3	443,612 (64)	2,275,443 (77)	3,247,437 (87)	1,340,835 (97)	78,921 (99)	7,386,248 (84)
	4	543,677 (78)	2,287,892 (78)	3,215,387 (86)	1,317,755 (96)	78,921 (99)	7,443,632 (84)
	5	539,883 (78)	2,193,400 (74)	3,105,719 (83)	1,297,797 (94)	78,882 (99)	7,215,680 (82)
	6 & 10	442,901 (64)	2,174,035 (74)	3,113,465 (83)	1,316,569 (95)	78,921 (99)	7,125,891 (81)
	7	501,114 (72)	2,137,518 (72)	3,089,002 (83)	1,297,797 (94)	78,882 (99)	7,104,313 (80)
	8	442,901 (64)	2,174,035 (74)	3,113,465 (83)	1,316,569 (95)	78,921 (99)	7,125,891 (81)
	9	530,477 (77)	2,056,344 (70)	3,143,144 (84)	1,350,991 (98)	78,921 (99)	7,159,878 (81)
Oregon	1	1,245,631 (72)	2,932,344 (76)	2,354,562 (77)	832,765 (92)	28,217 (99)	7,393,520 (77)
	2	1,087,195 (63)	2,428,702 (63)	2,065,552 (67)	810,279 (89)	28,217 (99)	6,419,945 (67)
	3	1,123,396 (65)	2,433,523 (63)	2,071,836 (68)	810,753 (89)	28,217 (99)	6,467,725 (68)
	4	1,146,633 (67)	2,160,242 (56)	1,898,383 (62)	788,543 (87)	28,217 (99)	6,022,018 (63)
	5	1,111,816 (65)	1,805,511 (47)	1,585,503 (52)	757,875 (83)	28,217 (99)	5,288,922 (55)
	6 & 10	1,094,783 (64)	2,010,106 (52)	1,789,149 (58)	781,824 (86)	28,217 (99)	5,704,080 (60)
	7	852,249 (50)	1,575,583 (41)	1,554,243 (51)	757,440 (83)	28,217 (99)	4,767,732 (50)
	8	1,094,783 (64)	2,010,106 (52)	1,789,149 (58)	781,824 (86)	28,217 (99)	5,704,080 (60)
	9	1,009,815 (59)	1,814,442 (47)	1,742,239 (57)	776,805 (85)	28,217 (99)	5,371,519 (56)
California	1	318,136 (84)	1,607,318 (71)	1,852,658 (78)	670,971 (86)	39,243 (97)	4,488,326 (77)
	2	287,429 (76)	1,314,791 (58)	1,507,451 (63)	547,273 (70)	38,018 (94)	3,694,962 (63)
	3	287,468 (76)	1,314,830 (58)	1,507,609 (63)	551,225 (71)	38,018 (94)	3,699,151 (63)
	4	226,924 (60)	1,282,384 (56)	1,491,485 (63)	545,020 (70)	37,979 (94)	3,583,792 (61)
	5	223,644 (59)	1,218,678 (54)	1,411,022 (59)	528,106 (68)	37,702 (93)	3,419,152 (58)
	6 & 10	222,379 (59)	1,244,406 (55)	1,467,299 (62)	532,809 (68)	37,386 (92)	3,504,278 (60)
	7	215,107 (57)	1,159,438 (51)	1,369,249 (58)	527,908 (68)	37,702 (93)	3,309,405 (57)
	8	222,379 (59)	1,244,406 (55)	1,467,299 (62)	532,809 (68)	37,386 (92)	3,504,278 (60)
	9	229,097 (60)	1,299,339 (57)	1,480,143 (62)	559,327 (72)	38,097 (94)	3,606,002 (62)
Three State Total	1	2,112,581 (76)	6,908,807 (76)	7,542,985 (82)	2,848,918 (93)	146,382 (99)	19,559,673 (81)
	2	1,813,652 (65)	5,978,348 (66)	6,781,632 (74)	2,698,347 (88)	145,157 (98)	17,417,136 (72)
	3	1,854,476 (66)	6,023,796 (66)	6,826,882 (74)	2,702,812 (88)	145,157 (98)	17,553,124 (72)
	4	1,917,234 (69)	5,730,519 (63)	6,605,254 (72)	2,651,318 (86)	145,117 (98)	17,049,442 (70)
	5	1,875,343 (67)	5,217,588 (58)	6,102,244 (66)	2,583,778 (84)	144,801 (97)	15,923,754 (66)
	6 & 10	1,760,063 (63)	5,428,546 (60)	6,369,913 (69)	2,631,202 (86)	144,525 (97)	16,334,248 (67)
	7	1,568,470 (56)	4,872,539 (54)	6,012,494 (66)	2,583,146 (84)	144,801 (97)	15,181,450 (63)
	8	1,760,063 (63)	5,428,546 (60)	6,369,913 (69)	2,631,202 (86)	144,525 (97)	16,334,248 (67)
	9	1,769,389 (63)	5,170,125 (57)	6,365,526 (69)	2,687,123 (88)	145,236 (98)	16,137,399 (67)

[a] Large Reserves are the combined Congressional Reserves, Administrative Reserves, Late Successional Reserves and Option 3 Managed Late Successional Areas. Option 9 Adaptive Management Areas are included in the Matrix.

Table IV-15. Acres of Riparian Reserves by elevation bands, and percent (in parentheses) of total federal land represented by those reserves in each elevation band.

		Elevation bands in thousands of feet.					Totals
		0-2	2-4	4-6	6-8	8-16	
Acres of Federal Land							
Washington		693,220 (8)	2,951,156 (33)	3,735,628 (42)	1,379,564 (16)	79,514 (1)	8,839,083 (100)
Oregon		1,719,436 (18)	3,844,861 (40)	3,061,812 (32)	910,027 (10)	28,415 (0)	9,564,551 (100)
California		379,471 (6)	2,275,601 (39)	2,380,724 (41)	780,599 (13)	40,587 (1)	5,856,983 (100)
Three State Total		2,792,128 (12)	9,071,618 (37)	9,178,164 (38)	3,070,190 (13)	148,516 (1)	24,260,617 (100)
Acres of Riparian Reserves							
	Option						
Washington	1	44,728 (6)	224,832 (8)	146,070 (4)	11,215 (1)	213 (0)	427,059 (5)
	2	41,363 (6)	208,219 (7)	143,481 (4)	9,268 (1)	159 (0)	402,490 (5)
	3	43,870 (6)	221,752 (8)	149,644 (4)	10,751 (1)	162 (0)	426,179 (5)
	4	46,243 (7)	258,127 (9)	193,168 (5)	19,756 (1)	213 (0)	517,507 (6)
	5	41,765 (6)	254,203 (9)	196,656 (5)	21,519 (2)	171 (0)	514,314 (6)
	6 & 10	40,290 (6)	228,878 (8)	171,201 (5)	14,811 (1)	159 (0)	455,339 (5)
	7	11,195 (2)	59,948 (2)	46,247 (1)	5,027 (0)	41 (0)	122,458 (1)
	8	30,334 (4)	157,609 (5)	114,081 (3)	9,667 (1)	107 (0)	311,797 (4)
	9	16,159 (2)	231,006 (8)	170,306 (5)	8,299 (1)	162 (0)	425,932 (5)
Oregon	1	221,712 (13)	373,984 (10)	242,920 (8)	20,570 (2)	46 (0)	859,233 (9)
	2	231,355 (13)	423,700 (11)	250,490 (8)	19,942 (2)	33 (0)	925,520 (10)
	3	222,815 (13)	457,059 (12)	270,025 (9)	20,061 (2)	33 (0)	969,993 (10)
	4	263,249 (15)	671,076 (17)	407,315 (13)	33,245 (4)	46 (0)	1,374,931 (14)
	5	225,309 (13)	666,104 (17)	397,696 (13)	29,860 (3)	33 (0)	1,319,002 (14)
	6 & 10	224,260 (13)	541,515 (14)	320,493 (10)	24,861 (3)	33 (0)	1,111,161 (12)
	7	66,479 (4)	152,728 (4)	86,493 (3)	6,795 (1)	8 (0)	312,503 (3)
	8	151,428 (9)	338,785 (9)	198,833 (6)	15,311 (2)	20 (0)	704,376 (7)
	9	205,558 (12)	546,875 (14)	329,998 (11)	28,033 (3)	33 (0)	1,110,496 (12)
California	1	15,769 (4)	287,804 (13)	231,876 (10)	48,034 (6)	566 (1)	584,050 (10)
	2	20,195 (5)	293,019 (13)	275,150 (12)	75,536 (10)	809 (2)	664,709 (11)
	3	22,974 (6)	321,290 (14)	301,468 (13)	77,823 (10)	815 (2)	724,369 (12)
	4	54,488 (14)	430,372 (19)	395,519 (17)	106,929 (14)	1,155 (3)	988,463 (17)
	5	42,262 (11)	353,422 (16)	335,716 (14)	85,648 (11)	920 (2)	817,969 (14)
	6 & 10	39,283 (10)	313,838 (14)	287,750 (12)	80,040 (10)	996 (2)	721,907 (12)
	7	9,835 (3)	80,144 (4)	75,028 (3)	19,232 (2)	213 (1)	184,453 (3)
	8	25,977 (7)	207,367 (9)	190,036 (8)	54,974 (7)	688 (2)	479,042 (8)
	9	38,862 (10)	299,863 (13)	278,812 (12)	76,496 (10)	791 (2)	694,824 (12)
Three State Total	1	282,209 (10)	886,620 (10)	620,867 (7)	79,819 (3)	826 (1)	1,870,341 (8)
	2	292,912 (10)	924,937 (10)	669,121 (7)	104,746 (3)	1,002 (1)	1,992,719 (8)
	3	289,659 (10)	1,000,102 (11)	721,137 (8)	108,634 (4)	1,010 (1)	2,120,542 (9)
	4	363,980 (13)	1,359,574 (15)	996,002 (11)	159,931 (5)	1,414 (1)	2,880,902 (12)
	5	309,336 (11)	1,273,729 (14)	930,069 (10)	137,027 (4)	1,124 (1)	2,651,285 (11)
	6 & 10	303,833 (11)	1,084,231 (12)	779,443 (8)	119,712 (4)	1,188 (1)	2,288,407 (9)
	7	87,509 (3)	292,820 (3)	207,768 (2)	31,054 (1)	262 (0)	619,414 (3)
	8	207,739 (7)	703,761 (8)	502,949 (5)	79,951 (3)	815 (1)	1,495,215 (6)
	9	260,579 (9)	1,077,745 (12)	779,115 (8)	112,828 (4)	986 (1)	2,231,253 (9)

Table IV-16. Acres of Matrix[a] by elevation bands, and percent (in parentheses) of total federal land represented by Matrix in each elevation band.

		Elevation bands in thousands of feet.					Totals
		0-2	2-4	4-6	6-8	8-16	
Acres of Federal Land							
Washington		693,220 (8)	2,951,156 (33)	3,735,628 (42)	1,379,564 (16)	79,514 (1)	8,839,083 (100)
Oregon		1,719,436 (18)	3,844,861 (40)	3,061,812 (32)	910,027 (10)	28,415 (0)	9,564,551 (100)
California		379,471 (6)	2,275,601 (39)	2,380,724 (41)	780,599 (13)	40,587 (1)	5,856,983 (100)
Three State Total		2,792,128 (12)	9,071,618 (37)	9,178,164 (38)	3,070,190 (13)	148,516 (1)	24,260,617 (100)
Acres of Matrix							
	Option						
Washington	1	99,678 (14)	357,179 (12)	253,793 (7)	23,168 (2)	380 (0)	734,197 (8)
	2	212,830 (31)	508,081 (17)	383,518 (10)	29,501 (2)	434 (1)	1,134,364 (13)
	3	205,738 (30)	453,960 (15)	338,547 (9)	27,979 (2)	431 (1)	1,026,655 (12)
	4	103,300 (15)	405,138 (14)	327,073 (9)	42,053 (3)	380 (0)	877,944 (10)
	5	111,572 (16)	503,553 (17)	433,253 (12)	60,248 (4)	462 (1)	1,109,089 (13)
	6 & 10	210,030 (30)	548,243 (19)	450,962 (12)	48,184 (3)	434 (1)	1,257,853 (14)
	7	180,912 (26)	753,690 (26)	600,379 (16)	76,740 (6)	591 (1)	1,612,312 (18)
	8	219,986 (32)	619,513 (21)	508,083 (14)	53,328 (4)	485 (1)	1,401,395 (16)
	9	146,584 (21)	663,806 (22)	422,178 (11)	20,274 (1)	431 (1)	1,253,273 (14)
Oregon	1	252,094 (15)	538,533 (14)	464,329 (15)	56,691 (6)	151 (1)	1,311,799 (14)
	2	400,886 (23)	992,460 (26)	745,769 (24)	79,806 (9)	165 (1)	2,219,086 (23)
	3	373,226 (22)	954,279 (25)	719,951 (24)	79,213 (9)	165 (1)	2,126,833 (22)
	4	309,554 (18)	1,013,543 (26)	756,114 (25)	88,239 (10)	151 (1)	2,167,602 (23)
	5	382,311 (22)	1,373,247 (36)	1,078,613 (35)	122,292 (13)	165 (1)	2,956,627 (31)
	6 & 10	400,393 (23)	1,293,241 (34)	952,170 (31)	103,342 (11)	165 (1)	2,749,310 (29)
	7	800,708 (47)	2,116,550 (55)	1,421,077 (46)	145,791 (16)	190 (1)	4,484,316 (47)
	8	473,225 (28)	1,495,971 (39)	1,073,830 (35)	112,892 (12)	178 (1)	3,156,096 (33)
	9	504,063 (29)	1,483,544 (39)	989,575 (32)	105,189 (12)	165 (1)	3,082,536 (32)
California	1	45,566 (12)	380,479 (17)	296,190 (12)	61,594 (8)	777 (2)	784,607 (13)
	2	71,847 (19)	667,791 (29)	598,123 (25)	157,790 (20)	1,759 (4)	1,497,312 (26)
	3	69,029 (18)	639,480 (28)	571,648 (24)	151,551 (19)	1,754 (4)	1,433,462 (24)
	4	98,059 (26)	562,845 (25)	493,720 (21)	128,650 (16)	1,454 (4)	1,284,727 (22)
	5	113,565 (30)	703,501 (31)	633,986 (27)	166,845 (21)	1,965 (5)	1,619,862 (28)
	6 & 10	117,809 (31)	717,357 (32)	625,676 (26)	167,750 (21)	2,205 (5)	1,630,797 (28)
	7	154,528 (41)	1,036,019 (46)	936,447 (39)	233,459 (30)	2,672 (7)	2,363,125 (40)
	8	131,115 (35)	823,828 (36)	723,390 (30)	192,817 (25)	2,513 (6)	1,873,662 (32)
	9	111,512 (29)	676,399 (30)	621,770 (26)	144,776 (19)	1,699 (4)	1,556,156 (27)
Three State Total	1	397,338 (14)	1,276,191 (14)	1,014,312 (11)	141,453 (5)	1,308 (1)	2,830,602 (12)
	2	685,563 (25)	2,168,332 (24)	1,727,411 (19)	267,098 (9)	2,357 (2)	4,850,762 (20)
	3	647,993 (23)	2,047,720 (23)	1,630,145 (18)	258,744 (8)	2,349 (2)	4,586,951 (19)
	4	510,913 (18)	1,981,525 (22)	1,576,908 (17)	258,942 (8)	1,985 (1)	4,330,273 (18)
	5	607,449 (22)	2,580,301 (28)	2,145,852 (23)	349,385 (11)	2,591 (2)	5,685,578 (23)
	6 & 10	728,232 (26)	2,558,841 (28)	2,028,808 (22)	319,277 (10)	2,803 (2)	5,637,961 (23)
	7	1,136,149 (41)	3,906,259 (43)	2,957,902 (32)	455,990 (15)	3,452 (2)	8,459,752 (35)
	8	824,326 (30)	2,939,312 (32)	2,305,303 (25)	359,037 (12)	3,176 (2)	6,431,153 (27)
	9	762,159 (27)	2,823,749 (31)	2,033,523 (22)	270,240 (9)	2,294 (2)	5,891,965 (24)

[a] Matrix is composed of Partial Cut, Long Rotation, General Forest and Option 9 Adaptive Management Areas. Option 3 Managed Late-Successional Areas are included in Large Reserves.

growth and restore fire-dependent types of old-growth. Manage entire public landbase to achieve late-successional/old growth objectivesat a landscape scale rather than just designated reserves. Allow for more dynamic and less stable levels of late-successional/old growth habitat to reflect the dynamic character of the landscape. These mitigation measures could increase the ratings for outcomes 1 and 2 combined to at least 60-79 percent.

2. *Effects of land use history and ownership patterns.* Past management practices and current ownership patterns and land use objectives contribute to the relatively low likelihood for outcome 1. Given the nature of the disturbance regime and the possibility of climate change, none of the options provides broad latitude for large-scale change and uncertainties of knowledge. Public lands alone may be adequate in area to maintain late successional ecosystems in the face of large-scale change. From a regional perspective the current area and diversity of late-successional/old-growth forest ecosystems has been reduced to less than 20 percent of the landscape (public and private land). Some late-successional/old-growth forest types, such as fire-dependent ponderosa pine, have been reduced to a small fraction of historical levels. Some community and ecosystem types of low elevations and valley margins have been totally lost. Stand level practices that have created dense young plantations within Reserves in all of the options have altered the typical pathways by which stands develop into old-growth. Artificially created overly dense young plantations may not develop late-successional conditions, such as multiple canopy layers, for long periods. In addition, plantations may be more susceptible to insect, disease, and fire disturbances that could threaten existing late-successional forests within reserves. It was our hypothesis that, without silvicultural practices to "correct" or "restore" stand development conditions in plantations, the current and future late-successional ecosystem is at a relatively high risk of loss or inadequate development. This is the primary reason that Option 1, which Reserves the largest area for late-successional forest, did not achieve an 80 percent or greater likelihood rating in the overall ecosystem for outcomes 1 and 2 combined (table IV-13). We felt that the absence of restoration silviculture in plantations in Reserves under this option reduced the likelihood of achieving outcome 1 and 2 combined to below 80 percent.

   Potential mitigations:

   Moist Provinces: Suggest potential management for late-successional/old-growth ecosystems or components of late-successional/old-growth ecosystems on state and private lands in provinces where federal lands occupy a small percentage of the land base, such as the California and Oregon Coast Range Provinces and areas where private and federal lands are interspersed in a checkerboard pattern of alternating sections. State lands in the western Washington Lowlands and northern Oregon Coast Range offer significant opportunities to fill gaps in the regional late-successional ecosystem. We hypothesize that careful application of restoration silviculture in young plantations to promote development of late-successional/old-growth forests would probably improve the rating of Option 1 to at least an 80 percent likelihood of reaching outcome 1 and 2 combined.

   Eastern Cascades and Klamath provinces: Past history of fire exclusion has altered ecosystem structure and function and resulted in a loss of fire-dependent ecosystem conditions, such as Ponderosa Pine. Reintroducing fire or a suitable substitute, such as thinning and reducing fuels, could mitigate against this loss.

3. *Lack of scientific information.* The relatively low likelihood ratings for outcomes 1 and 2 combined for most options reflects either (1) some assurance that the outcomes are not likely, or (2) a lack of information about: processes and functions of late-successional and old-growth ecosystems; the nature, role, and importance of landscape-level ecological processes including disturbance; the role and relationship of species diversity and ecosystem functions such as productivity, nutrient cycling, and decomposition; and the effects of climate change. There was high uncertainty and differences of opinion among experts on the panel about particular outcomes. This reduced likelihood scores for all outcomes under all options.

   Potential mitigation:

   All provinces: continue to increase basic studies of ecosystem structure, function, and dynamics at multiple spatial and temporal scales. Conduct monitoring and long-term studies of processes associated with late-successional/old-growth and related ecosystems. Such studies might increase or decrease ecosystem ratings and suggest changes to standards and guidelines that increase the possibility of meeting ecological and resource objectives.

4. *Additional mitigation measures on federal lands.* Modifications to standards and guides. See item 1 above for the Eastern Cascades and Klamath provinces.

Note that the likelihoods of achieving functional, well-distributed late-successional/old-growth ecosystems, for some options were lower than the likelihoods of providing well-distributed habitat on federal lands for some individual species or species groups. Provision of individual species or species groups, in other words, does not ensure the provision of all aspects of late-successional/old-growth ecosystems. Also, the outcomes for the species evaluations, by their nature, described different conditions than did the outcomes for the ecosystems evaluations.

Assessment of Viability of Each Species Under Each Option

Fungi

Fungi are neither plants nor animals but are recognized as a separate kingdom of organisms both in structure and function. The large number of fungi in late-successional and old-growth forests, especially those of uneven-aged structure, reflects the complexity of these ecosystems. Estimates indicate there are at least six species of fungi for every vascular plant species in a given temperate ecosystem (Hawksworth 1991).

The fungal flora of the Pacific Northwest is extremely diverse. Of the 527 species of fungi that were evaluated here as closely associated with late-successional and old-growth forests, 109 (21 percent) are considered to be endemic to the Pacific Northwest (appendix table IV-A-1) (J. Ammirati, J. Trappe, W. Denison, 1993, personal communication). Extirpation of these endemic species from this area would equate to extinction of the species.

Fungi may be saprobic (decomposers), parasitic, or symbiotic (mutualistic). The macrofungi (those that produce fruiting bodies visible to the naked eye) have either a short-lived, annual, or perennial vegetative stage (mycelium) from which the fruiting bodies (e.g., mushrooms) develop. The lifespan of these fruiting bodies is variable and depends on the species, lasting from several hours to decades. The fruiting bodies typically produce sexual spores. Spores are commonly dispersed by air currents, or by animals, including invertebrates, or water.

Many of the forest fungi that produce large fruiting bodies (mushrooms, boletes, corals, etc.) are involved in symbiotic relationships with vascular plants. The survival of most conifers and many flowering plants depends on their association with these mycorrhizal fungi for the uptake of nutrients and water (Harley and Smith 1983, Trappe and Luoma 1992). Thousands of ectomycorrhizal species occur in the Pacific Northwest. Nearly 2,000 species are associated with Douglas-fir (Trappe 1977). Many ectomycorrhizal fungi are host specific, while others have broad host ranges (Molina et al. 1992).

Equally prominent in the mycorrhizal flora of the Pacific Northwest forests are fungi that fruit below ground such as hypogeous fungi, including truffles, false truffles, and their allies. These organisms are not often seen by the casual observer. Hypogeous fungi and certain mushrooms are important food for small mammals, that in turn are important in spore dispersal of the fungi. The northern flying squirrel and red-backed vole, which use these fungi as their primary food source, are also the major prey of the northern spotted owl over much of its range (Maser et al. 1978, Ure and Maser 1982).

Saprobic fungi are a major component of all forest ecosystems, growing on a variety of substrates (e.g., recently fallen trees to well-decayed logs, litter, dung, and other fungi). They play an important role in decomposition and recycling of nutrients. Saprobes release nutrients bound in dead plant, fungus, and animal tissues that later become incorporated into the soil. Among the most notable are the white rot fungi which are responsible for the decay of lignin. In late-successional and old-growth conifer forests, saprobes are often abundant both in the number of species and the number of individual fruiting bodies. Conks or polypores are particularly prevalent in mature and old-growth forests because of the diversity of habitat structures and host species, and the abundance of coarse woody debris and standing dead trees.

Parasitic fungi (e.g., pathogens) have often been viewed as having negative impacts on forest health and productivity, but they may also increase forest diversity (Trappe and Luoma 1992). Disease-killed trees leave openings in the canopy, creating structural and habitat diversity for other organisms. Standing dead trees also provide habitat for cavity nesting birds and mammals.

The microfungi of late-successional forests have received little attention except for the few that cause disease in commercial timber species. There are several hundred known species, but undoubtedly many remain to be discovered (Carroll et al. 1980, Carroll 1981). Many species of these microscopic fungi are narrow specialists, recycling specific substrates, while others parasitize insects or foliage. Many have potential for future use as medicinals and biological control agents.

Preserving fungal diversity may have implications to human health. Fungi are major sources of antibiotics and show great potential as anticarcinogens (Stierle et al. 1993). Pharmaceutical companies are now actively screening many Pacific Northwest fungi.

Fungi are also important indicator species for monitoring forest stability and health. Forest decline in Europe has been accompanied by a precipitous decline in diversity of forest fungi (Arnolds 1991). Over the past 20 years, an increasing number of reports from continental Europe have documented substantial declines in diversity of species and the fruiting bodies of fungi. There has been a 42 to 54 percent decline in the number of fungus species since the early 1900's (Arnolds 1991, Bas 1978, Schlumpf 1976, Winterhoff 1978, Winterhoff and Krieglsteiner 1984). These decreases in fungal diversity occurred largely among ectomycorrhizal species; in some cases the number of saprobic species has increased (Arnolds 1991).

The reasons for these fungal declines are unclear, but they probably are associated with the deterioration in forest health occurring in many parts of Europe. Plochmann (1989) attributes many of these problems to results of intensive forestry practices, including the removal of coarse woody debris from the ecosystem (Esseen et al. 1992). Increases in amounts of available nitrogen (possibly in combination with acid rain), intensive collection of mushrooms for table use, air pollutants, acidification of forest soils, increased leaf litter accumulation, changes in the herb layer of forests, and decreased tree vitality are other possible factors contributing to declines of fungi (Arnolds 1991).

There is concern about a decrease in species richness of fungi in the Pacific Northwest from the removal of old-growth forests, particularly for many mycorrhizal species. Fungi are a major component of all stages of forest succession, with the greatest species richness in late-successional and old-growth forests (J. Ammirati and J. Trappe, 1993, personal communication). Each species has its own niche, its own season of active interaction with tree hosts, and its own combination of physiological functions (Molina et al. 1992, Trappe and Luoma 1992). This diversity lends seasonal and long-term resilience to the forest. A number of saprobic species also reach their peak in late-successional and old-growth forests.

Although fungi are seldom observed except when their fruiting bodies are present, extensive masses of fungal mycelium permeate the soil, litter, and logs on the forest floor, as well as being connected with the roots of most of the vascular plants. The vital role of fungi in forest ecosystems highlights the importance of maintaining viable populations of these species throughout the landscape.

Methods specific to fungi. A list of 527 species of fungi closely associated with late-successional and old-growth forests on federal lands, within the geographic range of the northern spotted owl, was developed following the criteria used by the Scientific Analysis Team (Thomas et al. 1993) (appendix table IV-A-1). While this list is not complete, it suggests the high degree of biological diversity of fungi that exist in late-successional and old-growth forests of the Pacific Northwest. There is little published information on the diversity of fungi in the old-growth forests of this region. Consequently, mycologists contributed to the development of this list based on their research and field experience throughout the region. The mycologists consulted included Joe Ammirati, Lorelei Norvell, Michelle Seidl, Glenn Walker, and Tom O'Dell of the University of Washington; Jim Trappe, Bill Denison, and Nancy Smith Weber of Oregon State University; Randy Molina of USDA Forestry Sciences Laboratory, Corvallis, Oregon; Dennis Desjardin and Harry Thiers of San Francisco State University; Dave Largent of Humboldt State University; Scott Redhead, Systematics Research Lab, Agriculture Canada; and Hal Burdsall, Tom Volk, Karen Nakasone, and G. Banik, USDA Forestry Sciences Laboratory, Madison, Wisconsin.

Table IV- 17. Projected future likelihoods of habitat outcomes for fungi under land management options.

Fungi	Option 1				Option 3				Option 4				Option 5				Option 7				Option 8				Option 9			
	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
Mycorrhizal																												
Bolete-GARU, Rare	83	10	7	0	77	15	8	0	73	17	10	0	67	22	8	3	67	22	8	3	63	22	12	3	67	22	8	3
Bolete/False Truffles, Rare (3 species)	0	3	91	5	0	2	92	7	0	2	88	10	0	2	83	15	0	2	82	17	0	2	82	17	0	2	83	15
Boletes (13 species)	93	7	0	0	83	17	0	0	77	23	0	0	67	33	0	0	67	33	0	0	67	33	0	0	70	30	0	0
Boletes, Low Elevation (2 species)	20	53	27	0	20	43	37	0	20	43	37	0	17	47	37	0	17	47	37	0	17	43	40	0	17	43	40	0
Boletes, Rare (2 species)	13	67	17	3	8	65	22	5	8	57	30	5	3	52	33	12	2	52	28	18	3	48	28	20	2	52	28	18
Chanterelle-CAFO, Rare	33	33	28	5	27	35	33	5	22	37	35	7	13	37	32	18	10	30	38	22	0	30	38	22	10	33	38	18
Chanterelle-POMU, Rare	40	47	10	3	33	52	12	3	35	45	17	3	27	45	20	8	17	50	25	8	20	43	27	10	22	43	27	8
Chanterelles (3 species)	73	27	0	0	73	27	0	0	63	37	0	0	57	43	0	0	60	40	0	0	57	43	0	0	60	40	0	0
Chanterelles-Gomphus (4 species)	83	13	3	0	77	15	8	0	68	20	10	2	62	23	12	3	53	25	18	3	53	23	20	3	57	22	18	3
Coral Fungi (50+ species)	85	10	5	0	80	10	10	0	70	18	10	3	60	18	15	8	55	20	18	8	50	23	20	8	55	20	18	8
Ecto-Puffballs (2 species)	93	7	0	0	90	10	0	0	87	13	0	0	80	20	0	0	73	23	3	0	77	23	0	0	80	20	0	0
Ecto-Polypores, Rare (3 species)	10	50	37	3	7	52	35	7	8	43	38	10	3	42	37	18	2	42	35	22	3	38	38	20	2	42	38	18
Ecto-Polypores, Uncommon (2 species)	70	20	10	0	60	25	15	0	53	27	20	0	42	32	20	7	40	30	23	7	38	32	23	7	42	32	20	7
Ecto-Polypore-COPE	93	7	0	0	93	7	0	0	87	13	0	0	83	17	0	0	80	20	0	0	80	20	0	0	83	17	0	0
Ecto-Resupinate Fungi (3 species)	97	3	0	0	97	3	0	0	93	7	0	0	87	13	0	0	83	17	0	0	83	17	0	0	87	13	0	0
False Truffle-MALY, Rare	8	10	75	7	7	10	75	8	5	12	72	12	2	12	72	15	0	10	72	18	0	12	70	18	0	12	72	17
False Truffles (10 species)	95	5	0	0	85	15	0	0	80	15	5	0	70	20	10	0	50	30	20	0	55	25	20	0	55	25	20	0
False Truffles, Rare (22 species)	20	30	40	10	15	35	40	10	15	35	40	10	5	35	50	10	0	35	50	15	0	35	50	15	0	35	50	15
False Truffles, Uncommon (4 species)	30	40	30	0	25	40	35	0	25	35	35	5	25	30	40	5	15	25	40	20	20	30	40	10	20	30	40	10
Gilled Mushroom-CHLO, Rare	0	3	91	5	0	2	92	7	0	2	88	10	0	2	83	15	0	2	82	17	0	2	82	17	0	2	83	15
Gilled Mushrooms (125 species)	93	7	0	0	83	17	0	0	73	23	3	0	63	33	3	0	60	33	7	0	63	30	7	0	67	27	7	0
Gilled Mushrooms, Rare (6 species)	20	60	15	5	15	65	15	5	10	58	25	8	5	50	28	18	5	45	28	23	5	45	30	20	5	50	28	18
Gilled Mushrooms, Uncommon (15 species)	65	25	10	0	60	30	10	0	50	33	18	0	40	35	15	10	40	30	15	15	35	30	20	15	40	30	15	15
Phaeocollybia (13 species)	70	23	7	0	63	30	7	0	53	37	10	0	47	38	10	5	40	35	15	10	42	38	15	5	45	38	12	5
Tooth Fungi (5 species)	93	7	0	0	83	17	0	0	73	23	3	0	73	33	3	0	60	33	7	0	63	30	7	0	67	27	7	0
Truffles (5 species)	90	10	0	0	90	10	0	0	85	15	0	0	80	20	0	0	75	25	0	0	75	25	0	0	75	25	0	0
Truffles, Rare (5 species)	10	20	60	10	8	23	60	10	8	20	58	15	3	20	60	18	0	18	55	28	0	15	60	25	0	18	60	23
Truffles-TURU	10	30	40	20	5	28	40	28	0	33	40	28	0	33	40	28	0	30	40	30	0	30	40	30	0	30	40	30
Undescribed Taxa, Rare (29 species)	0	10	80	10	0	10	70	20	0	10	60	30	0	0	60	40	0	0	50	50	0	0	60	40	0	0	60	40
Zygomycetes, Rare (3 species)	10	20	60	10	8	23	60	10	8	20	58	15	3	20	60	18	0	18	55	28	0	15	60	25	0	18	60	23

A-Well Distributed B-Locally Restricted C-Restricted to Refugia D-Extirpation

Likelihood values are expressed as percentages that total to 100 for a given species within an option. Number displayed may vary due to rounding errors. See text for fuller explanation and discussion of the rating scale.

Table IV- 17 (cont). Projected future likelihoods of habitat outcomes for fungi under land management options.

Fungi	Option 1				Option 3				Option 4				Option 5				Option 7				Option 8				Option 9			
	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
Parasitic																												
Cauliflower Mushroom	83	13	3	0	80	15	5	0	73	20	7	0	67	25	5	3	60	25	12	3	63	25	8	3	67	25	5	3
Parasitic Fungi (7 species)	65	25	10	0	60	30	10	0	50	28	23	0	40	30	25	5	35	30	25	10	35	30	30	5	40	30	25	5
Parasitic Fungi, Common (2 species)	90	10	0	0	90	10	0	0	80	20	0	0	75	25	0	0	70	30	0	0	70	30	0	0	75	25	0	0
Saprobic - (Decomposers)																												
Branched Coral Fungi (3 species)	90	10	0	0	85	15	0	0	75	25	0	0	65	35	0	0	60	40	0	0	60	40	0	0	65	35	0	0
Cup Fungi (15 species)	90	10	0	0	90	10	0	0	80	20	0	0	70	30	0	0	65	35	0	0	65	35	0	0	70	30	0	0
Cup Fungi, Rare (14 species)	15	40	28	18	10	40	33	18	0	45	35	20	0	35	38	28	0	35	38	28	0	30	38	33	0	35	38	28
Gilled Mushrooms (80 species)	90	10	0	0	85	15	0	0	75	25	0	0	65	35	0	0	60	40	0	0	60	40	0	0	65	35	0	0
Gilled Mushrooms, Rare (6 species)	10	55	25	10	10	50	25	15	3	50	30	18	0	40	38	23	0	35	43	23	0	35	40	25	0	40	38	23
Gilled Mushrooms, Uncommon (17 species)	65	30	5	0	60	30	10	0	50	33	18	0	40	35	15	10	35	35	15	15	35	35	20	10	40	35	15	10
Jelly Mushroom	60	35	5	0	55	35	10	0	55	33	13	0	35	30	25	10	35	25	25	15	30	30	30	10	35	30	25	10
Oxyporus nobilissimus	18	28	37	17	13	28	40	18	10	28	47	15	10	25	43	22	7	22	47	25	10	25	40	25	10	25	43	22
Polypores (10 species)	90	10	0	0	85	15	0	0	75	25	0	0	65	35	0	0	60	40	0	0	60	40	0	0	65	35	0	0
Resupinate Fungi (14 species)	90	10	0	0	85	15	0	0	75	25	0	0	65	35	0	0	60	40	0	0	60	40	0	0	65	35	0	0
Resupinates and Polypores, Rare (6 species)	10	70	10	10	10	70	10	10	5	60	20	15	0	50	25	25	0	50	25	25	0	40	30	30	0	50	25	25
Other																												
Bondarzewia mesenterica	40	30	30	0	40	30	30	0	35	28	33	5	30	25	30	15	30	20	30	20	25	25	35	15	30	25	30	15
Club Coral Fungi (unknown # of species)	85	10	5	0	80	15	5	0	65	23	13	0	55	30	10	5	50	30	15	5	50	25	20	5	55	25	15	5
Moss Dwelling Mushrooms (7 species)	55	35	10	0	50	35	15	0	45	35	20	0	40	35	25	0	35	40	25	0	35	40	25	0	40	35	25	0
Mushroom Lichen	95	5	0	0	95	5	0	0	90	10	0	0	80	20	0	0	75	25	0	0	75	25	0	0	80	20	0	0

A-Well Distributed B-Locally Restricted C-Restricted to Refugia D-Extirpation

Likelihood values are expressed as percentages that total to 100 for a given species within an option. Numbers displayed may vary due to rounding errors. See text for fuller explanation and discussion of the rating scale.

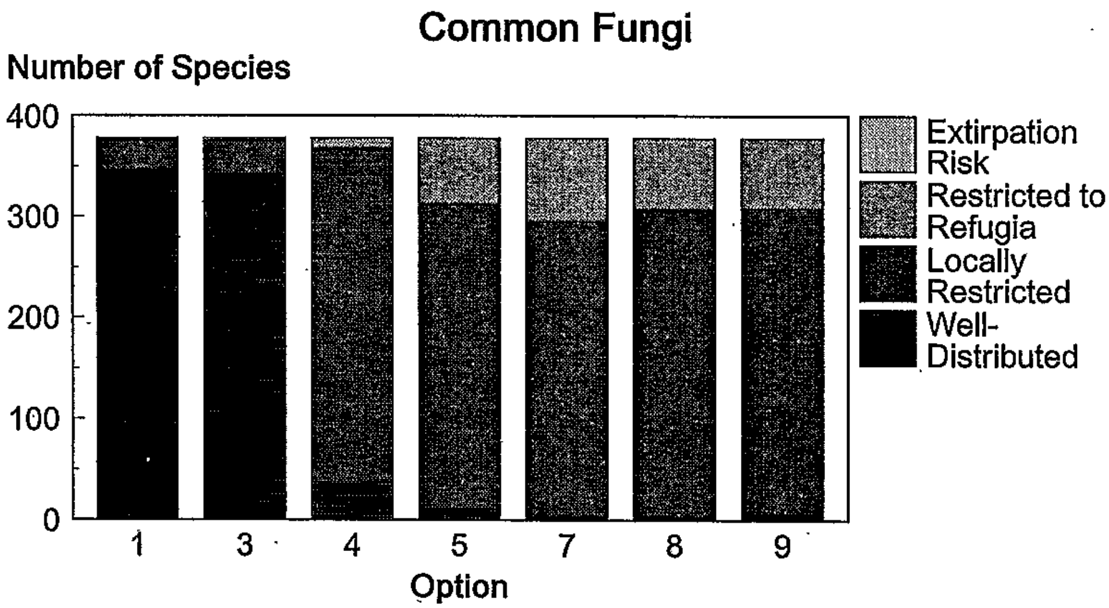

Figure IV-4. Outcomes for common fungi under each land management option. Values shown are the number of species that had an 80 percent or greater likelihood of achieving at least the specified outcome (based on distribution of habitat).

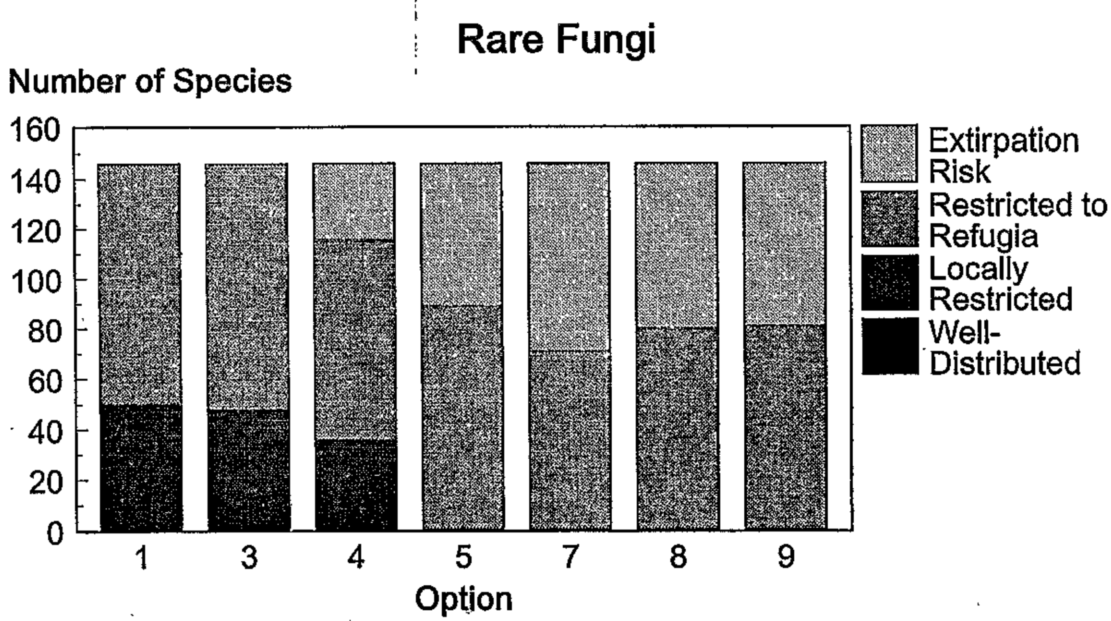

Figure IV-5. Outcomes for rare species of fungi under each land management option. Values shown are the number of species that had an 80 percent or greater likelihood of achieving at least the specified outcome (based on distribution of habitat).

Three mycologists were convened for the fungus panel. Two major functional divisions of fungi were identified, the ectomycorrhizal fungi, and the decomposers or saprobes. Several parasitic species were also included. The 527 species were divided into 36 groups, based on taxonomic and ecological relationships, and their degree of rarity.

Each species group was discussed and fungus species were added or deleted. Groups of species were finalized based on similarity in response to habitat provided by the various management options. Each group was then evaluated based on the projected future condition of habitat on federal lands (outcomes A-D, see Methods for assessing effects of options). Twelve species were treated individually because of differences in their biological or ecological attributes. Four species were not evaluated because of insufficient information and uncertainty about their biology and ecology. In addition, three orders of microfungi representing hundreds of species were discussed but not evaluated because of lack of information (appendix table IV-A-1).

A summary of outcome scores, based on the average scores of the three panelists, is presented for each group or species of fungi for each option (table IV-17).

Results. Ratings for the groups of fungi were based on habitat conditions on federal lands and varied considerably across the different options (table IV-17, figs. IV-4 and IV-5). For Option 1, 92 percent of the common fungi groups rated greater than 80 percent likelihood of having habitat of sufficient quality, distribution, and abundance to allow the species population to stabilize, well distributed across federal lands (outcome A), and 72 percent of the groups received this rating for Option 3. Options 4, 5, and 9 had lower ratings with 16-20 percent of the fungi groups rating 80 percent likelihood of outcome A, and only 8 percent received this rating for Options 7 and 8.

Mycorrhizal fungi: The 336 mycorrhizal fungi evaluated represent a diverse group of species, including boletes, chanterelles, corals, false truffles, gilled mushrooms, ecto-polypores, tooth fungi, and truffles (appendix table IV-A-1). These groups were subdivided into groups of common, uncommon, and rare species. Thirty-one percent of the mycorrhizal species evaluated were considered rare or uncommon (appendix table IV-A-1 and table IV-17).

Boletes (13 species), tooth fungi (5 species), and gilled mushrooms (125 species) represented 44 percent of the mycorrhizal species. As a group they were rated with an 80 percent likelihood of outcome A for Options 1 and 3. For Options 4, 5, 7, 8, and 9, they received an 80 percent likelihood of having habitat of sufficient quality, distribution, and abundance to allow populations to stabilize, but with significant gaps in the historic species distribution (outcome B) (table IV-17).

Phaeocollybia (13 species) and chanterelles (3 species) were rated with 80 percent likelihood of outcome B or better for all options (table IV-17). Four chanterelle-like species rated with an 80 percent likelihood of outcome A for Option 1, and an 80 percent likelihood of outcome B or better for the other options (table IV-17).

Fifty species of coral fungi were rated with an 80 percent likelihood of achieving outcome A for Options 1 and 3. They were rated with 80 percent likelihood of achieving outcome B or better for Option 4, and with 80 percent likelihood of achieving outcome C (habitat only allows species existence in refugia) or better for Options 5, 7, 8 and 9 (table IV-17).

Ten species of false truffles had an 80 percent likelihood of achieving outcome A for Options 1, 3, 4, and an 80 percent likelihood of achieving outcome B or better for Options 5, 6, 7, 8, and 9 (table IV-17). Five species of truffles had an 80 percent likelihood of achieving outcome A for Options 1-5, and an 80 percent likelihood of achieving outcome B or better for Options 7-9 (table IV-17).

The three ecto-resupinate (flat, smooth fruiting bodies) species and *Coltrichia perennis* were the only fungi that rated with an 80 percent likelihood of outcome A for all options (table IV-17).

Saprobic fungi (Decomposers): This group of fungi was represented by 167 species, including gilled mushrooms, polypores, cup fungi, and resupinate fungi (appendix table IV-A-1). A total of 61 percent of the saprobic fungi, including common gilled mushrooms, polypores, resupinate fungi, and three species of coral fungi (*Clavulina*), rated 80 percent likelihood of achieving outcome A for Options 1 and 3, and 80 percent likelihood of achieving outcome B or better for the other options (table IV-17). The cup fungi had 80 percent likelihood of outcome A for Options 1, 3, 4, and 80 percent likelihood of achieving outcome B or better for the other options.

The outcome scores for parasitic fungi are shown in table IV-17. The ten species of parasitic fungi showed a similar pattern for the options as the saprobic fungi.

Rare and uncommon species: Rare or uncommon fungi totaled 146 species, or 28 percent of the fungi evaluated (appendix table IV-A-1). Rare mycorrhizal fungi included boletes, false truffles, truffles, chanterelles, gilled mushrooms, and polypores. Rare saprobic fungi included polypores, gilled mushrooms, cup fungi, and resupinates. Many of these species are restricted to refugia and are known from only one or a few locations, while others may be more widespread but sporadic in their distribution or abundance. Narrow distributions may be due to inherent life history characteristics, or species requiring specific habitats that are sporadic or rare in the landscape.

The rare and locally endemic species were generally rated with an 80 percent likelihood of outcome C, which reflects their current distribution, (table IV-17, figure IV-5). For many of these species, there was little difference in ratings across the options. This reflects the relatively random chance that a population will actually occur within a given reserve.

Gastroboletus ruber was the only rare species that had an 80 percent likelihood of achieving outcome B or better for all options. This mycorrhizal species is host specific with mountain hemlock. It occurs at high elevations, and most known locations are in Wilderness Areas or National Parks.

Discussion. The projected future outcomes for fungi corresponded with the acreage of Late-Successional Reserves and management in the Matrix. Most of the common, widespread fungi had potential outcomes for habitat being well distributed (outcome A), or well distributed but with significant gaps (outcome B). Those options that had fewer old-growth patches, less coarse woody debris and less green tree retention in the Matrix were rated lower for groups of fungi, as were options with less acres in reserves. The majority of species considered here occur on upland sites, so riparian buffers may not be as relevant for many of them. However, fungi associated with riparian areas were not well represented in this evaluation (appendix table IV-A-1).

Even small fragments of old-growth forests within the Matrix are important for fungi, because of their limited dispersal capabilities. These small patches of old-growth provide biological legacies (i.e., coarse woody debris, habitat structures, and hosts) that carryover in younger stands. These old-growth fragments function as refugia where fungi may persist until suitable habitat conditions become available in adjacent stands. Many species of fungi may be dispersal limited or rely on small mammals or invertebrates to disperse their spores (J. Ammirati, 1993, personal communication).

Large coarse woody debris is critical for maintaining populations of mycorrhizal and saprobic fungi (Harvey et al. 1979). Coarse woody debris is an important factor in the distribution and seasonality of hypogeous fungi, hence, is important to small mammals. Amaranthus and Trappe (in preparation) report that during the hot, dry time of year, coarse woody debris in old-growth fragments provide sites for truffle fruiting; this could be critical for maintenance of small mammal populations that eat and disperse these fungi.

The species at greatest risk of extirpation were the rare or locally distributed fungi. There are over 100,000 specimens of fungi from the Pacific Northwest in collections dating back to the turn of the century. However, the rare taxa are poorly represented in these collections. It is unknown if these species have always been rare or have been extirpated from large parts of their range. Because of difficulties inherent in surveying species with ephemeral fruiting bodies, it is possible that other undiscovered populations of these species may occur.

Many fungi associated with late-successional forests have specific host and substrate requirements, and fungal diversity increases as communities mature. Species that are present in young stands, may also occur in mature to old-growth forests, but a large number of species occur exclusively in older stands (J. Ammirati, 1993, personal communication). Maintenance of fungal diversity and viable populations of late-successional fungi will require habitat diversity, various successional stages, mixtures of tree species and ages, and significant amounts of coarse woody debris.

Natural disturbance is important for certain species of fungi (Esseen et al. 1981). Windthrows, gaps, and other small scale disturbances enhance the structure and diversity of mature and old-growth stands, creating microsites suitable for a variety of fungi. However, large-scale disturbances and intense site treatments may have detrimental effects. Intensive burning is detrimental to many species of late-successional fungi (J. Ammirati, 1993, personal communication) and reduces the quality and abundance of coarse woody debris and the humus layer. Results from northeastern California indicate that commercial thinning and broadcast burning alter the genera composition of hypogeous fungi (Waters and Zabel, in review).

The commercial harvest of edible forest fungi is a multimillion-dollar industry with several thousand tons harvested annually (Molina et al. 1993). Four species, king bolete (*Boletus edulis*), golden chanterelle (*Cantharellus cibarius*), edible morel (*Morchella esculenta*), and matsutake (*Tricholoma magnivelare*), account for most of the commercial harvest. Many other edible species are harvested in smaller quantities for personal use and gourmet food markets. Additional species have medicinal properties, and some are used in crafts. Both ecologists and mushroom harvesters have concerns regarding the sustainability of these fungi due to overharvesting and habitat depletion (Molina et al. 1993).

Although fungi are essential to the function of ecosystems, we know relatively little about their specific roles. Interactions among species such as competition or mutualism are not well understood. Little is known about how the species composition of fungi changes over time during forest succession, and the relationship among species that occur in young, mature, and old stands.

An important consideration for management of Pacific Northwest forests is not only preservation of fungal species but preservation of their function across the landscape. Many species of fungi associated with old-growth forests will likely persist within Late-Successional Reserves. Patches of old-growth distributed throughout the Matrix would help maintain those species and their functional role in ecosystems across the landscape. Until we have more complete knowledge, it is important to maintain all components of the ecosystem. This diversity across the landscape will help provide the resilience that ecosystems need to respond to environmental and biological stresses, such as climatic change, catastrophic fires, and insect or pathogen outbreaks.

Mitigation for Fungi

Retention of old-growth patches within the Matrix: Likelihood ratings for some options could be increased by retaining patches of late-successional or old-growth forest within the Matrix. These small patches of old-growth distributed throughout the Matrix (such as required in Options 1 and 3, and in some areas under Option 9) are important refugia for late-successional fungi, as well as a source of inoculum for dispersal into adjacent young stands. These old-growth patches are also important in that they are a source of large logs and snags which would otherwise be lacking in cutover areas. Species associated with mature and old-growth stands may also be important in younger stands. We currently don't know enough about the role of various fungi to select or favor particular species in managed forests.

Distribution and spacing of old-growth fragments is important. Because many fungi have limited dispersal capabilities, these patches need to be distributed throughout a watershed unit. The distribution of these stands should be addressed on different scales and within a landscape context. Patches should be large enough (5-10 acres at a minimum), not only to provide for habitat needs but also to lessen the risk of windthrow and to minimize alteration of the microclimate. A diverse mosaic of stand types with respect to host species, age-class distributions, successional stages, habitat structures, plant associations, and topographic positions (i.e., riparian, mid-slope, and ridgetop), should be maintained across the Matrix.

In the Coast Range of Oregon and the coastal Olympics, remaining old-growth stands are especially important because they are rare across the landscape, particularly in the Sitka Spruce Zone. Old-growth stands are also scarce at lower elevations. For areas where old-growth stands are limited, we need to identify additional stands to mature into old-growth that will provide for fungi that occur in late-successional forests.

Stand ages between 80 and 200 years are uncommon for some areas in this region. Some stands of this age class should be maintained in the Matrix to provide a link in fungal succession between young and old stands.

Green tree retention: Likelihood ratings for some options could be increased by retaining 15 percent of the green trees in patches or clumps within harvest units, as under Option 9. These patches should include not only the biggest and oldest trees, but a diversity of tree sizes, species, and ages within a patch. It is important to maintain the microclimate and associated habitat by leaving clumps of trees, because single leave trees may not support late-successional fungi within a harvested unit.

An accumulation of leave trees should be provided over successive rotations. Leaving large enough clumps to persist over time would accomplish this. With the next harvest, provide an additional buffer around the original patch to maintain a renewable supply of older legacies, such as trees, logs and snags.

Coarse woody debris: Under the short rotation scenario in the Matrix, large coarse woody debris is not a renewable resource. As an area progresses through several short rotations, the input of large coarse woody debris declines; trees do not have sufficient time to attain large diameters under the prescribed rotation lengths, except on highly productive sites. Allowing some stands and patches within younger stands to mature into older age classes within the Matrix, would help provide for continued input of large coarse woody debris, and would also provide a favorable microclimate for fungi.

Significant quantities of logs are important, as well as a distribution of decay classes. Attempt to replicate the quantity and quality of coarse woody debris that would occur in natural, unmanaged stands for particular plant associations and stand types. Provisions for leaving 12 logs per acre as required in Option 3 could serve as a guide until models could be developed that replicate natural stand conditions.

Coarse woody debris needs to occur in the microclimate provided by the canopy of a forest patch to provide for the fungal species that occupy this substrate. Logs scattered in the Matrix are exposed to a much different microclimate and will be occupied by a different suite of fungi.

Minimize site disturbance: Most options could be improved for fungi by minimizing site treatments such as burning, unless appropriate for certain habitats, communities, or conditions. Other mitigations could include minimizing soil disturbance from yarding and heavy equipment, and the intensity and frequency of stand treatments. Removal of humus layers, coarse woody debris, and soil compaction may impact populations of fungi, as well as significantly alter the role of decaying wood in the nutrient cycling process (Maser and Trappe 1984).

Rare and locally endemic species: All options could be improved by mitigation measures providing protection for areas where rare and locally endemic fungi occur. Inventory and monitoring should be conducted for rare or locally endemic taxa, and areas should be surveyed before management treatments occur; sites where rare and locally endemic species are located should be protected. Locations and distribution of these species of fungi should be documented and maintained in a Geographic Information System. All type localities should be preserved, especially those of rare taxa. A type locality is the site where the original material of a species was collected. The type collection forms the basis for defining that species.

Sites that are known to support rare taxa, high species diversity, unique areas, special habitats, communities, or features should be identified and these sites protected by establishing special interest areas or mycological preserves. Buffers should be provided to protect the sites from disturbance. It is not feasible to mention all rare taxa here, so several species are discussed as examples.

Oxyporus nobillisimus, the "Fuzzy Sandoze", is an endemic and extremely rare polypore, occurring in isolated populations from the central Oregon Cascades north to the Olympic Peninsula and Snoqualmie River drainage. Also known as the Noble Polypore, it attains large sizes and until recently held the Guinness Book of Records designation for the largest pore fungus (Guinness Book of Records, 1966-1990). This species is host specific to true firs and is restricted to old stumps, snags, and very large, old living trees. Discovered by the Sandoze brothers in the 1940's, it is only known from about 12 localities, including historic locations. This species is closely associated with old-growth forests, and it does not transfer onto younger trees or substrates. This species is on list 1 of the Oregon Natural Heritage Program (1991). *Oxyporus nobillisimus* is in need of active protective measures to ensure its survival (ONHP 1991). All known locations should be protected and populations monitored.

Gastroboletus imbellus and *Chroogomphus loculatus* are only known from the type collections at the Potholes Area of the Willamette National Forest at 5,000 feet elevation. To mitigate for these species, this area could be identified as an area of biological diversity and designated as a mycological special interest area. Other species of interest at this site include *Glomus radiatum* and many *Rhizopogon* species. This area should be protected from wildfire.

Tuber rufum is host specific to oak (*Quercus* spp.), and its viability is directly tied to maintaining oak well distributed throughout the landscape. Oak is slow growing and sporadic in its reproduction. Many oak sites are being converted for other uses, particularly in the Willamette Valley and southward. Most oak stands on federal lands occur outside of the reserves. Older stands of oak should be maintained and distributed across the landscape in appropriate habitats. Inventory and monitoring of *Tuber rufum* and host populations should be conducted.

Commercial and recreational harvest: To determine appropriate levels of sustained harvest for fungi, inventories should be conducted, baseline data collected, and effects of harvest monitored. The ephemeral nature of the fruiting bodies of most fungi poses challenges to these efforts, yet research is under way to study productivity and the effects of methods of harvest on chanterelles (L. Norvell, 1993, University of Washington). Monitoring programs suggested by Molina et al. (1993) form the basis for determining the effects of harvest, predicting yields, and developing management practices to maintain and enhance wild mushroom harvest.

Role of nonfederal lands: There are species of fungi whose survival is affected by land ownerships and associated management activities or land use of nonfederal land, particularly in the Coast Range of Oregon and coastal Olympic Peninsula, southwestern Washington, Willamette Valley, and low elevation Cascades. These are areas of special concern where little old-growth remains in the landscape because of past harvesting, and natural disturbance such as fire. Many species of fungi occur at lower elevations; they may have been more widely distributed historically, but land management activities have restricted their distribution. Federal agencies should work with state and private landowners to protect known locations of species of concern and associated old-growth fragments.

Research and information needs. A critical need exists for information on the diversity, biology, ecology, and distribution of the old-growth associated fungi in the forests of the Pacific Northwest. This information will help identify standards and guidelines that can be used to develop future management techniques that will help increase or maintain fungal species diversity, especially in the Matrix. A variety of studies are discussed below.

An inventory program should be developed for fungi, especially for the rare, common, and commercially harvested species. Surveys should be conducted for a minimum of 3-5 years (optimally 10 years) because of their ephemeral nature and seasonal as well as longer term fruiting patterns. Develop protocols for surveying for fungi in coordination with mycologists and ecologists. Species known from only a few locations should be inventoried to determine the extent of populations in those areas.

All study areas should be prioritized. Areas should be selected that are rich in fungal flora, as well as representative plant associations throughout the Pacific Northwest. Areas of rich fungal diversity should be established as mycological special interest areas.

Ecological studies are needed to determine how forest succession relates to fungal diversity and the process of fungus succession with stand development throughout the landscape. Studies should include (1) changes in species composition over time and in different successional stages, (2) relationships among species that occur in different successional stages, (3) the association between fungus species and canopy closure, coarse woody debris, and other biotic and abiotic habitat factors, and whether that varies with stand history and age, (4) relationships between coarse woody debris and fungal fruiting, especially as they relate to size and decay class of logs in different habitat types, (5) population sizes, (6) distance and effectiveness of dispersal, (7) specific habitat requirements, (8) functional attributes of different fungal groups, including nutrient dynamics and food chains, etc. and (9) genetic diversity within fungal species and populations.

Monitoring of specific sites should be conducted throughout the region to measure changes in diversity of fungal communities, species composition, and biomass production, and baseline data gathered to monitor long-term effects of pollution or climatic change, and forest management activities. Monitoring should include both epigeous and hypogeous fungi and should identify keystone or indicator species. A long-term study of the *Oxyporus nobilissimus* population on Snow Peak, and perhaps other sites, should be initiated to monitor population trends. It should be determined if this species can enter younger stands or become established on younger substrates. Microfungi that occur in soil, humus, and other substrates also need evaluation. This group of fungi are likely of importance to the health of mature and old-growth forest ecosystems.

Long-term monitoring plans should be developed to evaluate effects of various stand management treatments, including survival and viability of fungus species in old-growth patches of different sizes within harvested areas and in various habitat types and geographic areas. Research should include the study of edge effects on interior forest fungi to assess (1) the importance of small isolated old-growth fragments as refugia and centers of biological diversity, (2) the effect at boundaries between stands of different ages, (3) how the diversity of fungal species is affected, (4) the distance from the edge where species richness stabilizes, (5) whether an abundant legacy of coarse woody debris in a young stand increases fungal diversity, and (6) the relationship between patch size and edge effect.

The relationship between patch size and survival and dispersal success of fungi also needs study. Effects of silvicultural manipulations on small mammal/fungal population interactions need research in order to develop suitable habitat for corridors between isolated populations.

Research should be conducted to identify the appropriate management to maintain an ecologically sustainable special forest products industry for fungi. Research should include the development of standards for harvest that take into account the production and abundance of fruiting to avoid damaging the resource and to ensure sustainability. Chanterelles and matsutake are important commercial species, and represent a substantial revenue for the special forest products industry. The possibility of managing stands for these species should be explored, and the techniques and benefits of co-managing chanterelles with forest trees, for example Douglas-fir/salal stands, as a cropping system to maximize economic output should be investigated.

A regional database and geographic information system layer should be developed that incorporates existing data for old-growth forest fungi from herbaria, historical and personal collections, and publications. This database should include host associates, habitats, patterns of occurrence, distribution and abundance, as well as other information, and should include a list of rare species. A regional geographic information system layer of locations for rare and locally endemic fungal species and type localities should be maintained. Information should be ground-truthed with a global positioning system. This source should be consulted when planning management activities to avoid extirpation of rare fungal species, or particularly rich habitats.

Education. Training for foresters and other professionals in resource management should be expanded to encompass a general understanding of mycology and to emphasize the importance of the fungal component of ecosystems and its relation to forest health. A communication system should be established that links natural resource personnel with mycologists.

Lichens

The lichen flora in the Pacific Northwest is diverse and abundant. Lichens are a conspicuous component of old-growth forest ecosystems where they play a major ecological role. They make significant contributions to nutrient cycling and biomass production and are critical in the food chain of mammals and invertebrates. The lichen flora of the Pacific Northwest includes many endemic species, so extirpation of these species in the region would equate to the extinction of the species. Twenty-six of these lichens closely associated with old-growth forests are endemic to the Pacific Northwest (Appendix, table IV-A-2).

Lichens are a symbiotic association between a fungus and alga or cyanobacteria (blue-green algae), but form an organism with its own distinct characteristics. Lichens absorb nutrients and moisture for growth from precipitation and atmospheric gases. The fungal component controls light intensity and absorbs moisture and nutrients that are transferred to the algae. The algae, in turn, conduct photosynthesis providing carbohydrates for the fungi. These fungal greenhouses provide for the growth of algae in sites where they could not exist without the protection and support of the fungi.

Lichen species occur in specific habitats and on specific substrates. Most forest lichens grow on trees but some grow on decaying wood, rock, soil, or in streams. Environmental factors limiting lichen distribution and growth include substrate, acidity, wetting and drying frequency, temperature regimes, humidity, light, and air pollution (Hawksworth and Hill 1984). Lichens occupy niches in the forest where they do not have to compete with other vegetation. Due to their ability to tolerate desiccation and their direct means of acquiring elements essential for growth lichens are able to survive in these variable microhabitats. Lichens contribute biological diversity and biomass, particularly within the canopy of a forest stand.

Lichens grow slowly compared to other organisms (Hawksworth and Hill 1984). Because of this slow growth, the persistence of substrate and amelioration of microclimate are important. Rapidly growing young trees are an unstable substrate that restricts lichen colonization and establishment. Microclimate also changes continuously as a young stand matures. Changes in substrate, humidity, and temperature within a forest canopy are reflected in a succession of lichen species present.

As a forest develops, an associated pattern of lichen succession also develops, portrayed by a change in species and an increase in lichen diversity and abundance. Some lichen species occur only after the stand has matured and provides stable and appropriate substrates with associated canopy microclimate. It may take over 200 years for these late successional lichens to become established in the forest (Lesica et al. 1991; McCune 1991; Henderson et al. 1988). Some lichens indicative of old-forest conditions occur only in forests that have not had major disturbances for centuries (500 or more years) (Goward 1992; Rose 1976). Old-growth forest lichen species require the ecological continuity of mature trees to persist, and they lack the ability to disperse widely, having only limited means of dispersal, making it difficult for them to invade new sites (Esseen et al. 1981). In England, a large number of lichen species are used as indicators of woodland age and ecological continuity (Broad 1989; Rose and Wolseley 1984).

The distribution of many lichens is dispersal limited (Esseen et al. 1981). Most forest lichens reproduce by asexual reproductive structures rather than by sexual spores. These vegetative propagules are small fragments composed of both fungal and algal cells and are more efficient than independent dispersal of the two symbionts (Hawksworth and Hill 1984). These fragments are larger than spores and therefore disperse only short distances. In the Oregon Cascades, half the biomass of lichen litterfall occurred within 6 meters of the edge of an old-growth forest patch, with a rapid decrease in litterfall with increasing distance from the old-growth forest edge (B. McCune 1993 personal communication).

Lichens are primary producers accumulating biomass and carbohydrates, and contribute to forest nutrient cycling. Arboreal lichens capture fog and retain moisture within the forest canopy. Many lichens fix atmospheric nitrogen (Denison 1973; Hawkworth and Hill 1984). Their litterfall provides organic material and increases the soil moisture holding capacity. The forage lichens are a major food source for animals such as flying squirrels, red-backed voles, and woodrats (Maser et al. 1985). They are also a food source for deer, elk and mountain goats during the winter (Hodgman and Bowyer 1985; Fox and Smith 1988). Native Americans used forage lichens for food (Turner 1990). Lichens provide habitat and food for canopy-dwelling invertebrates (Gerson and Seaward

1977), and are used by birds and small mammals for nest building material and camouflage (Broad 1989).

Air quality can be assessed by using lichens as biological indicators. Lichens are sensitive to sulfur dioxide and other gases and are efficient accumulators of heavy metals (McCune 1988). Some species of lichens show potential for antibiotic and medicinal qualities (Hawksworth and Hill 1984; Hale 1974).

Methods specific to lichens. The lichen panel assessed effects of the options on 157 lichen species that are closely associated with late-successional and old-growth forests. This is a fairly comprehensive list of the macrolichens that occur in old-growth forests in the Pacific Northwest. Nomenclature follows Egan (1987) and revisions. Lichen species were divided into 12 functional groups based on ecological relationships, and some of the groups were further subdivided by their degree of rarity. Some species were added, deleted, or moved among the various groups based on panel discussion. Seven species were not rated because of uncertainty about their biology or distribution (Appendix, table IV-A-2). The panel accepted the definitions of the outcomes A, B, C, and D as stated, rating the habitat conditions on federal lands. They felt that rare species that exist in refugia historically or "naturally" could not rate higher than outcome C because these species will always be distributed in isolated pockets or "refugia", regardless of the option. After refining the species groups and discussions about the ecology of each group, the panelists independently rated the expected outcome of each group for each option.

A summary of outcome scores for each group of lichens was based on the average scores of the five panelists (table IV-18).

Results. Viability assessments are presented here in table IV-18 for each of the ecological groups defined by the panelists.

Forage lichens: These species are long, pendant lichens on limbs and boles of trees or snags, and include the genera *Alectoria, Bryoria,* and *Usnea.* These lichens are an important food source for small forest mammals and ungulates, especially during the winter. Many of these species tend to be more common and abundant in montane forests. Eleven species were rated. One species is rare and verified from only three locations. This rare lichen, *Bryoria tortuosa*, rated an 80 percent or greater likelihood of outcome C or better under Options 1, 3, 4, and 9; and outcome D or better under Options 5, 7, and 8 (table IV-18). In contrast, the common forage lichens rated much higher with an 80 percent or greater likelihood of attaining outcome A under Option 1; outcome B or better under Options 3, 4, 5, and 9; and outcome C or better in Options 7 and 8 (table IV-18).

Arboreal leafy lichens: These lichens are short, tufted or flat, leaf-like species found on tree boles and twigs and include a variety of genera such as *Platismatia*, *Parmelia*, and *Cetraria*. Nineteen species were rated, including two rare species known only from only one or a few locations. The rare species rated with an 80 percent likelihood of attaining outcome C or better under all the options (table IV-18). The common arboreal leafy lichens were rated with an 80 percent or greater likelihood of attaining outcome A under Options 1 and 3; and outcome B or better for Options 4, 5, 7, 8, and 9 (table IV-18).

Table IV- 18. Projected future likelihoods of habitat outcomes for lichens under land management options.

Lichens	Option 1				Option 3				Option 4				Option 5				Option 7				Option 8				Option 9			
	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
Aquatic [3 species]	30	53	16	1	13	53	31	3	24	55	19	2	10	45	29	16	2	20	53	25	0	22	52	26	10	47	27	16
Decaying wood [8 species]	78	18	3	1	65	29	5	1	62	30	7	1	40	41	14	5	22	50	21	7	11	47	37	5	40	42	17	1
Forage Lichen (10 species)	80	18	1	1	70	27	2	1	58	39	2	1	47	41	9	3	28	49	19	4	34	47	17	2	61	32	5	2
Forage Lichen, Rare (1 species)	0	20	68	13	3	35	49	14	0	10	74	16	0	6	69	25	0	4	53	44	0	8	58	35	0	6	75	19
Leafy Arboreal (17 species)	89	9	1	1	81	17	1	1	76	19	4	1	59	33	7	1	37	45	17	1	36	45	18	1	52	40	7	1
Leafy Arboreal, Rare (2 species)	4	26	67	3	1	25	70	4	1	20	72	7	1	18	72	9	0	15	69	16	1	15	69	15	0	20	63	17
Nitrogen-fixing Lichens (20 species)	55	41	3	1	45	45	7	3	41	50	6	3	9	60	27	4	3	44	41	12	8	35	51	6	17	56	23	4
Nitrogen-fixing Lichens, Rare (6 species)	4	34	56	6	0	32	57	11	0	26	58	16	0	12	60	28	0	8	54	38	0	10	50	40	0	20	52	28
Oceanic Influence (4 species)	8	45	44	4	5	45	46	4	5	43	46	6	5	38	49	9	0	23	63	15	0	23	63	15	5	40	46	9
Oceanic Influence, Rare (12 species)	0	16	60	24	0	12	67	21	0	8	65	27	0	8	60	32	0	2	52	46	0	0	54	46	0	12	59	29
Pin Lichens (16 species)	37	47	15	1	30	48	21	1	30	48	21	1	23	47	27	3	11	38	42	9	10	30	51	9	22	46	29	3
Riparian (9 species)	18	61	18	3	11	53	33	3	16	62	19	3	6	52	36	6	2	36	48	14	4	26	50	20	9	54	32	5
Rock (4 species)	57	37	5	1	42	51	6	1	39	52	7	2	32	51	14	3	22	53	22	3	22	51	22	5	31	52	16	1
Rock, Rare (2 species)	3	15	65	18	0	15	60	25	0	13	64	24	0	13	59	29	0	10	45	45	0	8	49	44	3	13	56	29
Soil (8 species)	78	18	3	1	72	23	4	1	70	23	6	1	64	29	6	1	58	31	10	1	62	31	6	1	70	23	6	1
Tree boles (14 species)	76	21	2	1	69	26	4	1	60	33	4	3	55	36	6	3	26	57	13	4	26	60	11	3	46	44	7	3

A-Well Distributed B-Locally Restricted C-Restricted to Refugia D-Extirpation

Likelihood values are expressed as percentages that total to 100 for a given species within an option. Number displayed may vary due to rounding errors. See text for fuller explanation and discussion of the rating scale.

Nitrogen-fixing lichens: This is a group of medium to large, lettuce-shaped lichens that include the genera *Lobaria*, *Nephroma*, *Pannaria*, *Pseudocyphellaria*, *Sticta* and *Peltigera*. These lichens contain cyanobacteria (blue-green algae), which fix atmospheric nitrogen. Their addition of nitrogen to the forest ecosystem is significant (Pike 1978; Denison 1973). They are also critical in the food chain of many invertebrates. Many of these lichens do not enter forest stands until late successional stages, and they become more frequent or abundant only in old-growth conifer forests after 200 years. Twenty-six species were rated including six rare species known from only a few sites. The rare species rated poorly with an 80 percent or greater likelihood of outcome C or better under Options 1, 3, and 4; and outcome D or better under Options 5-9 (table IV-18). For the more common nitrogen-fixing lichens, there is an 80 percent or greater likelihood of attaining outcome B or better under Options 1, 3, and 4; and outcome C or better under Options 5-9.

Pin lichens: These small to diminutive lichens resemble small pins arising from a bed of green algae. They are inconspicuous but are well documented as being closely associated with late-successional and old-growth forests (Rose 1992). Many different genera make up this group, which occur in sheltered microsites with high humidity, often on the underside of large leaning trees. Pin lichens are substrate specific. The sixteen species of pin lichens were rated with an 80 percent or greater likelihood of attaining outcome B or better under Option 1; and outcome C or better for Options 3, 4, 5, and 9, with Options 7 and 8 receiving somewhat lower ratings (table IV-18).

Decaying wood lichens: This group includes eight species that occur only on decaying wood in various decay classes. This group includes species in the genus *Cladonia* as well as *Xylographa*, and *Icmadophila*. These species rated with an 80 percent or greater likelihood of attaining outcome B or better under Options 1, 3, 4, 5, and 9; and outcome C under Options 7 and 8 (table IV-18).

Tree bole lichens: This diverse group of lichens includes 14 species that occur on the base and boles of trees or snags. Several genera are represented, including crustose lichens. This group received an 80 percent or greater likelihood of attaining outcome B or better under all the options (table IV-18).

Soil lichens: This group includes eight species that occur on soil, protecting the forest floor from surface erosion. This group rated with an 80 percent or greater likelihood of attaining outcome B or better under all the options (table IV-18).

Rock lichens: This group of six lichens occur on rocks in shaded, ameliorated climatic conditions maintained by old-growth forests canopies. Two of the species are rare and rated with an 80 percent or greater likelihood of outcome C or better only under Option 1; and outcome D or better under all the other options. The more common rock lichens rated higher with an 80 percent or greater likelihood of attaining outcome B or better under Options 1, 3, 4, 5, and 9; and outcome C or better under Options 7 and 8 (table IV-18).

Aquatic lichens: The three lichen species in this group are truly aquatic and unlike most other lichens will die if desiccated. They are found on rocks in streams and create conditions that enhance aquatic invertebrate populations. These species are good indicators of water quality and constancy of stream flow levels. These lichens rated with an 80 percent or greater likelihood of outcome B or better under Options 1 and 4;

with outcome C or better under Option 3, 5 and 9; and outcome D or better under Options 7 and 8 (table IV-18).

Riparian lichens: This group includes nine species found on trees in riparian areas. The increased humidity and hardwood component within the riparian areas appear critical to the distribution of these species. They are generally medium to large, long, pendent lichens that become locally abundant and are usually conspicuous. These lichens rated with nearly an 80 percent or greater likelihood of attaining outcome B or better under Options 1 and 4; and outcome C or better in all the other options (table IV-18).

Oceanic influenced lichens: This diverse group includes 16 species that occur in mature trees within a short distance of the Pacific Ocean. Frequent fog along the coast, combined with moderate temperatures, create a unique environment for these lichens. All of these species are considered rare from a regional perspective with 12 considered very rare and known from only one or a few locations in the Pacific Northwest; three of these species are listed and three others are proposed for listing with the Oregon Natural Heritage Program (1991) as species of concern. These 12 rare Oceanic influenced species rated an 80 percent or greater likelihood of outcome D or better under all of the options. The more common species rated with an 80 percent or greater likelihood of attaining outcome C or better under all of the options (table IV-18).

Discussion. Outcomes for lichens were generally correlated with the acreage of Late-Successional Reserves, stand treatments within the Matrix, and protection for riparian corridors. Ratings were higher for lichens in the options with greater acreage within Late-Successional Reserves. Ratings were higher for aquatic and riparian lichens in the options with wider riparian buffer areas. Overall outcomes were highest for Options 1, 2, then 4, intermediate for 5 and 9 (equal) and lowest under 7 and 8 (table IV-18).

Some of the rare lichen species have narrow geographic ranges and only occur in specialized habitats. This group rated much lower than the others (fig. IV-6, IV-7). These species are typically distributed across the landscape only in isolated special habitats. Therefore, they need to be evaluated at a different scale than the common species that are more widely and evenly distributed. The management options considered here do not specifically address the concerns of species occurring in special habitats, which include geologic sites, refugia from fire, oceanic dune deflation plains, waterfalls, and river gorges. Many of these special habitats occur as rare combinations of abiotic and biotic conditions such as specific tree species in the fog zone of a waterfall at low elevations. These special habitats need to be addressed at the local level and were not mapped for the present review. Specific measures need to be implemented under all options that conserve such special habitats if the rare species are to be conserved.

Many of the lichen species addressed here occur worldwide, yet have experienced marked declines or extirpation in many parts of Europe and eastern North America (Olsen and Gauslaa 1991; Rose 1988; Rose and Wolseley 1984). The extirpation and drastic decline of these species has been attributed to both cutting of woodlands and air quality degradation (Alstrup and Sochting 1989; Broad 1989). In Denmark, 88 species of lichens have been extirpated due to air pollution and forestry practices (Alstrup and Sochting 1989). The decline of *Lobaria*, *Sticta*, *Pseudocyphellaria*, and *Nephroma* species in England is attributed to selective cutting of the mature large diameter trees (Rose 1988). The following 14 species are associated with old-growth forests in the Pacific Northwest and are documented to have been extirpated from parts of Europe:

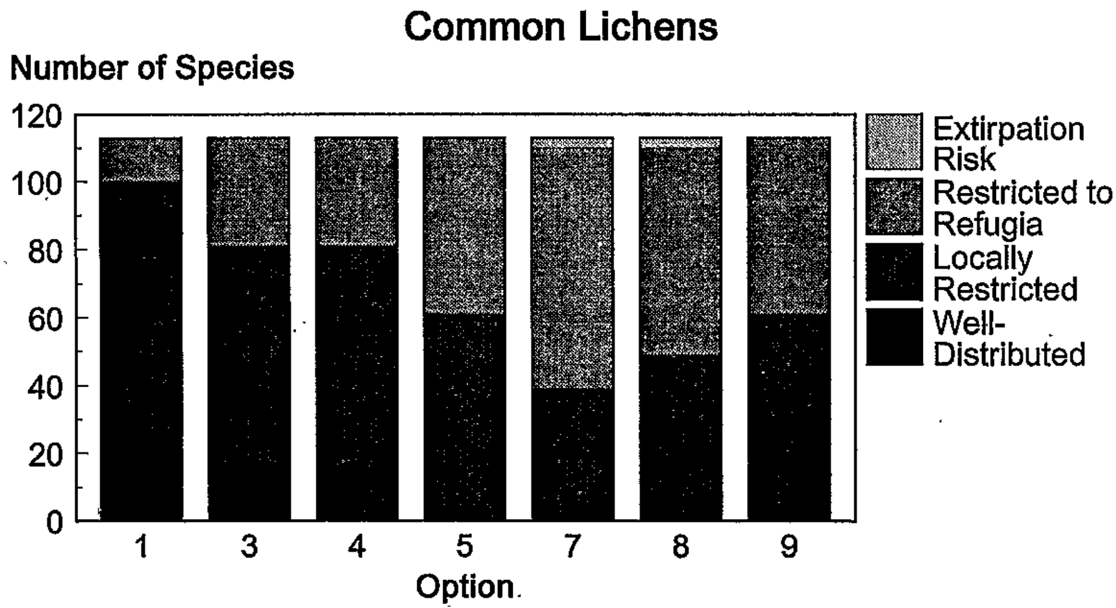

Figure IV-6. Outcomes for common lichens under each land management option. Values shown are the number of species that had an 80 percent or greater likelihood of achieving at least the specified outcome (based on distribution of habitat).

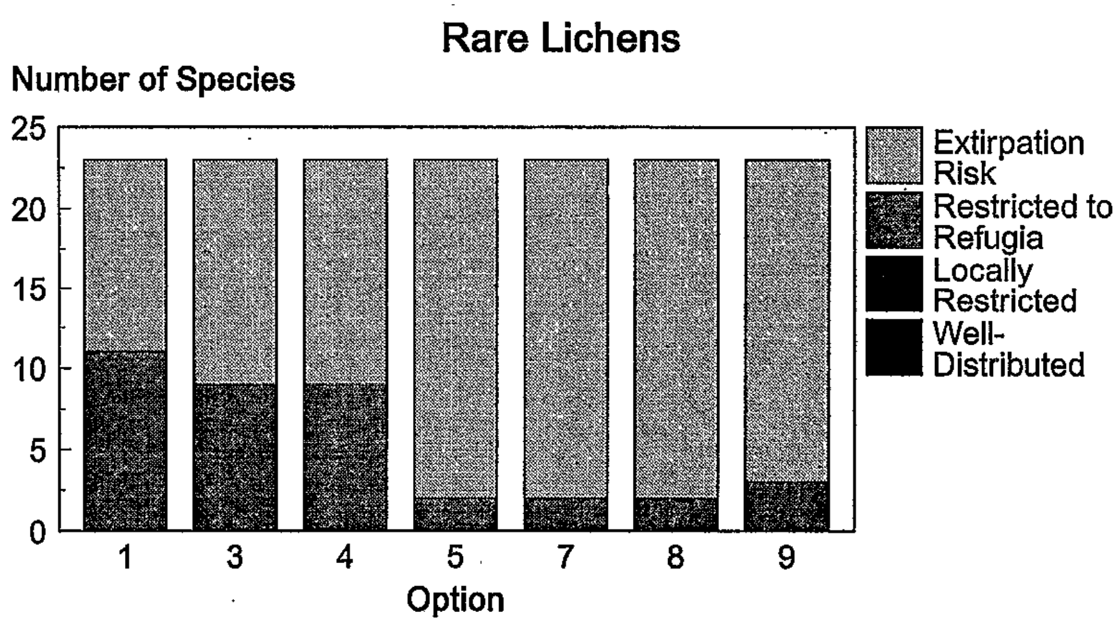

Figure IV-7. Outcomes for rare lichens under each land management option. Values shown are the number of species that had an 80 percent or greater likelihood of achieving at least the specified outcome (based on distribution of habitat).

Lobaria pulmonaria, *Lobaria scrobiculata*, *Nephroma bellum*, *Nephroma laevigatum*, *Nephroma parile*, *Peltigera collina*, *Pannaria rubignosa*, *Pannaria mediterranea*, *Leptogium cyanescens*, *Leptogium saturninum*, *Collema nigrescens*, *Sticta fuliginosa*, *Sticta limbata*, and *Usnea longissima* (Olsen and Gauslaa 1991; Rose 1988). Populations of these species should be closely monitored as indicators of biological diversity and forest ecosystem health.

Mitigation for Lichens

Several of these lichen species have limited dispersal capabilities and are not able to move far from the parent plant. Small patches (10-40 acres) of old-growth forests distributed across the landscape are important as refugia and centers of dispersal (Esseen et al. 1992). Some lichens, particularly the nitrogen-fixing species, do not become established until stands are several hundred years old (McCune 1993). Older stands that are well distributed geographically are critical to the survival and persistence of these species in the ecosystem. Riparian buffers on all orders of streams are important for the riparian and aquatic lichens.

Many lichen species are rare, endemic, and not well studied; additional surveys are needed to identify populations of rare or endemic species, sites of species diversity, special habitats, or unique communities. Protection of key populations of rare lichen species from adverse management activities and designation of Botanical Special Interest Areas or Areas of Critical Environmental Concern are important mitigation for these groups. Conservation strategies have been developed by federal agencies for many rare animals and vascular plants; similar plans could be developed to address rare lichen species. Conservation strategies provide biological and habitat information, management direction, and recommendations for selecting and monitoring of key populations. Interagency coordination will improve the conservation and enhancement efforts for these rare species. The State Natural Heritage Programs coordinate, store, and track information on these rare species across all land ownerships and should be involved in this coordination process.

Leave trees should be clumped within managed stands to moderate climatic factors and provide a variety of microhabitats which contribute to the survival of many lichen species. These lichens are slow to recolonize and grow so old-growth clumps act as "seed trees." Therefore, it would be beneficial to maintain patches of large, old trees within the forest Matrix rather than leaving widely spaced individual retention trees. These patches may then become the source of genetic material and propagules to disperse lichens into the adjacent stands when conditions become suitable. Big, old trees with large lateral branches provide the best substrate for many species of lichens, and trees that have emergent crowns or are the largest, oldest trees in the stand should be retained. Maintaining the same leave trees over several harvest rotations is important due to the slow colonization and growth of most lichens. Additional mitigation in the Matrix under most options could include selecting for diverse tree species and structure in the leave tree patches; leaving large down logs within the shelter of the retention tree clumps to provide additional microhabitat and microclimatic conditions. Other mitigating measures include retention of trees on ridgelines for some lichen species because this location optimizes dispersal and interception of fog. This pattern mimics the retention patterns created by natural fire.

Buffering rock outcrops with a "halo" of trees at least one tree height in width maintains the appropriate shade and microclimate required by lichens that grow on rocks is another type of mitigation that will increase the likelihood of meeting outcome A for some lichen species.

Forage lichens: Bryoria tortuosa the only rare species in this group has only three documented locations. It is known from Eagle Point in Jackson County, Oregon, and in Washington from the Olympic Peninsula and in the Columbia River Gorge. Protection of these known locations is critical for its survival. Survey adjacent areas to determine its presence before management treatments occur.

Arboreal leafy lichens: Three rare species need site-specific habitat management. *Hypotrachyna revoluta* is known from one site in Washington. *Tholurna dissimilis* is a monotypic genus with seven known sites on windswept, stunted trees, in the fog zone, and in the upper canopy of old-growth low elevation Douglas-fir trees on the H.J. Andrews Experimental Forest (Pike 1972; Otto 1983). *Hypogymnia duplicata* is known from only three sites: Larch and Saddle Mountains in Oregon, and Sulfur Creek Lava Flow in Washington. Protection of the known sites for these three rare species is critical to their survival. Additional surveys should be conducted for new locations to prevent inadvertent destruction of site locations. Monitoring these known populations to assess their viability and trends should be conducted to determine management strategies. Other mitigation for the species could include protecting mature trees on ridgelines and windswept sites, especially within the Columbia River Gorge.

Nitrogen-fixing lichens: Most of these species, including the rare ones, are known to occur only in stands that are several hundred years old. Old-growth stand fragments including small scale 10-40 acres in size, distributed across the landscape are necessary to maintain viable populations of these species, due to their limited dispersal capabilities. This group of lichens includes several species that are restricted to lower elevation old-growth stands. Increasing the acreage of lower elevation old-growth stands would be beneficial for these species.

Nitrogen-fixing lichens are negatively affected by air pollution and are especially sensitive to sulfur dioxide (Hawksworth and Hill 1984). Air quality in forested areas is important to maintain healthy populations of these species. Air quality monitoring should be established to determine baseline conditions as well as to monitor changes in forest health.

Few known sites for rare nitrogen-fixing lichens occur within reserves. *Dendriscocaulon intricatulum* is known from only one site in Washington, at Sulfur Creek Lava Flow on the Mt. Baker-Snoqualmie National Forest; one site in Oregon, and more sites are known in British Columbia and Alaska. *Nephroma occultum* is known from only five sites in the United States and from several sites in British Columbia. It occurs in the upper canopy of old trees, generally over 400 years of age (Goward 1992). *Pseudocyphellaria rainierensis* is locally endemic and known from eight sites where it occurs in the canopy and lower tree boles in old stands. *Pannaria rubiginosa* is known from one site at Fisherman's Bend, a Bureau of Land Management recreational site near Salem. Protection of these sites is critical to the survival of the above lichens.

Pin lichens: All these species require stable, high atmospheric humidity provided by old-growth forest conditions (Tibell 1980). They occur on large tree boles, in microsites that are sheltered from the direct rain. Complex canopy structure and especially leaning boles of trees are optimal sites for these species. Retention of large coarse woody material will benefit these species. Standards and guidelines should be developed for all the options to retain clusters of trees, (rather than scattered individuals) including "leaning trees," selecting of leave trees that are the largest and oldest, along with some asymmetrical trees, and distributing the clumps of leave trees across a variety of landscape and topographic positions.

Aquatic and Riparian lichens: Reduced water quality and fluctuation of water flow can destroy aquatic lichens. Sediment in streams act as an abrasive, and sand-blast lichens off the rocks. Cumulative effects of logging in watersheds may have a detrimental impact on these organisms in the stream system. These lichens are limited by abilities to disperse and may recolonize slowly, especially upstream. Watershed protection guidelines that are part of Options 1, 3, 4, 5, and 9 are beneficial to both the aquatic and riparian lichen species. Surveys for these species should be conducted as part of the watershed analysis conducted before activities are allowed in these riparian buffers including hydroelectric projects.

Oceanic influenced lichens: Mitigation can be improved by surveying, monitoring, and developing conservation strategies to maintain viable populations of the rare oceanic species. Designating botanical special interest areas to protect known populations is critical to the survival of the species. Sutton Creek on the Siuslaw National Forest and located within the Matrix is an important location for many rare Oceanic lichens. Recreational activities and management guidelines to conserve these unique botanical resources should be developed.

Along the immediate coast, old-growth forests are rare, allowing more stands to develop into old-growth, to provide additional habitat for these rare and locally distributed species would enhance the survival of oceanic lichen species. Coordination between state and private sectors to inventory, evaluate and establish sites for conservation of these species is necessary. Portions of the Siuslaw National Forest near the ocean that are managed as Matrix should be surveyed, and suitable rare lichen habitat should be protected.

The role of nonfederal lands. The oceanic influenced lichens are locally distributed and many are rare. This group could benefit from management on nonfederal lands. Recreational developments should minimize degradation of botanical resources in state parks. Coastal areas should be surveyed for these species and suitable botanical areas acquired. Little old-growth forest remains in coastal areas of the Pacific Northwest as a result of fire history and past harvesting. Stands in coastal areas should be developed into old-growth conditions to provide habitat for coastal species.

Much of the low elevation forest land in the Pacific Northwest is under nonfederal ownership. This land includes thousands of acres and is generally managed on short harvest rotations. Given that lichens are slow to establish in rapidly growing stands and do not become abundant until later in the successional development, most of these stands are harvested before lichens have a chance to establish significant populations. Most lichen species are not able to disperse across extensive areas of young stands. Therefore, these lichen species may not be able to disperse across these non-federal lands.

Research and information needs. Lichen research needs include: basic inventory and monitoring, status reviews of rare species, successional studies, effectiveness of retention trees for dispersal, studies of lichen functions (e.g., climate control, nutrient cycling, forage for wildlife), and air quality monitoring.

Baseline inventories are needed to document presence of lichen species abundance, biomass, habitat requirements, and geographic distribution. Lichen inventory data should be incorporated into the general forest inventory, computerized, and mapped. Sampling methods for forest epiphytes need to be standardized. Identifications should be verified with voucher specimens deposited in recognized regional herbaria. Identification guides and annotated catalogs for lichens in each physiographic region should be developed. Land management agencies need knowledgeable and qualified staff to conduct lichen inventory and monitoring.

Status reviews and comprehensive surveys should be conducted for rare species. This information needs to be shared with the State Heritage Programs, that track species information across all land ownerships. Conservation strategy plans should be developed for rare species to enhance their viability through specific mitigation, standards and guidelines, and designation of reserves.

Successional studies should be conducted on lichen communities, including establishment, diversity, and abundance in stands of different ages and different plant associations, substrates, and vertical succession in the canopy. Basic research is needed to determine lichen dispersal patterns by species, groups of species (guilds), and forest types. This would be useful to quantify the importance of small, closely spaced forest fragments to the viability of these species.

Monitoring and research plans to evaluate the effects of forest management practices on lichens should be developed. The impacts from management activities including timber harvesting, silvicultural practices, grazing, and recreation should be monitored. For example, questions to be answered include: what species of lichens survive in retention trees and how is this survival affected by topographic position, tree symmetry, crown type, or clumping retention trees? What is the advantage of selecting leave trees that contain a diversity of lichen species and how effective are lichens on retention trees as centers of dispersal?

Nitrogen fixation rates of the nitrogen-fixing lichens in different forest types throughout the year should be determined. The quantity and nutrient content of lichen litter-fall should be determined for different forest types. Research projects should be conducted on the role of lichen litter-fall in the nutrient cycling and biomass production of the various types and ages of forests. Research should be conducted on both the west and east side forests on the trophic relationships of lichens, small mammals, and predators such as the spotted owl. Research into the species preferences of lichens for nest building by flying squirrels should be conducted to guide management actions. The role of lichens as habitat and food for forest mammals and invertebrates should also be investigated.

Research is also needed on the amount of fog moisture captured by epiphytic lichens and bryophytes, the role of these epiphytes in creating and maintaining the unique ameliorated climatic conditions under the canopy of old-growth forests, and the relationship between lichen abundance and structural diversity in the forest.

An integrated, regional air quality monitoring program should be developed using lichens as biological indicators of forest health, including impacts on lichen species and trends in lichen populations would further aid in their conservation. Forage and nitrogen-fixing lichens are especially sensitive to air pollution and should be monitored to detect reduction in their viability from a decline in air quality (Rose 1988).

Bryophytes

Hornworts, liverworts, and mosses, collectively known as bryophytes, are small, green, nonvascular, spore-bearing plants that have evolved a wide array of species well adapted to nearly every habitat on earth. About 170 species of liverworts and 450 species of mosses occur within the range of the northern spotted owl. About 20 percent of these species are endemic to western North America or to the Pacific Northwest (Lawton 1971).

Although bryophytes can reproduce by means of spores, dispersal is more often accomplished by vegetative means, either through fragmentation of leaves or stems, or by special asexual propagules. Given their proclivity for asexual reproduction, distribution of species is erratic and unpredictable, but populations will be viable as long as sufficient suitable habitat is available.

Epiphytic mosses and lichens can total up to 2.6 metric tons per hectare in old-growth Douglas-fir forests of western Oregon (McCune 1993). In the understory, mosses often comprise 20 percent of the biomass and 95 percent of the photosynthetic tissue biomass (Binkley and Graham 1981).

Old-growth forests may be essential to the continued existence of some bryophytes. Most species of bryophytes do not become established in stands until 100 years, and they are best developed in stands 400 years or older. Norris (1987) found nine of 128 bryophyte species of late-successional redwood forests to be absent from stands that had been clearcut 100 years earlier, and 22 other species were reduced in abundance in younger stands. McCune (1993) observed significant differences in species composition and biomass of epiphytic bryophytes in stands aged 95, 145, and 400 or more years. He noted a marked reduction of bryophyte biomass and species in the younger age classes. Lesica et al. (1991), found seven of eleven species of leafy liverworts to be restricted to old-growth stands, in a Montana forest, where their preferred substrate, decaying wood was more abundant. Additional studies in Europe (Söderström 1988, Laaka 1992) indicated that late-successional forests serve as refugia for bryophyte species that no longer occur in, or cannot colonize younger stands because of air pollution, acid rain effects, or short rotations in managed forests.

Bryophytes provide food and habitat for a host of invertebrates (Russell 1979, Gersun 1982, Varga 1992) and vertebrates. Marbled murrelets nest in moss mats in old-growth trees. Flying squirrels, birds, and mammals commonly use mosses as material in their nests.

The bryophytes are involved with nutrient cycles in old-growth stands. They act as sinks for nitrogen leachate from canopy lichens and free-living cyanobacteria that commonly cover tree leaves (McKee et al. 1987, Blinn et al. 1988, Greene and Blinn 1991). Bryophytes intercept, absorb, and buffer nutrients and water in the canopy and understory (Brown and Bates 1990). Bryophytes play an important role in the dynamics of understory vegetation, as well as soil structure, soil stability, and interception and retention of water. Many liverworts are mycorrhizal (Schuster 1966), and are generally limited to decaying wood in old-growth and late-successional stands.

Bryophytes are well developed in riparian areas on the maples and cottonwoods. Nadkarni (1984) showed that the mineral content of the epiphytes on bigleaf maple in the Olympic forests exceeded that of the leaves on the same tree. Bryophytes are also a major component of the forest stream ecosystem, providing year-round habitat for a wide array of algal species, aquatic invertebrates, and amphibians at all trophic levels. They are a perennial source of organic material. Bryophytes function as efficient filters for trapping sediments and small organic material.

Christy (1991) reviewed the findings of the International Association of Bryologists worldwide survey. More than 60 percent of the scientists surveyed cited forestry as causing the greatest decline of bryophytes, with epiphytes as the most threatened ecological group. Continued harvest of old-growth forest will cause a decline of bryophytes species that are restricted to or best developed in old-growth (Lesica et al. 1991). Old-growth stands provide sources of inoculum for adjacent stands when suitable habitat becomes available.

Air pollution is a potential threat to bryophytes within the range of the spotted owl. Hallingbäck (1992) described how air pollution has caused a widespread decline in bryophyte species, as well as a reduction in plant size and a decline in sexual reproduction. Small epiphytic species at the edge of stands and bryophytes on exposed summits and ridgelines may be seriously affected.

The unregulated harvest of "special forest products" is a potential threat to bryophytes of the old-growth forest. The harvest of bryophytes for the floral trade is depleting local populations and may have serious long-term implications for processes such as mineral cycling, moisture retention in logs, and seedbed availability for vascular plants. An estimated 40-60 tons of mosses are harvested each year in Oregon and Washington (J. Freed, 1989, Washington State University, Cooperative Extension, personal communication). A large portion of the harvested moss is exported. A related threat could be the marketing of rotten logs and stumps as a soil amendment, much as peat moss is used. This would have a negative effect on many liverwort species dependent on coarse woody debris.

Methods. The panel evaluated 106 species of mosses and liverworts closely associated with old-growth forests, including 32 species endemic to western North America or the Pacific Northwest (appendix table IV-A-3). Nomenclature for mosses follows Anderson et al. (1990), and Stotler and Crandall-Stotler (1977) for liverworts.

Bryophytes were divided into 13 habitat groups to facilitate discussion (appendix table IV-A-3). Groups were based on ecological relationships or habitat associations, and some of the groups were further subdivided by their degree of rarity. Each group was rated based on the projected future condition of habitat on federal lands (outcomes A-D, see Methods for assessing effects of options). Three species were rated individually because they did not fit into species groups or were too poorly known, eight were rated individually because they were rare species, 16 were not rated because of lack of information.

Table IV- 19. Projected future likelihoods of habitat outcomes for bryophytes under land management options.

Bryophytes	Option 1				Option 3				Option 4				Option 5				Option 7				Option 8				Option 9			
	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
Individual Species																												
Blindia flexipoda	80	20	0	0	70	30	0	0	80	20	0	0	70	30	0	0	70	30	0	0	60	40	0	0	80	20	0	0
Diplophyllum plicatum	10	30	30	30	10	30	30	30	10	30	30	30	10	30	30	30	10	30	30	30	10	30	30	30	10	30	30	30
Fontinalis howellii	97	3	0	0	93	7	0	0	93	7	0	0	83	17	0	0	77	23	0	0	73	27	0	0	90	10	0	0
Kurzia makinoana	100	0	0	0	91	3	3	3	91	3	3	3	91	3	3	3	82	6	6	6	82	6	6	6	91	3	3	3
Marsupella emarginata var. aquatica	0	30	60	10	0	30	60	10	0	30	60	10	0	30	60	10	0	30	60	10	0	30	60	10	0	30	60	10
Pseudoleskeella serpentinense (CA)	100	0	0	0	90	10	0	0	90	10	0	0	90	10	0	0	90	10	0	0	80	20	0	0	90	10	0	0
Ptilidium californicum (CA only)	100	0	0	0	90	10	0	0	80	20	0	0	80	20	0	0	70	30	0	0	70	30	0	0	100	0	0	0
Racomitrium pacificum	70	30	0	0	70	30	0	0	60	40	0	0	60	40	0	0	50	50	0	0	50	50	0	0	70	30	0	0
Schistostega pennata (WA only)	100	0	0	0	100	0	0	0	100	0	0	0	80	20	0	0	80	20	0	0	80	20	0	0	100	0	0	0
Scouleria marginata	100	0	0	0	100	0	0	0	100	0	0	0	80	20	0	0	80	20	0	0	80	20	0	0	100	0	0	0
Thamnobryum neckeroides	70	13	17	0	67	13	20	0	67	13	20	0	60	20	20	0	53	23	20	3	53	17	20	10	60	20	20	0
Tritomaria exsectiformis	0	30	40	30	0	30	40	30	0	30	40	30	0	30	40	30	0	30	40	30	0	30	40	30	0	30	40	30
Bryophyte Groups																												
Abundant Decaying Wood	100	0	0	0	97	3	0	0	97	3	0	0	93	7	0	0	83	17	0	0	73	27	0	0	97	3	0	0
Aquatic	100	0	0	0	97	3	0	0	100	0	0	0	87	13	0	0	80	20	0	0	77	23	0	0	97	3	0	0
Canopy-Branch, Interior	77	23	0	0	73	27	0	0	70	30	0	0	70	30	0	0	70	30	0	0	63	37	0	0	73	27	0	0
Canopy-Twigs, Exterior	95	5	0	0	95	5	0	0	95	5	0	0	95	5	0	0	95	5	0	0	65	35	0	0	95	5	0	0
Decaying Wood	93	7	0	0	87	13	0	0	87	13	0	0	83	17	0	0	77	23	0	0	73	27	0	0	90	10	0	0
Flood Plain	100	0	0	0	97	3	0	0	97	3	0	0	90	10	0	0	77	23	0	0	77	23	0	0	97	3	0	0
Shaded Duff/Humic Soil	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	97	3	0	0	93	7	0	0	100	0	0	0
Shaded Mineral Soil	87	13	0	0	83	17	0	0	83	17	0	0	83	17	0	0	80	20	0	0	77	23	0	0	87	13	0	0
Shaded Rock Outcrops	93	7	0	0	80	20	0	0	77	23	0	0	73	27	0	0	67	30	3	0	60	37	3	0	83	17	0	0
Splash Zone	100	0	0	0	100	0	0	0	100	0	0	0	97	3	0	0	83	17	0	0	83	17	0	0	100	0	0	0
Tree Boles/Decaying Wood	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0
Tree Boles/Understory	90	10	0	0	90	10	0	0	90	10	0	0	90	10	0	0	83	17	0	0	80	17	3	0	90	10	0	0
Wet Shaded Humic Soil	100	0	0	0	97	3	0	0	97	3	0	0	93	7	0	0	83	17	0	0	80	20	0	0	93	7	0	0

A-Well Distributed B-Locally Restricted C-Restricted to Refugia D-Extirpation

Likelihood values are expressed as percentages that total to 100 for a given species within an option. Numbers displayed may vary due to rounding errors. See text for fuller explanation and discussion of the rating scale.

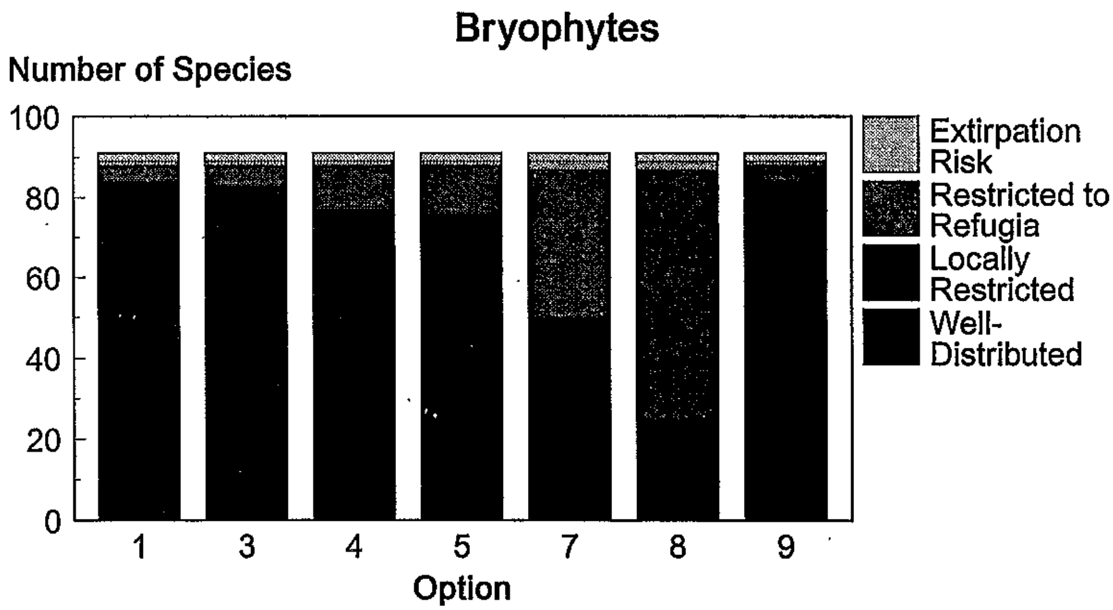

Figure IV-8. Outcomes for bryophytes under each land management option. Values shown are the number of species that had an 80 percent or greater likelihood of achieving at least the specified outcome (based on distribution of habitat).

Results. Ratings for bryophytes are presented by habitat association groups and for some individual species (table IV-19). A summary of outcome scores for each group or species was based on the average scores of three expert panelists (table IV-19, fig. IV-8).

Canopy exterior: The two species in this group are common and widespread on twigs and branches in the canopy of old-growth forests at low to middle elevations. *Ulota megalospora* is more common on slopes and ridgetops, and *Ulota obtusiuscula* is frequent on branches of hardwoods in stream valleys. They occur in drier, more exposed portions of the canopy where lichens replace bryophytes as the dominant epiphytes (Pike et al. 1975). Hallingbäck (1992) noted that *Ulota* was one of the genera in serious decline in Sweden due to air pollution. A likelihood rating of 80 percent or better in outcome A was achieved in all but Option 8.

Canopy interior: The two species in this group occur in the interior portion of tree canopies. *Antitrichia curtipendula* is a dominant moss, forming large mats in the inner canopy of old-growth conifers, and is best developed in wet coastal forests and stream terraces. It is common at low to middle elevations throughout the region. These extensive moss mats eventually form "perched soils" in the canopy, complete with rooted vascular plants, fungi, and an invertebrate fauna. They act as large sponges, absorbing and retaining both moisture and nutrients leached from lichens and foliage in the upper canopy (Pike 1978). The mats also form platforms used as nesting sites by the marbled murrelet and red tree vole. Although not well studied, *A. curtipendula* may be a "keystone" species in the canopy, helping to regulate microclimate and nutrient flow, as well as providing habitat for other organisms.

The liverwort *Douinia ovata* is frequently abundant on the underside of limbs beneath mats of *Antitrichia*, where it may be dependent on nutrients leached from the mats and intercepted in stem flow. It also occurs on trunks and branches of trees at the edge of stands, where fog interception occurs.

The two species rated at an 80 percent or greater likelihood of attaining outcome B or better for all options. This rating results from concerns about the "keystone" nature of this group in an already fragmented landscape.

Tree boles and decaying wood, common: Three species were treated in this group, which are common on the bark of conifers and to a lesser extent on decaying logs. A rating of 100 percent in outcome A was achieved for all options.

Tree boles/understory - less common: Five species were treated in this group, which are common on the bark of conifers. A rating of 100 percent in outcome A was achieved for all options.

Shaded mineral soil: The five species in this group are pioneers on exposed mineral soil within the shaded and humid microclimate of the old-growth forest at low to middle elevations. Except for *Pseudotaxiphyllum elegans*, none are common. Typical habitats are root balls of windthrown trees, banks of trails, and small soil slumps. An 80 percent or greater likelihood rating in outcome A was achieved for this group under all options except 8.

Shaded rock outcrops with thin soil: The base of rock outcrops, when shaded by an old-growth canopy, is habitat for a distinctive group of species found nowhere else in the landscape. Most are widespread throughout the region. *Heterocladium* species grow directly on cool, shaded rock faces; the other species grow on ledges that accumulate shallow soils. Removal of the canopy at these sites results in replacement of this group by xerophytic bryophytes and vascular plants typical of exposed outcrops. The seven bryophytes in this species group probably develop only after long periods of canopy stability. Options 1, 3, and 9 rated with an 80 percent likelihood of attaining outcome A, while Options 4, 5, 7, and 8 rated with an 80 percent or greater likelihood of attaining outcome B or better.

Wet shaded humic soil: This group of five species occurs on moist to wet soils with high organic content. The species are widespread in the region at lower to middle elevations. The liverwort genus *Plagiochila* is probably represented in this habitat by more than one species (Hong 1992). *Calypogeia azurea* and *C. muelleriana* may also occur on decaying wood. This group is sensitive to desiccation and requires the shaded, moist microclimate provided by old-growth canopies. *Calypogeia* is most common in riparian stands and on stream terraces. Riparian protection, including buffers on intermittent streams, is important for their viability. Outcome A was achieved with an 80 percent or greater likelihood for all options.

Shaded duff and humic soil: These three species occur on shaded duff and humic soil at middle to upper elevations. They typically occur midslope, on benches or in concave microtopography subject to snow accumulation. They rated with an 80 percent or greater likelihood of attaining outcome A under all options.

Decaying wood - common species: This group of 15 species contains the highest proportion of liverworts in old-growth forest and is composed of relatively common species that are widespread at low to middle elevations throughout the region. They occur exclusively on logs without bark (decorticated) to well-decayed logs and stumps, in cool to moist forest stands with deep shade. They are most abundant in riparian areas and stream terraces. This group is sensitive to changes in light level and microclimate caused by removal or thinning of the canopy. They also depend on continued input of coarse woody debris in various decay classes and diameters for their substrate. This group rated with an 80 percent or greater likelihood of attaining outcome A under all options except Option 8.

Decaying wood - less common species: These 11 species of liverworts and mosses are restricted to coarse woody debris in various stages of decay, in cool, moist, and deeply shaded stands. This group rated with an 80 percent or greater likelihood of attaining outcome A under all options except 8.

Aquatic submerged: These three species are inundated by perennially cold, clear water and occur throughout the region at low to middle elevations. *Chiloscyphus polyanthos* grows on rocks, submerged wood, or organic matter in springs or seeps, with low flows. The other two species occur on submerged rocks in swift flowing streams or rivers. This group rated with an 80 percent or greater likelihood of attaining outcome A under all options except 8.

Splash zone: Five species of bryophytes in this group occur on rocks just above the level of mean (low) summer flows, in small to large fast-flowing streams, or in the spray zone of rapids and waterfalls. They are adapted to fluctuating water levels, and are sensitive to abrasion by sediment carried by the force of the current (Rosentreter 1984). *Jungermannia atrovirens* is most common in coastal streams in Oregon and northern California. Outcome A was achieved with an 80 percent or greater likelihood under all options.

Floodplain: The 13 floodplain species occur on a variety of substrates at low to high elevations throughout the region in both the Cascades and Coast Range. Most are common and widely distributed, but *Rhizomnium nudum* is uncommon to rare. *Conocephalum conicum, Dicranella palustris, Hookeria lucens, Pellia epiphylla, Pellia neesiana,* and *Rhytidiadelphus subpinnatus* occur in dense shade, on moist to wet, organic substrate, decaying logs, gravel and rocks, along streambanks, or on steam terraces. *Rhizomnium nudum* occurs on wet, rotten wood within these habitats. *Porotrichum bigelovii, Racomitrium obesum* and *Schistidium agassizii* occur on wet rocks, gravel, or mineral soil in streambeds and on banks. *Plagiomnium insigne* is common on moist, shaded soil and duff on stream terraces. *Apometzgeria pubescens* and *Metzgeria conjugata* occur on cool, shaded boles of hardwoods and on moist rock faces on streambanks and stream terraces. *Plagiomnium insigne* appears to be mycorrhizal.

These species were grouped together because they are almost exclusively associated with riparian zones and would be influenced by riparian prescriptions identified in the management options. All are dependent on shade, wet soils, organic litter and humid microclimate. This group rated with an 80 percent or greater likelihood for attaining outcome A under all options except 7 and 8.

Species rated individually: These species were rated individually because they did not fit readily into other habitat groups, or because there was a lack of information about them.

Fontinalis howellii (= *F. antipyretica* var. *oregonensis*) grows on sediment and submerged wood in cold, clear water of spring-fed ponds and pools, on both stream terraces and midslope in sag ponds (ponds formed by land slumps on slopes). While not containing significant populations of fish, these ponds and pools are extremely important as breeding areas for amphibians. This group rated with an 80 percent or greater likelihood of attaining outcome A under all options except 7 and 8.

Kurzia makinoana grows on well-shaded rotten wood and humic soil (Hong et al. 1989) at low elevation. It occurs throughout the region but apparently is uncommon. California populations are more common in mires (small bogs), while those in Oregon and Washington are more closely associated with old-growth forests. This species rated with an 80 percent or greater likelihood of attaining outcome A for all options.

Thamnobryum neckeroides, endemic to the Pacific Northwest, occurs in dense shade, on moist organic soil and rocks in thickets of willow, vine maple, and Sitka alder at middle to higher elevations. These thickets usually occur at the margins of avalanche tracks, seepage areas, and the bases of talus slopes, adjacent to stands of old-growth forest. Sites often have snowpacks that persist until early summer. This species rated with nearly an 80 percent or greater likelihood of attaining outcome B or better for all options except Option 8, reflecting its present somewhat spotty distribution.

Rare species: *Blindia flexipoda* is only known from a limited area of serpentine along the Smith River in northern California, where it occurs in the splash zone of streams. It is an effective sediment trap, and gold miners remove large quantities of this species to extract gold. This species rated with an 80 percent or greater likelihood of attaining outcome A under Options 1, 4, and 9, and rated to outcome B or better in the other options.

Diplophyllum plicatum occurs sparsely in two sites in old-growth Sitka spruce forest on the Oregon Coast (Schofield and Godfrey 1979; Oregon Natural Heritage Program 1991). It has also been collected in the North Cascades and Olympic National Park (Hong et al. 1989). It grows on bark, decaying wood, and thin soil over rock. It rated with an 80 percent or greater likelihood of outcome D or better under all options.

Marsupella emarginata var. *aquatica* is known in our region from one site at Waldo Lake in the Oregon Cascades, where it is abundant on submerged rocks of a high elevation stream. This is the only known location in western North America. It rated with an 80 percent or greater likelihood of attaining outcome C or better for all options.

Pseudoleskeella serpentinense is restricted to the Smith River watershed in northern California and southwestern Oregon; it grows on serpentine outcrops near streams (Wilson and Norris 1989). It rated with an 80 percent or greater likelihood of attaining outcome A for all options, indicating that riparian prescriptions are adequate for continued viability.

Ptilidium californicum, common on boles of conifers, particularly old-growth silver fir, throughout montane forests in Oregon and Washington, becomes rare in northern California, where it is only known from old-growth white fir at high elevations. It rated with an 80 percent or greater likelihood of attaining outcome A for all but Options 7 and 8, which rated at an 80 or greater likelihood of attaining outcome B or better.

Racomitrium pacificum occurs sporadically on perennially moist, partially-shaded rocks in humid old-growth forests at low elevations (Frisvoll 1988), usually near streams. It occurs primarily in coastal forest, but is found more commonly under Douglas fir than Sitka spruce. It rated with an 80 percent or greater likelihood of attaining outcome B or better for all options.

Schistostega pennata is known in the region only from Washington, where it occurs on soil in dark, moist crevices under root wads of fallen trees. It can also occur on rock in dark, moist crevices, and caves. It rated with an 80 percent or greater likelihood of attaining outcome A for all options.

Tritomaria exsectiformis and *Tritomaria quinquedentata* occur on shaded moist soil or rocks (Hong et al. 1989), from low to high elevation. In Oregon, *Tritomaria exsectiformis* occurs primarily in riparian areas. It rated with an 80 percent or greater likelihood of outcome D or better for all options. A similar species *Tritomaria quinquedentata* is known in Oregon only from Saddle Mountain State Park in the northern Coast Range and it was not rated.

Species not Rated: Sixteen species were not rated due to a lack of either sufficient ecological or distributional knowledge to properly evaluate and rate them at this time.

Discussion. In general, the ratings for the species groups indicate that bryophyte diversity in old-growth forests within the region is greatest in three general habitats: (1) streams and riparian zones, (2) bases of shaded rock outcrops, and (3) trees on summits and along ridgelines subject to fog interception. Most species of bryophytes closely associated with old-growth forests require the shaded and moist microclimates provided in these sites. Nearly all the liverworts are more sensitive to desiccation than mosses. There is significant overlap in optimal habitat requirements for bryophytes and amphibians.

The common, widely distributed species rated with nearly an 80 percent or greater likelihood of attaining outcome A under all options. Options 1, 3, 4, 5, and 9 consistently rated higher than Options 7 and 8 for most bryophytes (table IV-19). Four extremely rare species have outcomes of less than 80 percent likelihood of attaining outcome B or better. These ratings do not vary by option and are not primarily reflective of option design.

The riparian prescriptions in all options except 7 and 8 caused the ratings for the majority of the bryophyte groups to be near an 80 percent or greater likelihood of attaining outcome A. However, riparian buffer widths were often inadequate to protect the "flood plain bryophytes" that occur in stream terraces. In addition, intermittent streams are extremely important habitat for bryophytes, and adequate buffers should be extended to these areas in all watersheds.

Bryophyte groups associated with rock outcrops and soil had somewhat lower ratings for those options that afforded less protection to shaded rock outcrops and fog-prone summits. These sites are habitat for some of the rarest bryophytes in the region, particularly the coastal fog-drenched peaks. They may be impacted by ridgeline roads, landings, trails, and telecommunication towers. However, the ratings of these rare species should be accorded less significance because by definition the species already have significant gaps in their distributions, and populations are isolated from one another. In most cases, this scattered distribution seems to have been the historical distribution.

Mitigation for Bryophytes

Bryophytes should receive considerable protection under riparian prescriptions, especially those with full SAT riparian buffers. However, protection for some bryophytes should be extended to encompass the entire floodplain because considerable species diversity exists on stream terraces that may extend beyond one or two tree lengths. Large areas in the floodplains have been lost to roads. Some of these roads should be removed from the stream terraces. Riparian stands older than 80 years should not be thinned or harvested.

Commercial collecting of the special forest product "moss" or "decaying wood" should not be permitted in any Reserve area or in the riparian buffers under any of the options. These mosses buffer water and nutrient loading. Harvesting of special forest products in the Matrix should be regulated for sustained yields.

The following specific mitigation measures for bryophytes should raise the probability of the group or species attaining outcome A to greater than 80 percent rating. For bryophytes that occur on shaded rock outcrops with thin soil, the base of rock outcrops could be buffered by retaining protective clumps of green trees (two to three tree lengths) around each rock outcrop. These buffers will protect the shaded microclimate needed for these species.

Longer rotations in the Matrix would provide a variety of age and diameter classes. Additional green tree retention in some options will help maintain recruitment of large woody debris essential for bryophytes that thrive on decaying wood. Clumped retention of green trees in the Matrix would provide appropriate microclimate for bryophytes to survive. Large riparian buffers, as proposed in Thomas et al. (1993), that includes small and intermittent streams, are essential to maintain suitable substrate. Retention of coarse woody debris in harvest units will provide suitable habitat for species requiring this substrate.

Rare species: Four extremely rare species have outcomes of less than 80 percent likelihood of attaining outcome B or better. These ratings do not vary by option and are not primarily reflective of option design. Important mitigation for these species for all options is conducting surveys and protecting locations where these rare species occur.

Intensive inventories should be conducted to locate additional populations of these species and to provide data for species management guidelines, as is done for vascular plants. Populations of rare bryophytes should be protected and monitored to determine successional status and population trends. More acreage of old-growth Sitka spruce forests should be managed in the coastal areas. Cold springs need to be recognized as important resources for biological diversity. Water pollution from sewage and motorboats at Waldo Lake could negatively impact the population of *Marsupella emarginata* var. *aquatica.* For *Schistostega pennata,* windfalls need to be left in place to provide structurally diverse habitat. Windfirm buffers of trees along fog-drenched ridges would maintain biological diversity.

Role of nonfederal lands. There is little habitat for late-successional/old-growth bryophyte species on private lands in the region. Most of the old-growth coniferous forest on private lands within the range of the northern spotted owl has been logged, and the landscape currently is being managed on relatively short (30-70 year) rotations. There will be little chance for survival or effective dispersal of most bryophytes in such a landscape. Survival of other species at lower elevations in nonconiferous habitats (e.g., *Antitrichia curtipendula* in oak stands in the Willamette Valley) is equally in doubt. Many of these oak stands are being converted to agricultural or residential developments. Potential declines in air quality may further affect this species.

The bryophytes of the aquatic habitat group are affected by sedimentation, temperature change, hydroelectric projects, mining, and nonpoint source pollution that can occur on state and private lands. These species are sensitive to such changes.

State lands, and state parks especially, provide a brighter picture for viability, particularly in the coastal Sitka spruce region. Many of these parks contain the last remnant of old-growth forests. Saddle Mountain State Park in Oregon, a high peak with a fog-drenched summit, hosts some of the rarest bryophytes in the Pacific Northwest. Unfortunately, these sites also may be impacted by declining air quality, although not so severely as parks in the interior valleys or Cascade foothills.

Research and information needs. Bryophyte research needs include basic inventory, status reviews of rare species, monitoring, ecosystem function, nutrient cycling, and sustainable moss harvest studies.

Baseline inventories to document species presence, abundance, biomass, habitat requirements, and geographic distribution are needed. Methods for sampling forest epiphytes need to be standardized. Identifications should be verified with voucher collections deposited in herbaria. The taxonomic status of many rare bryophyte species needs to be clarified. Land management agencies should conduct status surveys on rare bryophyte species and special habitats. This information needs to be shared with the state Natural Heritage Programs, which track species information and occurrences across all land ownerships. Conservation strategy plans should be developed for rare species to enhance their viability through specific mitigation, standards and guidelines, and designation of reserves. Establishment of small, site-specific special interest areas for rare bryophytes is needed to conserve the diversity of these species. The land-management agencies should provide training opportunities for field personnel in bryophyte taxonomy, and coordinate with bryologists to develop monitoring and inventory protocols.

Monitoring of rare bryophytes and their habitats is needed on a regional basis. Permanent, long term study plots of bryophyte population trends should be established on a regional basis. Key bryophyte indicator species should be identified for monitoring water quality. Use of mosses and liverwort species as indicators of microclimatic changes caused by forest management actions should be developed. Succession patterns of liverwort species on large decaying wood should be investigated. Interspecific relationships among bryophytes and their symbiont species need to be studied.

Ongoing forest management studies should include the effects of various silvicultural practices on the epiphytic and coarse woody debris species of bryophytes. Research on moss species used for nesting sites of marbled murrelets and those selected by flying squirrels should be conducted.

The special forest products market for bryophytes needs to be studied and regulated. Management should determine which species, locations, forest types and quantities of bryophytes that are being harvested. The effects of the harvest on forest functions such as nutrient cycling, water regulation, soil moisture retention, invertebrate habitat, and seedbed formation for vascular plants should be investigated.

Vascular Plants

The largest and most dominant organisms of the late-successional and old-growth forest ecosystem are the vascular plants, which may tower over 300 feet, with lifespans over 1,000 years. They create the structure of the forest and function as the primary producers, capturing sunlight through photosynthesis and converting its energy to foods consumed by animals and fungi. Ranging from the dominant conifers to the delicate ferns, vascular plants are defined as those that contain conducting or vascular tissue. They include seed-bearing plants (flowering plants and conifers) and spore-bearing forms, such as ferns, horsetails, and clubmosses. In general, vascular plants provide substrate and habitat for other organisms, influence microclimate (e.g., sunlight, humidity, temperature, and interception of snow and rainfall), and provide forage, hiding, and thermal cover for vertebrate and invertebrate species. They produce litterfall that contributes to organic matter and soil development. Many species are symbiotic with mycorrhizal fungi and other vascular plants (e.g., mycotrophic ericads and orchids), while others fix nitrogen (e.g., alder, ceanothus, members of the pea family).

Trees provide nesting and denning habitat for a wide range of birds and mammals. For example, trees colonized by dwarf mistletoe develop dense broom-like structures that are utilized by northern spotted owls and flying squirrels. When trees fall, they provide habitat for invertebrates, lichens, mosses, fungi, amphibians, and small mammals. Many vascular plants have close relationships with specific animal pollinators and seed dispersers, which facilitate plant gene flow through pollen and seed dispersal, and provide a food source for animal vectors.

In addition to their vital role in maintaining a functioning forest ecosystem, vascular plants provide important commercial resources, including both timber and other special forest products. Harvest of medicinal, horticultural, and edible plants from Pacific Northwest forests has increased dramatically in recent years. The total annual wholesale value of floral and holiday greens, Christmas trees, edible, medicinal, and landscaping plants in the Pacific Northwest is estimated at $174 million (J. Freed and J. Myer, Washington State University, 1993, personal communication). In addition to the timber species, commercially important vascular plants include beargrass, salal, huckleberry, sword-fern, Pacific yew, and cascara. Many additional species are harvested on a smaller scale.

The vascular flora of the Western United States is highly diverse. In Washington, Oregon, and California, the number of recorded taxa (including species, varieties, and subspecies) is 4,302, 5,343, and 7,700, respectively (K. Urban, U.S. Forest Service, 1993, personal communication; Smith 1987). Within the range of the northern spotted owl, several important areas of high diversity are recognized that feature plants restricted to narrow geographical areas. The Klamath Province, the Columbia River Gorge, and the

Olympic and Wenatchee Mountains are among the areas with high endemism. Several rare species are restricted to the coastal redwood forests. Rare and local plants are often restricted to peculiar soils, such as those developed from ultramafic rocks in southwestern Oregon, northern California, and the Wenatchee Mountains of Washington, and to special habitats, such as rock outcrops, bogs, and wetlands.

While hundreds of vascular plant species occur in late-successional forests in the Pacific Northwest, less than 130 species are considered closely associated with this seral stage. In addition to the obvious dominance of the conifers, many other families are well represented (appendix table IV-A-4). Numerous species of heaths and orchids are closely associated with late-successional forest, and both groups have photosynthetic and nongreen representatives. The nonphotosynthetic species, such as fringed pinesap and coralroot orchid, are characterized by complex, symbiotic relationships involving both fungi and photosynthetic vascular plants (Wells 1981, Furman and Trappe 1971). Of the species considered closely associated with late-successional and old-growth forest, 29 have federal, state, or agency status.

At least 200 additional species occur within special habitats such as serpentine barrens, bogs, and wetlands within the range of the northern spotted owl. These species and their habitats may be affected by forest management, but are not specifically addressed in this report. At least 54 of these special habitat species have status as federally listed or candidate species.

Whereas many vascular plants colonize habitat quickly and have short reproductive cycles, most species closely associated with late-successional and old-growth forests are long-lived perennials. Many woody and herbaceous vascular plants are extremely long-lived, and decades may be required before plants reach reproductive size (Hanzawa and Kalisz 1993). Recolonization of disturbed areas and establishment may be slow, particularly for species with limited dispersal and special requirements. Many rare plants are characterized by low seedling production (Crowder 1978; Fredricks 1992). Recruitment of young plants into populations is often limited by low seed production, high seed predation, limited numbers of "safe sites", and competition from other species.

Methods specific to vascular plants. The "short list" of vascular plant species in the Scientific Analysis Team Report (Thomas et al. 1993, appendix 5-B) formed the basis of the list developed for this analysis. Species that met the criteria of close association with old growth as defined by the Scientific Analysis Team (Thomas et al. 1993) in any significant portion of their range were included.

The present list was developed with input from botanists with the Bureau of Land Management, Oregon Department of Agriculture Plant Conservation Biology Program, U.S. Fish and Wildlife Service, National Park Service, Oregon State University, Humboldt State University, Berry Botanic Garden, Pacific Northwest Experimental Station, Pacific Southwest Experiment Station, Southern Oregon College, University of Washington, The Nature Conservancy, University of Oregon, the Pacific Northwest and Pacific Southwest Regions of the U.S. Forest Service, and the Heritage Programs of Washington, Oregon, and California. Twenty-five species not evaluated in the Scientific Analysis Team Report (Thomas et al. 1993) were added. Nine species considered in the Scientific Analysis Team Report were found not to meet the criteria of close association with late-successional and old-growth forests and were omitted from this analysis. While the list is fairly comprehensive, it is possible that further study and new information may justify inclusion of additional species.

The vascular plant panel included six professional botanists whose knowledge of the vascular plant flora spanned the geographic range of the northern spotted owl. A total of 124 vascular plant species were evaluated based on the projected future condition of habitat on federal lands (outcomes A-D, see Methods for assessing effects of options). Four other species were not rated. Seven species that exhibited different ecological characteristics in different portions of their range were rated separately based on geographical areas.

Maps illustrating the locations of populations of 19 threatened, endangered, and sensitive plants tracked by the state Natural Heritage Programs were overlayed on the 1:500,000 scale maps of the withdrawn and Reserve areas being considered in the analysis. The species maps included both historic localities and current occurrences. The number and percentage of known populations that occur within various Reserve areas and the Matrix were also calculated by option and used in this analysis.

Rare and geographically restricted (endemic) species were identified and treated separately in some analyses. In this report, rare species include those with state, federal, or agency status as threatened, endangered, or sensitive, as well as those that are infrequently encountered (e.g., *Allotropa virgata*).

Results. Average ratings for vascular plant habitat varied considerably among options (table IV-20; fig. IV-9). A total of 110 vascular plant species or species ranges (84 percent) received greater than 80 percent likelihood of having habitat of sufficient quality, distribution, and abundance to allow populations to stabilize well-distributed across federal lands within their natural geographic range (outcome A) in Option 1, while only 78 species or species ranges (59 percent) received the same rating under Option 7. Ratings among Options 3, 4, and 5 were similar (fig. IV-9). Option 9 tended to have likelihoods of achieving outcome A that were lower than Options 3, 4, and 5 and higher for most species than for Options 7 and 8. Options 7 and 8 consistently received the lowest ratings.

In general, ratings tended to be lowest for rare species that were geographically restricted (e.g., *Aster vialis*) or sparsely distributed throughout a larger range (e.g., *Allotropa virgata, Cypripedium fasciculatum*) (table IV-20). Because rare species are often restricted to localized areas, the Reserve areas in this analysis afforded different degrees of protection to individual species. The Late-Successional Reserve areas in Option 1 provide greatest protection to the 19 rare species tracked by state Natural Heritage Programs; 83 percent of the populations tabulated occurred in these areas (table IV-21). In Options 7 and 9, 55 and 53 percent, respectively, of the populations are within Late-Successional Reserves.

Many of the populations of *Poa laxiflora* (86 percent) and *Cimicifuga elata* (23 percent) occur within 50 miles of salt water. Of the populations of *Collomia mazama*, 43 percent occur within Administratively and Congressionally Withdrawn Areas. Key Watersheds are important for both riparian and upland species including *Botrychium montanum, Coptis trifolia, Corydalis aquae-gelidae, Frasera umpquaensis*, and *Pleuricospora fimbriolata*.

Table IV- 20. Projected future likelihoods of habitat outcomes for vascular plants under land management options.

Vascular Plants	Option 1				Option 3				Option 4				Option 5				Option 7				Option 8				Option 9			
	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
Abies lasiocarpa (California)	50	13	38	0	50	13	38	0	50	13	38	0	50	13	38	0	50	13	38	0	50	13	38	0	50	13	38	0
Achlys triphylla	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	85	15	0	0	82	19	0	0	97	4	0	0
Adenocaulon bicolor	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	95	5	0	0	95	5	0	0	100	0	0	0
Adiantum pedatum	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	92	8	0	0	92	8	0	0	98	2	0	0
Adiantum jordanii	100	0	0	0	78	23	0	0	78	23	0	0	75	25	0	0	68	33	0	0	68	33	0	0	78	23	0	0
Allotropa virgata	62	34	4	0	34	53	13	0	34	53	13	0	33	51	17	0	19	52	25	4	28	52	17	4	28	53	16	4
Anemone deltoidea	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	92	9	0	0	92	9	0	0	98	2	0	0
Apocynum pumilum	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	75	25	0	0	90	10	0	0	90	10	0	0
Aralia californica	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	87	13	0	0	87	13	0	0	94	6	0	0
Arceuthobium tsugense	0	80	20	0	0	80	20	0	0	80	20	0	0	60	40	0	0	50	50	0	0	50	50	0	0	50	50	0
Arnica latifolia	100	0	0	0	100	0	0	0	100	0	0	0	98	2	0	0	93	7	0	0	98	2	0	0	100	0	0	0
Asarum caudatum	97	4	0	0	87	14	0	0	88	12	0	0	87	14	0	0	81	19	0	0	82	18	0	0	87	14	0	0
Asarum hartwegii	100	0	0	0	93	7	0	0	87	13	0	0	83	17	0	0	72	28	0	0	75	25	0	0	83	17	0	0
Asarum marmoratum	80	20	0	0	60	40	0	0	60	40	0	0	60	40	0	0	60	40	0	0	60	40	0	0	60	40	0	0
Asarum wagneri	100	0	0	0	100	0	0	0	90	10	0	0	90	10	0	0	80	20	0	0	80	20	0	0	90	10	0	0
Aster vialis	0	61	39	0	0	61	39	0	0	59	41	0	0	56	44	0	0	26	74	0	0	26	74	0	0	48	53	0
Bensoniella oregana (California)	90	10	0	0	0	0	50	50	0	0	50	50	0	0	50	50	0	0	50	50	0	0	50	50	0	0	50	50
Bensoniella oregana (Oregon)	78	23	0	0	68	33	0	0	73	28	0	0	63	38	0	0	31	43	26	0	31	43	26	0	58	33	10	0
Berberis pumila	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	95	5	0	0	98	3	0	0	100	0	0	0
Boschniakia strobilacea	88	12	0	0	80	20	0	0	80	20	0	0	80	20	0	0	58	33	8	0	62	30	8	0	80	20	0	0
Botrychium minganense	30	58	12	0	30	50	20	0	30	50	20	0	30	50	20	0	30	43	27	0	30	43	27	0	30	50	20	0
Botrychium montanum	30	58	12	0	30	50	20	0	30	50	20	0	30	50	20	0	30	43	27	0	30	43	27	0	30	50	20	0
Botrychium virginanum	63	32	5	0	58	35	7	0	58	37	5	0	54	39	7	0	48	32	20	0	48	32	20	0	52	41	7	0
Calypso bulbosa	90	10	0	0	86	14	0	0	86	14	0	0	86	14	0	0	80	16	4	0	82	14	4	0	84	16	0	0
Chamaecyparis lawsoniana (north)	87	7	7	0	80	13	7	0	80	13	7	0	77	17	7	0	60	27	13	0	60	27	13	0	77	17	7	0
Chamaecyparis lawsoniana (south)	80	10	10	0	60	30	10	0	60	30	10	0	60	30	10	0	30	50	20	0	30	50	20	0	60	30	10	0
Chamaecyparis nootkatensis	100	0	0	0	98	2	0	0	98	2	0	0	98	2	0	0	93	7	0	0	93	7	0	0	98	2	0	0
Chimaphila menziesii	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	92	8	0	0	94	6	0	0	98	2	0	0
Chimaphila umbellata	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	92	8	0	0	94	6	0	0	98	2	0	0
Cimicifuga elata	69	21	10	0	53	36	11	0	50	39	11	0	48	41	11	0	29	40	31	0	34	38	29	0	48	40	13	0

A-Well Distributed B-Locally Restricted C-Restricted to Refugia D-Extirpation

Likelihood values are expressed as percentages that total to 100 for a given species within an option. Numbers displayed may vary due to rounding errors. See text for fuller explanation and discussion of the rating scale.

Table IV- 20 (cont). Projected future likelihoods of habitat outcomes for vascular plants under land management options.

Vascular Plants	Option 1				Option 3				Option 4				Option 5				Option 7				Option 8				Option 9			
	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
Cimicifuga laciniata	100	0	0	0	90	10	0	0	90	10	0	0	90	10	0	0	80	20	0	0	80	20	0	0	90	10	0	0
Clintonia andrewsiana	80	20	0	0	70	27	3	0	70	27	3	0	70	27	3	0	57	33	10	0	60	30	10	0	70	27	3	0
Clintonia uniflora	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	93	8	0	0	93	8	0	0	98	2	0	0
Collomia mazama	100	0	0	0	85	15	0	0	85	15	0	0	85	15	0	0	70	30	0	0	70	30	0	0	85	15	0	0
Coptis asplenifolia	0	10	90	0	0	10	90	0	0	10	90	0	0	10	90	0	0	0	90	10	0	0	90	10	0	10	90	0
Coptis laciniata	98	3	0	0	93	8	0	0	93	8	0	0	90	10	0	0	71	29	0	0	71	29	0	0	83	18	0	0
Coptis trifolia	50	30	20	0	30	30	40	0	30	30	40	0	30	30	40	0	0	30	40	30	0	30	40	30	20	30	50	0
Corallorhiza maculata	98	2	0	0	97	3	0	0	97	3	0	0	97	3	0	0	86	14	0	0	88	13	0	0	95	5	0	0
Corallorhiza mertensiana	98	2	0	0	97	3	0	0	97	3	0	0	97	3	0	0	88	13	0	0	89	11	0	0	95	5	0	0
Corallorhiza striata	98	2	0	0	98	2	0	0	97	3	0	0	97	3	0	0	88	13	0	0	89	11	0	0	95	5	0	0
Corydalis aquae-gelidae	20	49	31	0	17	47	37	0	20	49	31	0	10	48	40	2	2	32	57	10	2	30	58	10	10	48	40	2
Cypripedium fasciculatum (Cascades)	0	28	38	33	0	17	43	40	0	17	43	40	0	17	40	43	0	8	40	52	0	8	37	55	0	8	37	55
Cypripedium fasciculatum (Klamath)	50	40	10	0	15	50	20	15	15	50	20	15	5	55	30	10	0	40	35	25	0	43	38	20	0	43	38	20
Cypripedium montanum (east Cascades)	0	75	25	0	0	50	50	0	0	50	50	0	0	50	50	0	0	25	50	25	0	25	50	25	0	25	75	0
Cypripedium montanum (west Cascades)	12	33	41	14	0	25	50	25	0	25	48	27	0	23	50	27	0	14	42	44	0	17	41	42	0	21	52	27
Dentaria californica	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	95	5	0	0	95	5	0	0	100	0	0	0
Disporum hookeri	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	92	8	0	0	92	8	0	0	98	2	0	0
Disporum smithii	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	91	9	0	0	91	9	0	0	98	2	0	0
Dryopteris austriaca	100	1	0	0	100	1	0	0	100	1	0	0	100	1	0	0	87	13	0	0	87	13	0	0	95	6	0	0
Eburophyton austiniae	83	8	8	0	83	8	8	0	83	8	8	0	83	8	8	0	76	11	13	0	78	9	13	0	82	5	13	0
Erythronium montanum	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	97	3	0	0	97	3	0	0	100	0	0	0
Frasera umpquaensis	78	20	3	0	65	33	3	0	65	33	3	0	63	35	3	0	33	51	16	0	33	51	16	0	60	35	5	0
Galium kamtschaticum	0	90	10	0	0	90	10	0	0	90	10	0	0	70	30	0	0	70	30	0	0	70	30	0	0	70	30	0
Galium oreganum (Klamath)	98	3	0	0	98	3	0	0	98	3	0	0	93	8	0	0	85	15	0	0	88	13	0	0	93	8	0	0
Gaultheria humifusa	95	5	0	0	95	5	0	0	95	5	0	0	90	10	0	0	85	15	0	0	85	15	0	0	85	15	0	0
Gaultheria ovatifolia	98	2	0	0	98	2	0	0	98	2	0	0	98	2	0	0	94	6	0	0	96	4	0	0	98	2	0	0
Goodyera oblongifolia	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	95	5	0	0	97	4	0	0	98	2	0	0
Gymnocarpium dryopteris	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	96	4	0	0	96	4	0	0	100	0	0	0
Habenaria orbiculata	0	100	0	0	0	80	20	0	0	80	20	0	0	80	20	0	0	50	50	0	0	50	50	0	0	50	50	0
Habenaria saccata	100	0	0	0	98	2	0	0	98	2	0	0	98	2	0	0	91	9	0	0	91	9	0	0	96	4	0	0

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Table IV- 20 (cont). Projected future likelihoods of habitat outcomes for vascular plants under land management options.

Vascular Plants	Option 1				Option 3				Option 4				Option 5				Option 7				Option 8				Option 9			
	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
Habenaria unalascensis	100	0	0	0	98	3	0	0	98	3	0	0	98	3	0	0	94	6	0	0	94	6	0	0	98	3	0	0
Hemitomes congestum	82	18	0	0	69	23	8	0	69	23	8	0	63	29	8	0	52	29	19	0	57	24	19	0	58	26	16	0
Hierochloe occidentalis	100	0	0	0	92	8	0	0	92	8	0	0	88	12	0	0	72	28	0	0	72	28	0	0	87	13	0	0
Hypopitys monotropa	90	10	0	0	69	23	8	0	69	23	8	0	66	26	8	0	55	29	16	0	58	26	16	0	62	28	10	0
Isopyrum hallii	80	20	0	0	70	30	0	0	70	30	0	0	70	30	0	0	60	40	0	0	60	40	0	0	70	30	0	0
Lathyrus polyphyllus	100	0	0	0	95	5	0	0	95	5	0	0	95	5	0	0	89	11	0	0	91	9	0	0	95	5	0	0
Listera borealis	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	90	10	0	0	90	10	0	0	100	0	0	0
Listera caurina	98	3	0	0	96	4	0	0	96	4	0	0	91	9	0	0	84	16	0	0	89	11	0	0	88	13	0	0
Listera convallarioides	97	3	0	0	95	5	0	0	95	5	0	0	88	12	0	0	83	17	0	0	90	10	0	0	83	17	0	0
Listera cordata	100	0	0	0	99	1	0	0	99	1	0	0	96	4	0	0	87	13	0	0	91	9	0	0	92	9	0	0
Luzula hitchcockii	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	96	4	0	0	96	4	0	0	100	0	0	0
Lycopodium selago	93	7	0	0	83	17	0	0	83	17	0	0	80	20	0	0	73	27	0	0	73	27	0	0	83	17	0	0
Lysichiton americanum	100	0	0	0	98	2	0	0	98	2	0	0	97	4	0	0	93	7	0	0	93	7	0	0	96	4	0	0
Melica subulata	98	2	0	0	98	2	0	0	98	2	0	0	98	2	0	0	96	4	0	0	97	3	0	0	98	2	0	0
Menziesia ferruginea	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	91	9	0	0	91	9	0	0	100	0	0	0
Mitella breweri	97	3	0	0	97	3	0	0	97	3	0	0	97	3	0	0	90	10	0	0	90	10	0	0	97	3	0	0
Mitella caulescens	98	3	0	0	95	5	0	0	98	3	0	0	95	5	0	0	86	14	0	0	86	14	0	0	95	5	0	0
Mitella ovalis	98	2	0	0	97	3	0	0	98	2	0	0	97	3	0	0	89	11	0	0	89	11	0	0	95	5	0	0
Mitella pentandra	97	3	0	0	93	7	0	0	93	7	0	0	93	7	0	0	87	13	0	0	87	13	0	0	90	10	0	0
Mitella trifida	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	85	15	0	0	85	15	0	0	90	10	0	0
Monotropa uniflora	89	11	0	0	70	25	5	0	70	25	5	0	62	28	10	0	58	30	12	0	60	28	12	0	63	27	10	0
Oxalis oregana	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	98	2	0	0	98	2	0	0	100	0	0	0
Oxalis trilliifolia	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	88	13	0	0	88	13	0	0	100	0	0	0
Pedicularis howellii	85	15	0	0	40	45	15	0	40	45	15	0	40	45	15	0	20	30	40	10	25	25	35	15	30	40	25	5
Phlox adsurgens	100	0	0	0	96	4	0	0	96	4	0	0	96	4	0	0	88	13	0	0	88	13	0	0	95	5	0	0
Picea breweriana	83	17	0	0	82	18	0	0	82	18	0	0	82	18	0	0	67	23	10	0	68	22	10	0	82	18	0	0
Pityopis californica	92	8	0	0	78	22	0	0	78	22	0	0	78	22	0	0	60	33	7	0	70	23	7	0	73	23	3	0
Pleuricospora fimbriolata	88	12	0	0	78	22	0	0	78	22	0	0	76	24	0	0	60	33	7	0	63	30	7	0	72	27	2	0
Poa laxiflora (Cascade)	85	15	0	0	70	30	0	0	80	20	0	0	70	30	0	0	55	35	10	0	55	35	10	0	70	30	0	0
Poa laxiflora (Coast)	90	10	0	0	83	17	0	0	83	17	0	0	83	17	0	0	60	40	0	0	60	40	0	0	83	17	0	0

A-Well Distributed B-Locally Restricted C-Restricted to Refugia D-Extirpation

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Table IV- 20 (cont). Projected future likelihoods of habitat outcomes for vascular plants under land management options.

Vascular Plants	Option 1				Option 3				Option 4				Option 5				Option 7				Option 8				Option 9			
	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
Polystichum californicum (Cascades)	100	0	0	0	78	23	0	0	73	28	0	0	73	28	0	0	50	50	0	0	63	38	0	0	73	28	0	0
Pterospora andromedea	82	18	0	0	78	23	0	0	78	23	0	0	73	28	0	0	62	33	6	0	64	30	6	0	73	28	0	0
Pyrola asarifolia	100	0	0	0	99	1	0	0	99	1	0	0	97	3	0	0	89	11	0	0	91	9	0	0	95	5	0	0
Pyrola chlorantha	97	3	0	0	97	3	0	0	97	3	0	0	93	7	0	0	90	10	0	0	93	7	0	0	93	7	0	0
Pyrola dentata	100	0	0	0	95	5	0	0	95	5	0	0	93	8	0	0	81	19	0	0	84	16	0	0	93	8	0	0
Pyrola picta	98	2	0	0	98	2	0	0	98	2	0	0	97	3	0	0	90	10	0	0	92	8	0	0	95	5	0	0
Pyrola secunda	100	0	0	0	99	1	0	0	99	1	0	0	97	3	0	0	91	9	0	0	92	8	0	0	95	5	0	0
Pyrola uniflora	93	7	0	0	87	13	0	0	87	13	0	0	83	17	0	0	75	25	0	0	78	22	0	0	87	13	0	0
Rubus lasiococcus	100	0	0	0	99	2	0	0	99	2	0	0	99	2	0	0	95	5	0	0	95	5	0	0	97	3	0	0
Rubus nivalis	98	2	0	0	94	6	0	0	94	6	0	0	92	8	0	0	86	14	0	0	89	11	0	0	90	10	0	0
Rubus pedatus	100	1	0	0	100	1	0	0	100	1	0	0	95	6	0	0	95	6	0	0	95	6	0	0	100	1	0	0
Sarcodes sanguinea	73	21	6	0	64	24	13	0	64	24	13	0	61	26	13	0	53	33	15	0	58	28	15	0	60	28	13	0
Satureja douglasii	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	93	8	0	0	93	8	0	0	100	0	0	0
Scoliopus biglovei	100	0	0	0	73	28	0	0	73	28	0	0	73	28	0	0	55	45	0	0	55	45	0	0	65	35	0	0
Scoliopus hallii	100	0	0	0	90	10	0	0	98	3	0	0	90	10	0	0	78	23	0	0	78	23	0	0	90	10	0	0
Selaginella oregana	60	33	7	0	53	40	7	0	53	40	7	0	53	40	7	0	47	47	7	0	47	47	7	0	53	40	7	0
Smilacina racemosa	100	0	0	0	99	1	0	0	99	1	0	0	99	1	0	0	95	5	0	0	95	5	0	0	97	4	0	0
Smilacina stellata	100	0	0	0	99	1	0	0	99	1	0	0	99	1	0	0	95	5	0	0	95	5	0	0	97	4	0	0
Streptopus amplexifolius	100	0	0	0	99	1	0	0	99	1	0	0	99	1	0	0	93	7	0	0	93	7	0	0	97	4	0	0
Streptopus roseus	100	0	0	0	97	3	0	0	97	3	0	0	97	3	0	0	86	14	0	0	86	14	0	0	95	5	0	0
Streptopus streptopoides (Oregon)	95	5	0	0	80	20	0	0	80	20	0	0	80	20	0	0	60	40	0	0	60	40	0	0	80	20	0	0
Streptopus streptopoides (Washington)	90	10	0	0	90	10	0	0	90	10	0	0	90	10	0	0	90	10	0	0	90	10	0	0	90	10	0	0
Synthyris schizantha	97	3	0	0	97	3	0	0	97	3	0	0	97	3	0	0	93	7	0	0	93	7	0	0	97	3	0	0
Taxus brevifolia (entire range)	97	4	0	0	93	7	0	0	93	7	0	0	92	9	0	0	78	22	0	0	80	20	0	0	87	14	0	0
Taxus brevifolia (NW California)	80	20	0	0	60	40	0	0	60	40	0	0	60	40	0	0	40	60	0	0	40	60	0	0	40	60	0	0
Thuja plicata	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	98	2	0	0	98	2	0	0	98	2	0	0
Tiarella trifoliata	100	0	0	0	97	3	0	0	99	1	0	0	97	3	0	0	95	5	0	0	95	5	0	0	97	3	0	0
Tiarella unifoliata	100	0	0	0	97	3	0	0	99	1	0	0	97	3	0	0	95	5	0	0	95	5	0	0	97	3	0	0
Trillium ovatum	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	98	2	0	0	98	2	0	0	100	0	0	0
Vaccinium alaskaense	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	98	3	0	0	98	3	0	0	100	0	0	0

A-Well Distributed B-Locally Restricted C-Restricted to Refugia D-Extirpation

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Table IV- 20 (cont). Projected future likelihoods of habitat outcomes for vascular plants under land management options.

Vascular Plants	Option 1				Option 3				Option 4				Option 5				Option 7				Option 8				Option 9			
	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
Vaccinium membranaceum	100	0	0	0	99	1	0	0	99	1	0	0	99	1	0	0	98	2	0	0	99	1	0	0	99	1	0	0
Vaccinium ovalifolium	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0
Vaccinium parvifolium	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0
Vancouveria hexandra	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	97	4	0	0	97	4	0	0	100	0	0	0
Vancouveria planipetala	97	3	0	0	88	12	0	0	87	13	0	0	85	15	0	0	75	25	0	0	75	25	0	0	88	12	0	0
Vicia americana var. villosa	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	98	2	0	0	98	2	0	0	100	0	0	0
Viola glabella	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	96	4	0	0	96	4	0	0	97	3	0	0
Viola orbiculata	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	97	3	0	0	97	3	0	0	100	0	0	0
Viola renifolia	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	95	5	0	0	95	5	0	0	100	0	0	0
Whipplea modesta	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	98	2	0	0	98	2	0	0	100	0	0	0
Xerophyllum tenax (Olympic Penisula)	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0

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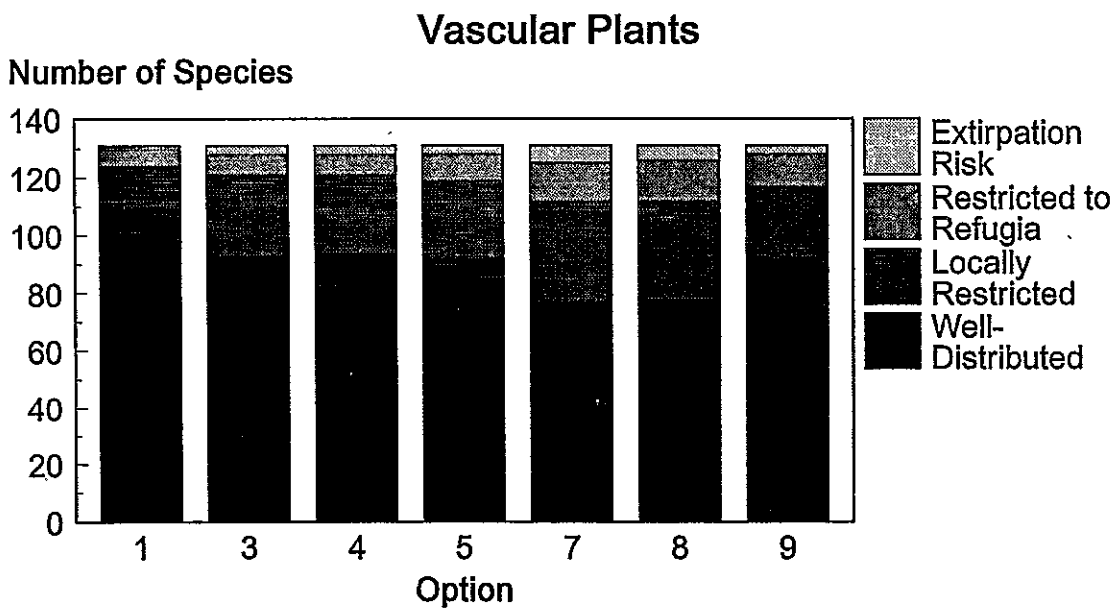

Figure IV-9. Outcomes for vascular plants under each land management option. Values shown are the number of species/species ranges that had an 80 percent or greater likelihood of achieving at least the specified outcome (based on distribution of habitat).

Only two species were considered to have risk of extirpation under Option 1, and for those only within portions of their range (*Cypripedium fasciculatum* in the Cascades Province and *C. montanum* in the Western Cascades). Three species were considered to have greater than 40 percent likelihood of extirpation under Option 7 (*Bensoniella oregana* in California, *Cypripedium fasciculatum* in the Cascades Province, *Cypripedium montanum* in the Western Cascades).

In Option 1, 22 species or species ranges had less than 80 percent likelihood of achieving outcome A. Five of these species are local endemics, three are on the periphery of their range, and thirteen are rare or uncommon. One species, *Arceuthobium tsugense*, is a parasitic epiphyte found principally on older hemlocks (*Tsuga heterophylla*) and is most abundant in stands generally older than 600 years, particularly in the wetter climatic areas (J. Henderson, 1993, U.S. Forest Service, personal communication). Significant gaps in its historic range currently exist, and panel members predicted that the gaps would persist even under Option 1. Seven species were considered to have no likelihood of achieving outcome A; three of these species (*Coptis asplenifolia, Galium kamtschaticum,* and *Habenaria orbiculata*) are more common to the north. Historic data suggest that two species, *Cypripedium montanum* and *C. fasciculatum*, were previously more common; past forest management activities may have contributed to declines in their populations. It is unlikely that most populations of these two species have retained the potential to interact. Because of their extremely slow growth rate, complex symbiotic relationships with other organisms, and possible fire requirements it was concluded that recolonization of these species throughout their former range was unlikely. However, both species fared considerably better in Option 1 than in the other options, in part due to the protection of all the smaller late-successional and old-growth fragments within the Matrix.

Table IV-21. Percent of vascular plant populations within Reserve Areas (R), Managed Late-Successional Areas (MA), Adaptive Management Areas (AA) and Matrix (M) by Option for 19 rare species tracked by Oregon, Washington, and California Natural Heritage Programs. Riparian buffers included in Matrix for this analysis. N = number of federal populations analyzed.

		Option 1		Option 3			Option 4		Option 5		Option 7		Option 8		Option 9		
Species	N	R	M	R	M	MA	R	M	R	M	R	M	R	M	R	M	AA
Asarum wagneri	31	77	23	65	35	0	65	35	45	55	42	58	65	35	52	45	3
Aster vialis	10	60	40	10	70	20	30	70	20	80	20	80	10	90	10	90	0
Bensoniella oregana	64	83	17	66	34	0	66	34	66	34	27	73	66	34	45	55	0
Botrychium minganense	9	89	11	89	11	0	89	11	78	22	78	22	89	11	89	11	0
Botrychium montanum	8	88	12	88	12	0	88	13	75	25	75	25	88	0	100	0	0
Cimicifuga elata	38	82	18	53	39	8	55	45	39	61	34	66	53	47	42	42	16
Collomia mazama	42	90	10	83	12	5	83	17	74	26	74	26	83	17	79	21	0
Coptis asplenifolia	1	100	0	100	0	0	100	0	100	0	100	0	100	0	100	0	0
Coptis trifolia	3	67	33	33	33	33	33	67	33	67	33	67	33	67	33	67	0
Corallorhiza trifida	2	100	0	100	0	0	100	0	100	0	100	0	100	0	100	0	0
Corydalis aquae-gelidae	73	79	21	62	27	11	63	37	48	52	48	52	62	38	37	67	1
Cypripedium fasciculatum	78	79	21	47	35	18	49	51	37	63	35	65	46	54	33	31	36
Frasera umpquaensis	44	91	9	66	27	7	84	16	75	25	73	27	66	34	75	25	0
Galium kamtschaticum	3	100	0	100	0	0	100	0	100	0	100	0	100	0	100	0	0
Lycopodium selago	78	83	17	40	36	24	41	59	33	67	32	68	40	60	42	58	0
Pleuricospora fimbriolata	187	86	14	80	15	5	88	12	80	20	80	20	79	21	63	34	3
Poa laxiflora	85	74	26	69	31	0	73	27	71	29	53	47	69	31	49	18	33
Polystichum californicum	7	71	29	57	29	14	57	43	43	57	43	57	57	43	42	29	29
Streptopus streptopoides	54	85	15	74	17	9	74	26	69	31	67	33	74	26	74	24	2
Total	817	83	17	65	26	9	69	31	61	39	55	45	64	36	53	38	9

In Option 7, 53 species had less than 80 percent likelihood of achieving outcome A. In addition to the 22 species that received a similar outcome in Option 1, two commercially important conifers were included in this category for Option 7. Pacific yew (*Taxus brevifolia*) and Port Orford Cedar (*Chamaecyparis lawsoniana*) would have less than 80 percent likelihood of being well distributed throughout their range under this option.

Under Option 9, 39 species had less than 80 percent likelihood of achieving outcome A. Pacific yew in the Klamath Province and Port Orford Cedar throughout its range are included in this category. Others included seven mycotrophic species, three orchids, one root parasite, and five species of ferns.

Although all the nonphotosynthetic, mycotrophic species fared well under Option 1, as a group they received lower ratings, on average, under the other options compared to other species. This reflects their complex life histories involving fungal symbionts, other vascular plants, and in some cases, unidentified seed disseminators.

Discussion. While relatively few vascular plant species occur only in old-growth, many species reach their highest frequency in late-successional and old-growth stands, and others require habitat components characteristic of old-growth stands. Some species establish only on large rotting logs, while others require specific fungi for germination and growth (e.g., most orchids, some heaths). At least 12 species of nongreen flowering plants are closely associated with late-successional and old-growth forests; most are symbiotic species that require the close relationship between a truffle-forming fungus and a photosynthetic conifer or flowering plant. Ten of these are nonphotosynthetic orchids and ericads and are rarely found in stands less than 80 years old.

Rare species may occur only in rare habitats, they may be very localized, or they may have few individuals; in fact, seven types of rarity are generally recognized (Kruckeberg and Rabinowitz 1985, Rabinowitz et al. 1986). Fifteen species closely associated with late-successional and old-growth forests were considered locally endemic, while 18 species were identified as more widespread, but restricted in habitat or population size throughout their range. In addition, many species may be rare within portions of their ranges. Other rare and endemic species that have narrow habitat specificity were not considered closely associated with late-successional and old-growth forests, but occur within special habitats which may be affected by timber harvest.

The importance of down logs for the establishment of western hemlock seedlings in late-successional and old-growth forest communities has been well documented (Harmon 1986). In addition, some herbaceous species establish primarily on coarse woody debris (e.g., *Pyrola uniflora, Allotropa virgata, Listera borealis*). *Streptopus streptopoides* appears to be completely restricted to rotting wood substrates, leading to the suggestion that fungal interactions may be involved (Kagan and Vrilakas 1993). Quality and quantity of coarse woody debris are therefore necessary for these species; Matrix prescriptions with larger numbers of logs, snags, and green trees per acre may provide future habitat for these and other species.

Some vascular plants require canopy gaps that may have been maintained historically by natural fires caused by lightning (e.g., *Aster vialis, Cimicifuga elata, Frasera umpquaensis*). Fire reduces understory competition, increases light, provides a pulse of available nitrogen, and stimulates germination of some fire-adapted species. The role of fire in the life history of *Cypripedium montanum* and *C. fasciculatum* warrants further investigation. The mechanism remains unclear, but it appears fire is necessary for the maintenance of viable populations of these species. Underburning treatments prescribed in the standards and guidelines were considered in the evaluations. Although these prescriptions may improve habitat for fire-adapted species, site-specific treatments were considered more important than broad scale treatments for these species.

Small fragments of late-successional and old-growth forests may be vital to certain vascular plants with limited dispersal capabilities. Species with ephemeral seeds may be particularly vulnerable to isolation, while those with seed banks are at lower risk. Even small fragments of late-successional forest may serve as genetic Reserves for recolonization of adjacent habitat. Distribution and spacing of fragments are also important for pollen vectors and animal seed dispersers. Presence and distribution of small fragments of late-successional forest stands were considered important in the discussion and rating of species including *Arceuthobium tsugense, Adiantum jordanii, Allotropa virgata, Bensoniella oregana, Clintonia andrewsiana, Coptis trifolia, Corallorhiza striata, Cypripedium fasciculatum, C. montanum, Habenaria orbiculata, Hemitomes congestum, Hypopitys monotropa, Isopyrum hallii, Monotropa uniflora, Pedicularis howellii, Pityopus california, Pterospora andromedea,* and *Scoliopus bigelovii.* Protection of small remnant stands of late-successional and old-growth forest resulted in higher ratings (greater than 15 likelihood points) in Option 1 over other options for most of these species.

At least 12 species closely associated with old-growth typically occur below 3000 feet in elevation, yet low elevation old growth is particularly limited. Remaining small fragments of old-growth forest are especially critical to locally endemic low elevation species, such as *Aster vialis* and *Scoliopus bigelovii.*

Many vascular plants associated with late-successional and old-growth forests occupy upper headwaters, intermittent streams, and seeps within late-successional and old-growth forests. Twenty-nine species that were evaluated occupy riparian and wetland habitats. Many additional species that occur in special habitats, such as bogs, wet meadows, and other wetlands, were not considered for this analysis. Opening of the canopy and disrupting the hydrology of these sites may adversely affect shade-tolerant species. There was some concern that riparian standards and guidelines may be insufficient to protect some riparian-inhabiting species. Those species with highly restricted ranges (e.g., *Bensoniella oregana, Corydalis aquae-gelidae, Scoliopus bigelovii*) received the lowest ratings of the riparian inhabitants, particularly in Options 7 and 8, which had the most limited riparian reserves.

Four species were more widespread north of the range considered here (*Coptis asplenifolia, Coptis trifolia, Galium kamtschaticum,* and *Listera borealis*). Because disjunct populations and populations on the fringe of a species' range may be genetically distinct, populations of these species warrant special protection.

Effects of air pollution and climate change on vascular plants are poorly known. However, concerns were raised regarding other environmental conditions off federal lands for several species. Due to the close restriction of *Bensoniella oregana* to the coastal fog belt, fluctuations and changes in climate could affect its distribution over the next century. The less populations are reduced by management, the more resilient they will be to climatic change and other environmental stresses.

Mitigation for Vascular Plants

General mitigations: General guidelines address maintaining quality habitat necessary to ensure viable populations. The following features need to be defined and maintained: (1) corridors for seed dispersal to facilitate gene exchange, (2) adequate distribution and spacing of old-growth fragments, and (3) viable populations of pollinators and seed dispersers.

Special area designations: The Late-Successional Reserve areas are insufficient to ensure viability of some rare and locally endemic species, such as *Aster vialis, Bensoniella oregana, Cimicifuga elata, Corydalis aquae-gelidae, Frasera umpquaensis, Poa laxiflora,* and *Streptopus streptopoides.* Establishment of special Reserves (e.g., Botanical Special Interest Areas and Areas of Critical Environmental Concern) on federal lands to protect habitat and key populations of species at risk will be necessary. Key habitat and populations of many of these species have been already identified in existing conservation strategies (Cripps 1993; Gamon 1991; Goldenberg 1990; Grenier 1992; Kagan and Vrilakas 1993; Kaye and Kirkland 1993; Lang 1988, USDA Forest Service 1983a, USDA Forest Service 1983b).

Species specific mitigation and habitat treatments: Many rare vascular plants have conservation strategies in preparation, draft, or final form prepared by the Bureau of Land Management and Forest Service, often in conjunction with other cooperators. These documents provide biological and habitat information, management direction, and recommendations for protection and monitoring of key populations. Developing, updating, and implementing conservation strategies for species, species groups, and habitats not provided for by the options, can reduce risk for many sensitive species.

While establishment of special botanical areas or protecting known locations may provide sufficient mitigation for many rare and endemic species, others will require specific management practices to enhance their viability. Some may benefit from prescribed fire (e.g., *Aster vialis, Cypripedium fasciculatum, C. montanum*) while others may be fire-intolerant (e.g., *Taxus brevifolia*, Pacific Yew, USDA Forest Service 1992b). Specific protocols need to be developed to apply fire effectively.

A pathogenic root rot (*Phytophthora lateralis*) has spread through much of the range of Port Orford cedar (*Chamaecyparis lawsoniana*), resulting in the elimination of stands from some habitats and threatening the commercial status of the species throughout its range (Zobel et al. 1985). The root rot has spread from the northern portions of the species range into remote areas, killing trees of all ages. No known genetic resistance or chemical control has been identified. The spores are spread via water or are transported by people, machinery, and animals, and through root grafts (Zobel et al. 1985). Therefore, it is critical for the conservation of this species to close roads and restrict further road construction in watersheds that contain uninfected stands (e.g, inland California populations).

Retention of habitat components: Specific habitat element standards and guidelines in most options include Matrix prescriptions that retain coarse woody debris, green trees, and snags. Coarse woody debris provides a habitat component necessary for vascular plant species that require rotting logs for establishment (e.g., *Allotropa virgata, Pyrola uniflora, Listera borealis, Streptopus streptopoides*). Coarse woody debris in the Matrix without canopy cover, however, may be inferior to that within the closed canopy.

While it may provide future substrate for establishment of these species, removal of the canopy alters the effective microclimate, log decay processes, and fungal associations. It is uncertain how these alterations in large woody debris ecology influence the future utilization of these logs by late-successional and old-growth associated vascular plants.

Mycotrophic species, such as *Pleuricospora fimbriolata,* are characterized by complex interactions involving symbiotic relationships with fungi and photosynthetic vascular plants and may require seed dissemination by fungivores such as the red-backed vole and northern flying squirrel. Maintenance of viable populations of these co-dependent organisms is essential to their survival.

Role of nonfederal lands. While the panels only evaluated habitat on federal lands, land ownership patterns may affect future viability of at least 10 species, including a number of coast range inhabitants that occur in areas where there is little federal land. Uncertainty regarding the management of nonfederal habitat is a concern for species that have significant portions of their range or key populations occurring off federal lands. Species most strongly influenced by nonfederal land ownership patterns include *Adiantum jordanii, Aralia californica, Aster vialis, Bensoniella oregana* (particularly in California), *Cimicifuga elata, Clintonia andrewsiana, Cypripedium fasciculatum* (Cascades Province), *Isopyrum hallii, Poa laxiflora* (coast range), and *Scoliopus bigelovii.* One of these species, *Scoliopus bigelovii,* occurs in the redwood forests of California and would benefit by both reducing redwood harvest and increasing the time between harvests. All could benefit from land exchanges, coordination among nonfederal landowners and federal agencies, protection of old-growth fragments with documented populations and suitable habitat, and maintenance of old-growth fragments and corridors to facilitate gene exchange among populations.

Special habitats. Most species that occur in special habitats including meadows, rock outcrops, bluffs, serpentine barrens and savannahs, marshes, and bogs were not included on the list to be analyzed, but in many situations they would be affected by adjacent activities in late-successional and old-growth forests. Many rare plants restricted to special habitats require highly specific site characteristics, although the factors limiting these species are often unknown. Modification of the hydrology, shading, and microclimate of these sites could result in extirpation of locally adapted species with highly specific habitat requirements. To maintain viable populations, development and implementation of standards and guidelines for special habitats will be essential (Dimling and McCain 1992). Mapping of these habitats using geographical information systems, in conjunction with species-specific surveys, will aid in managing these species and their habitats. Interagency coordination involving State Natural Heritage Programs, will be essential in this effort.

Research and information needs. Life histories and distributions of many vascular plant species are well documented, however, we lack basic information for others. In addition to inventories, biological and ecological studies of plant species should be conducted, particularly for the rare taxa. Ecological requirements need to be identified to be able to predict potential habitats. A regional database and associated geographic information system layer should be developed for rare and sensitive taxa, with continued and increasing coordination with state Natural Heritage Programs. Global positioning systems can be used to facilitate accurate mapping of rare plant localities.

Well-designed monitoring studies should be implemented to track population trends of rare species, as well as continuing those that are currently in progress. This should be identified as a priority for rare species, particularly those that have been identified as being at risk. Demographic monitoring and modeling studies to predict the future of rare plant populations such as those conducted by Menges (1986), and Guerrant (1992), and Fredricks (1992) are necessary to evaluate trends and provide management recommendations.

Biological studies of obligate old-growth species are needed to determine specific habitat characteristics necessary to maintain populations, as well as to ensure that essential habitat features are retained or developed in forest corridors and Matrix. Corridors are most important for species with limited dispersal potential in order to maintain gene exchange.

Studies of limiting factors and management prescriptions may provide valuable insights into rare plant management. Demographic studies of the *Cyripedium* species should be conducted to investigate their extremely low reproductive rates, and controlled burns monitored to determine if seedling establishment is fire limited.

Monitoring studies that investigate the effects of disturbance on species of concern are warranted prior to further alteration of their habitat. For example, investigating the effectiveness of buffers for maintaining *Pleuricospora fimbriolata* populations, the value of logging while the ground is covered by snow (to lessen impacts on species intolerant of ground disturbance), and the effect of canopy removal on *Asarum wagneri* are studies that are either under way or have been proposed.

Baseline monitoring is recommended for selected species to determine if climatic change is altering their distribution. Studies to evaluate effects of climate on species thought to be at risk (e.g., *Abies lasiocarpa*, "fog-belt species" such as *Clintonia andrewsiana*, *Scoliopus bigelovii*) could be incorporated into the environmental monitoring and assessment program. Species with highly specific habitat requirements would likely be most sensitive to climatic influence.

Approximately 23 percent of the species evaluated here occur in wetland and riparian habitats, including five species of special concern with federal, state, or agency status. Protocols for wetland and riparian vegetation inventory and classification by the Forest Service, Bureau of Land Management, U.S. Fish and Wildlife Service, and National Park Service need to be developed and implemented and riparian vegetation mapped.

Markets for special forest products have increased dramatically in recent years (e.g., Pacific yew, beargrass). Basic inventories and studies to determine sustainable yields should be conducted to avoid overexploitation of these resources.

Species should be prioritized for future study, including all listed and sensitive taxa, as well as selected common species. At least four general categories of field research should be identified, including (1) demography (i.e., long-term monitoring of populations on a yearly basis to provide data for modeling population growth or decline; (2) reproduction (i.e., focusing on short term detriments or benefits to fecundity and population recruitment, such as pollination and pollinator requirements, levels of seed-set and germinability, effects of disturbance and isolation on population genetics, and rates of vegetative propagation); (3) environment (i.e., examining autecological factors and various biotic interactions that influence the viability of populations); and (4) biogeography (i.e., documenting range-wide distributions of species and the importance of remaining old-growth and late-successional forests and their survival). These studies should be designed to compare undisturbed sites with sites subjected to varying levels of forest disturbance, and investigate aspects of succession, species reactions to natural disturbance, and the importance of habitat fragmentation to distribution and abundance.

Mollusks

The mollusks represent a major source of biological diversity in late-successional forests of the Pacific Northwest. Mollusk species of Northwest coniferous forests comprise the land snails, slugs, and aquatic snails and clams. They are diverse in number and function and many species have highly restricted geographic ranges and narrow ecological requirements. Scientists are still discovering and describing new species in coniferous forests of the Northwest, and estimate that the known number of species may eventually double (Frest and Johannes 1993; Roth 1993). Currently, approximately 350 species of mollusks are known to occur in forests within the range of the northern spotted owl.

Land snails and slugs account for over 150 of the 350 species of mollusks. Most are found in moist forest environments and in areas around springs, bogs, and marshes. Basalt and limestone talus slopes are also important habitats for many species. Several areas within the range of the northern spotted owl are characterized by large numbers of endemic species. Their distribution is influenced by geological history, soil type, moisture requirements, and vegetative cover. Over 100 species have been identified as being associated with late-successional forests.

The land snails and slugs are mostly herbivores. A few consume animal matter, and several, (for example, *Ancotrema*) are carnivorous on other snail species. Primary food items for the herbivorous species include deciduous tree leaves (both green and fallen), understory vegetation, large fungi, and inner bark layers. Many mammals, snakes and some birds are consumers of land snails and slugs. Local populations of slugs or snails are often termed colonies. Densities of colonies vary from species to species, and potentially stable colonies can occupy areas ranging in size from tens to hundreds of square feet. Most of the land mollusks are poor dispersers and do not move far from their natal sites. Because of their restricted ranges and dispersal capabilities, land snails and slugs are vulnerable to disturbances from fire, timber harvesting, grazing, and other forest activities.

The freshwater mollusks are found in permanent water bodies of all sizes. In the Pacific Northwest, spring-fed streams and pools often support the greatest abundance and diversity of both clams and snails. Many freshwater snails are restricted geographically, with the highest concentration of endemism in northern California and southern Oregon. In this area, some species inhabit only a few seeps or springs, resulting in total ranges that cover only a few square miles.

The freshwater mollusks are primary herbivores. They serve as food for a variety of other species including fish, aquatic insects, and birds. Some clams and snails are also eaten by raccoons, otters, and beavers. Generally, freshwater mollusks are negatively affected by any increase in siltation, decrease in water flow, nutrient enrichment, or increase in temperature. These sensitivities make them vulnerable to grazing, removal of canopy cover, and damming of water flow. Narrowly endemic mollusks are often found closely associated with other endemic groups or species including arthropods and some salamanders.

Methods specific to mollusks. The list of species considered in this assessment was developed by Drs. Terrence Frest, Edward Johannes, and Barry Roth. It was partially based on lists developed for two previous efforts (Thomas et al. 1993; USDI 1992c). The current list represents updated information that was not available for the previous efforts.

The assessment of likely future habitat condition for mollusks was based on an expert panel. The three scientists who developed the list also participated on the panel. As with other taxa, members of the Forest Ecosystem Management Assessment Team made the final assessment of species' viability based on the panel results, but because no Team member is a recognized expert in mollusks, the panel's assessments were accepted without modification.

Results. The list of mollusks considered in the Final Draft Recovery Plan for the Northern Spotted Owl (USDI 1992c) and Thomas et al. (1993) included 58 species. The list for this effort included 108 species. However, six of those species were not assessed because they are not known to occur on public land, or they are likely extinct. The final list of 102 species that were assessed included 38 land snails, 7 slugs, 54 freshwater snails, and 3 freshwater clams (table IV-22). Most of these species are associated with both late-successional forests and riparian areas. However, the strength of these associations is not well understood in many cases, and some species are probably more closely associated with riparian vegetation than they are with late-successional forests. The 102 species that were assessed included eight that had been identified as candidates for federal listing. Seven are classified as category 2 candidates for federal listing (*Anodonta californiensis, Monadenia fidelis minor, Monadenia setosa, Monadenia troglodytes troglodytes, Vespericola karokorum, Fluminicola columbiana,* and *Pisidium (C.) ultramontanum*) and one category 3 candidate species (*Fisherola nuttalli nuttalli*).

Habitat assessments for Land Snails: The results of the assessments, in table IV-22, indicate the likelihood of achieving specified habitat conditions for each species under each option. One possible display of these results is presented in figures IV-10 through IV-13. These figures show the least favorable outcome that would be expected with a cumulative total of 80 percent likelihood.

For land snails, the likelihood of achieving outcome A only reached 80 percent for four species under option 1 (table IV-22). No land snail species was judged to have 80 percent likelihood of reaching outcome A under any of the other options. Looking at species judged to have 50 percent likelihood of reaching outcome A helps display the relative pattern among options. Under option 1, 35 species were judged to have a 50 percent likelihood or better of reaching outcome A; 15 species under Option 3; 7 species under Option 4; 6 species under Option 6; 4 species under Option 7; and 5 species under Options 8 and 9. This trend is also seen clearly in figure IV-10. In addition, the figure shows that there were a significant number of species for which the 80 percent cumulative likelihood included outcome D (extirpation).

Table IV-22. **Projected future likelihoods of habitat outcomes for mollusks under land management options.**

Mollusks	Option 1				Option 3				Option 4				Option 5				Option 7				Option 8				Option 9			
	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
Land Snails																												
Ancotrema voyanum	57	33	7	3	3	20	50	27	0	27	47	27	0	17	47	37	3	13	27	57	0	13	33	53	7	13	30	50
Cryptomastix devia	33	33	20	13	17	30	33	20	10	25	48	17	13	20	50	17	0	10	47	43	0	10	47	43	0	7	50	43
Cryptomastix hendersoni	53	30	10	7	47	28	18	7	32	23	30	15	32	23	30	15	13	20	33	33	27	22	25	27	27	22	25	27
Helminthoglypta arrosa monticola	70	23	7	0	63	28	8	0	57	33	7	3	57	33	7	3	53	33	3	10	60	27	13	0	53	30	17	0
Helminthoglypta hertleini	50	33	10	7	40	28	25	7	40	28	25	7	40	28	25	7	23	35	30	12	33	23	32	12	32	27	30	12
Helminthoglypta talmadgei	57	33	10	0	40	38	22	0	33	40	20	7	33	40	23	3	22	37	32	10	27	37	30	7	27	40	27	7
Megomphix californicus	57	25	18	0	47	32	20	2	33	30	27	10	27	33	27	13	13	23	37	27	17	27	30	27	17	30	30	23
Megomphix hemphilli	43	40	17	0	30	37	27	7	23	37	30	10	17	37	33	13	7	23	47	23	10	30	43	17	13	33	37	17
Monadenia callipeplus	60	27	10	3	20	28	22	30	20	28	25	27	20	28	22	30	7	23	27	43	17	22	28	33	20	22	25	33
Monadenia chaceana	53	33	10	3	35	35	25	5	35	35	25	5	30	25	30	15	25	30	30	15	25	25	20	30	23	37	27	13
Monadenia churchi	70	23	7	0	53	33	10	3	47	30	13	10	43	33	13	10	33	33	17	17	33	33	17	17	40	33	13	13
Monadenia fidelis celeuthia	60	30	10	0	40	30	27	3	33	27	30	10	33	27	30	10	12	30	45	13	33	37	23	7	33	33	23	10
Monadenia fidelis flava	70	20	10	0	50	30	20	0	47	33	20	0	40	37	23	0	17	37	30	17	23	37	37	3	27	37	30	7
Monadenia fidelis klamathica	67	23	10	0	43	33	20	3	37	30	27	7	33	37	23	7	17	25	25	33	27	30	23	20	23	27	33	17
Monadenia fidelis leonina	43	33	17	7	40	30	20	10	33	30	27	10	30	30	30	10	17	22	28	33	23	30	30	17	27	33	30	10
Monadenia fidelis minor	70	20	10	0	50	32	18	0	47	32	22	0	43	35	22	0	28	32	22	18	43	32	15	10	43	35	22	0
Monadenia fidelis ochromphalus	60	33	7	0	47	33	13	7	43	37	17	3	40	33	20	7	23	37	27	13	33	33	20	13	40	30	20	10
Monadenia fidelis salmonensis	70	20	10	0	50	28	22	0	50	33	17	0	50	30	20	0	37	30	30	3	43	30	27	0	47	30	23	0
Monadenia rotifer	80	20	0	0	50	50	0	0	50	50	0	0	50	50	0	0	50	25	25	0	50	50	0	0	50	50	0	0
Monadenia scottiana	57	27	10	7	43	3	23	10	42	23	25	10	42	23	25	10	23	23	23	30	30	25	32	13	42	23	25	10
Monadenia setosa	63	23	10	3	33	30	30	7	33	30	33	3	37	28	28	7	23	23	30	23	27	27	30	17	30	28	28	13
Monadenia troglodytes troglodytes	67	27	7	0	60	30	10	0	33	37	17	13	33	37	17	13	27	33	23	17	30	30	27	13	33	37	17	13
Monadenia troglodytes wintu	67	27	7	0	60	30	10	0	33	37	17	13	33	37	17	13	27	33	23	17	30	30	27	13	33	37	17	13
Oreohelix n. sp.	55	30	15	0	50	30	15	5	40	35	15	10	40	35	15	10	35	35	20	10	40	35	15	10	40	35	15	10
Pristiloma articum crateris	63	30	7	0	47	37	13	3	47	33	17	3	40	37	17	7	40	37	17	7	40	37	17	7	40	37	17	7
Punctum (Toltecia) hannai	80	20	0	0	60	40	0	0	60	40	0	0	60	40	0	0	50	25	25	0	60	40	0	0	60	40	0	0
Trilobopsis roperi	63	27	7	3	47	23	20	10	40	30	23	7	37	30	27	7	27	27	30	17	37	27	23	13	37	30	23	10
Trilobopsis tehamana	67	23	7	3	50	27	17	7	43	33	20	3	40	33	23	3	30	30	27	13	40	30	20	10	40	33	20	7
Vertigo n. sp.	60	20	15	5	35	25	25	15	40	35	20	5	35	30	25	10	30	25	35	10	35	25	30	10	35	25	25	15
Vespericola depressa	63	30	7	0	50	32	18	0	47	32	22	0	43	35	22	0	25	28	25	22	43	35	22	0	43	35	22	0

A-Well Distributed B-Locally Restricted C-Restricted to Refugia D-Extirpation

Likelihood values are expressed as percentages that total to 100 for a given species within an option. Number displayed may vary due to rounding errors. See text for fuller explanation and discussion of the rating scale.

Table IV- 22 (cont). Projected future likelihoods of habitat outcomes for mollusks under land management options.

Mollusks	Option 1				Option 3				Option 4				Option 5				Option 7				Option 8				Option 9			
	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
Vespericola euthales	50	50	0	0	40	50	10	0	40	40	20	0	40	40	20	0	25	25	40	10	30	40	30	0	40	40	20	0
Vespericola karokorum	80	20	0	0	70	30	0	0	70	30	0	0	70	30	0	0	50	40	10	0	60	40	0	0	70	30	0	0
Vespericola pressleyi	50	50	0	0	20	40	30	10	20	40	30	10	20	40	30	10	0	20	50	30	10	20	50	20	20	40	30	10
Vespericola shasta	50	30	20	0	33	30	27	10	37	33	27	3	30	33	27	10	23	28	33	15	27	33	30	10	30	33	27	10
Vespericola sierrana	53	30	17	0	47	30	17	7	53	30	17	0	43	33	17	7	37	33	20	10	37	37	20	7	43	33	17	7
Vespericola undescribed # 1	70	20	10	0	50	30	10	10	40	30	20	10	40	30	20	10	0	20	50	30	30	30	30	10	40	30	20	10
Vespericola undescribed # 2	50	40	10	0	30	30	30	10	30	30	30	10	30	30	30	10	20	30	25	25	30	30	30	10	30	30	30	10
Vespericola undescribed # 3	80	20	0	0	70	30	0	0	70	30	0	0	70	30	0	0	50	40	10	0	60	40	0	0	70	30	0	0
Slugs																												
Deroceras hesperium	70	15	10	5	30	40	15	15	40	25	25	10	30	35	20	15	30	25	25	20	30	25	25	20	30	30	20	20
Hemphillia barringtoni	63	23	10	3	33	40	17	10	40	30	23	7	33	37	20	10	33	23	23	20	33	27	23	17	33	27	20	20
Hemphillia glandulosa	50	23	20	7	20	40	27	13	27	30	33	10	20	37	30	13	20	27	33	20	20	30	33	17	20	33	30	17
Hemphillia malonei	70	20	10	0	37	35	22	7	40	28	25	7	37	25	25	13	28	25	25	22	28	32	22	18	28	28	25	18
Hemphillia pantherina	70	20	7	3	50	28	18	3	47	28	18	7	40	25	22	13	32	25	22	22	43	28	18	10	32	25	22	22
Prophysaon coeruleum	65	30	5	0	50	25	15	10	50	30	15	5	50	25	15	10	50	25	15	10	50	25	15	10	50	25	15	10
Prophysaon dubium	63	23	3	0	57	23	17	3	57	27	13	3	57	23	17	3	53	25	18	3	57	23	17	3	57	23	17	3
Riparian																												
Anodonta californiensis	45	25	15	15	30	30	20	20	30	30	20	20	30	30	20	20	10	25	35	30	25	30	25	20	30	25	25	20
Anodonta wahlametensis	40	25	20	15	30	30	20	20	30	30	20	20	30	30	20	20	20	30	25	25	25	30	25	20	30	25	25	20
Fisherola nuttalli nuttalli	60	20	15	5	45	25	25	5	40	30	25	5	35	30	25	10	25	30	25	20	30	30	25	15	35	30	25	10
Fluminicola columbiana	60	20	15	5	45	25	25	5	40	30	25	5	35	30	25	10	25	30	25	20	30	30	25	15	35	30	25	10
Fluminicola n. sp. 1	60	20	15	5	50	20	20	10	50	25	25	0	40	20	30	10	30	20	30	20	30	20	30	20	40	20	30	10

A-Well Distributed B-Locally Restricted C-Restricted to Refugia D-Extirpation

Likelihood values are expressed as percentages that total to 100 for a given Species within an option. Numbers displayed may vary due to rounding errors. See [illegible] for fuller explanation and discussion of the rating scale.

Table IV- 22 (cont). Projected future likelihoods of habitat outcomes for mollusks under land management options.

Mollusks	Option 1				Option 3				Option 4				Option 5				Option 7				Option 8				Option 9			
	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
Fluminicola n. sp. 2	40	25	20	15	30	15	30	25	40	20	20	20	40	20	20	20	20	25	25	30	30	20	30	20	30	20	25	25
Fluminicola n. sp. 3	50	15	20	15	40	20	25	15	50	15	20	15	35	30	15	20	25	30	20	25	25	35	20	20	35	30	15	20
Fluminicola n. sp. 4	70	20	10	0	50	25	20	5	70	15	15	0	40	25	15	20	25	30	20	25	25	35	25	15	40	25	15	20
Fluminicola n. sp. 5	70	20	10	0	50	25	20	5	70	15	15	0	40	25	15	20	25	30	20	25	25	35	25	15	40	25	15	20
Fluminicola n. sp. 6	70	20	10	0	50	25	20	5	70	15	15	0	40	25	15	20	25	30	20	25	25	35	25	15	40	25	15	20
Fluminicola n. sp. 7	70	20	10	0	50	25	20	5	70	15	15	0	40	25	15	20	25	30	20	25	25	35	25	15	40	25	15	20
Fluminicola n. sp. 8	70	20	10	0	50	25	20	5	70	15	15	0	40	25	20	15	25	30	20	25	25	35	25	15	40	25	15	20
Fluminicola n. sp. 9	70	20	10	0	50	25	20	5	70	15	15	0	40	25	20	15	25	30	20	25	25	35	25	15	40	25	15	20
Fluminicola n. sp. 10	70	20	10	0	50	25	20	5	70	15	15	0	40	25	20	15	25	30	20	25	25	35	25	15	40	25	20	15
Fluminicola n. sp. 11	50	15	20	15	40	20	25	15	50	15	20	15	35	30	15	20	25	30	20	25	25	35	20	20	35	30	15	20
Fluminicola n. sp. 12	40	30	25	5	25	30	30	15	35	30	25	10	25	33	33	10	20	20	30	30	25	30	25	20	25	30	30	15
Fluminicola n. sp. 13	60	15	20	5	40	20	20	20	35	25	30	10	35	25	20	20	35	20	20	25	35	25	20	20	35	30	20	15
Fluminicola n. sp. 14	70	20	10	0	40	15	25	20	50	15	20	15	40	20	20	20	25	20	30	25	25	25	30	20	40	20	20	20
Fluminicola n. sp. 15	70	20	10	0	40	15	25	20	50	15	20	15	40	20	20	20	25	20	30	25	25	25	30	20	40	20	20	20
Fluminicola n. sp. 16	60	20	20	0	40	30	20	10	40	30	30	0	40	30	20	10	30	30	20	20	30	30	20	20	25	30	25	20
Fluminicola n. sp. 17	60	20	20	0	40	30	20	10	40	30	30	0	40	30	20	10	30	25	25	20	30	30	20	20	25	30	25	20
Fluminicola n. sp. 18	70	20	10	0	40	15	25	20	50	15	25	10	40	20	20	20	25	20	30	25	25	25	30	20	40	20	20	20
Fluminicola n. sp. 19	55	20	15	10	30	25	25	20	50	15	20	15	30	20	30	20	30	20	25	25	30	20	30	20	30	20	30	20
Fluminicola n. sp. 20	55	20	15	10	30	25	25	20	50	15	20	15	30	20	30	20	30	20	25	25	30	20	30	20	30	20	30	20
Fluminicola seminalis	70	20	10	0	35	30	20	15	50	20	25	5	35	25	25	15	25	25	30	20	30	25	25	20	30	25	25	20
Helisoma newberryi newberryi	70	20	10	0	45	25	25	5	60	30	10	0	50	25	20	5	35	20	10	35	40	15	20	25	40	20	20	20
Juga (C.) acutifilosa	70	20	10	0	45	20	15	20	70	20	10	0	50	20	15	15	35	20	10	35	40	15	20	25	40	15	15	30
Juga (C.) occata	70	20	10	0	45	20	15	20	70	20	10	0	40	25	15	20	35	15	15	35	40	20	15	25	40	20	15	25
Juga (J.) n. sp. 1	70	10	10	10	50	30	20	0	70	10	10	10	40	10	30	20	30	20	30	20	30	20	30	20	40	10	30	20
Juga (J.) n. sp. 3	70	10	10	10	50	30	20	0	70	15	10	5	45	10	25	20	30	20	25	25	30	20	30	20	40	10	30	20
Juga (O.) n. sp. 1	70	10	10	10	50	20	20	10	40	20	30	10	30	20	30	20	20	20	20	40	40	20	10	30	40	20	20	20
Juga (O.) n. sp. 2	70	15	10	5	50	20	20	10	40	20	30	10	30	20	30	20	25	20	20	35	40	20	15	25	40	20	20	20
Juga (O.) n. sp. 3	60	20	20	0	40	30	20	10	40	30	30	0	40	30	20	10	30	30	20	20	30	30	20	20	25	30	25	20
Juga (Oreobasis) chacei	70	20	10	0	50	20	20	10	60	20	20	0	40	30	20	10	30	25	25	20	40	25	25	10	40	25	25	10
Juga (Oreobasis) orickensis	70	20	10	0	50	30	10	10	60	30	10	0	40	40	10	10	30	20	30	20	40	20	20	20	40	40	10	10

A-Well Distributed B-Locally Restricted C-Restricted to Refugia D-Extirpation

Likelihood values are expressed as percentages that total to 100 for a given species within an option. Number displayed may vary due to rounding errors. See text for fuller explanation and discussion of the rating scale.

Table IV- 22 (cont). Projected future likelihoods of habitat outcomes for mollusks under land management options.

	Option 1				Option 3				Option 4				Option 5				Option 7				Option 8				Option 9			
Mollusks	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
Juga hemphilli dallesensis	50	20	10	20	50	30	20	0	50	20	10	20	40	10	30	20	30	20	20	30	30	20	30	20	40	10	30	20
Juga hemphilli hemphilli	70	10	10	10	50	30	20	0	70	10	10	10	40	10	30	20	30	20	20	30	30	20	30	20	40	10	30	20
Juga hemphilli n. subsp. 1	70	10	10	10	50	30	20	0	70	10	10	10	40	10	30	20	30	20	20	30	30	20	30	20	40	10	30	20
Lanx alta	70	20	10	0	50	30	20	0	70	20	10	0	40	15	30	15	30	20	20	30	35	20	30	15	40	15	30	15
Lanx klamathensis	50	20	20	10	40	20	20	20	50	20	20	10	40	20	20	20	30	20	20	30	30	20	30	20	40	20	20	20
Lanx patelloides	70	20	10	0	50	20	20	10	60	20	20	0	50	20	20	10	40	20	20	20	50	20	20	10	50	20	20	10
Lanx subrotundata	70	20	10	0	50	20	20	10	60	20	20	0	50	20	20	10	40	20	20	20	50	20	20	10	50	20	20	10
Lyogyrus n. sp. 1	70	10	10	10	50	30	20	0	70	10	10	10	40	10	30	20	30	20	20	30	30	20	30	20	40	10	30	20
Lyogyrus n. sp. 2	60	20	0	20	50	20	10	20	60	20	0	20	50	10	20	20	30	20	20	30	30	20	30	20	50	10	20	20
Lyogyrus n. sp. 3	40	30	20	10	30	20	20	30	30	25	20	25	35	20	20	25	25	20	25	30	30	20	20	30	30	20	20	30
Lyogyrus n. sp. 4	50	20	15	15	30	15	30	25	50	20	15	15	40	20	20	20	30	15	25	30	30	15	25	30	30	15	25	30
Lyogyrus n. sp. 5	50	20	15	15	30	15	30	25	50	20	15	15	40	20	20	20	30	15	25	30	30	15	25	30	30	15	25	30
Lyogyrus n. sp. 6	40	25	20	15	30	15	30	25	40	20	20	20	40	20	20	20	20	25	25	30	30	20	30	20	30	20	25	25
Physella columbiana	30	25	30	15	20	25	25	30	30	25	25	20	20	20	30	30	15	15	30	40	20	20	30	30	20	20	30	30
Pisidium (C.) ultramontanum	70	20	10	0	40	20	30	10	60	20	20	0	40	20	30	10	30	20	10	40	40	10	30	20	40	20	30	10
Pyrgulopsis archimedis	40	25	20	15	30	15	30	25	40	20	20	20	40	20	20	20	20	25	25	30	30	20	30	20	30	20	25	25
Pyrgulopsis intermedia	70	20	10	0	40	20	30	10	70	20	10	0	40	20	30	10	30	20	30	20	40	25	25	10	40	20	30	10
Pyrgulopsis n. sp. 1	40	25	20	15	30	15	30	25	40	20	20	20	40	20	20	20	20	25	25	30	30	20	30	20	30	20	25	25
Vorticifex klamathensis klamathensis	50	20	15	15	30	15	30	25	50	20	15	15	40	20	20	20	30	15	25	30	30	15	25	30	30	15	25	30
Vorticifex klamathensis sinitsini	40	25	20	15	30	15	30	25	40	20	20	20	40	20	20	20	20	25	25	30	30	20	30	20	30	20	25	25
Vorticifex n. sp. 1	40	30	20	10	30	20	20	30	30	25	20	25	35	20	20	25	25	20	25	30	30	20	20	30	30	20	20	30
Vorticifex neritoides	30	25	30	15	20	25	30	25	30	25	25	20	20	20	30	30	15	15	30	40	20	20	30	30	20	20	30	30

A-Well Distributed B-Locally Restricted C-Restricted to Refugia D-Extirpation

Likelihood values are expressed as percentages that total to 100 for a given species within an option. Numbers displayed may vary due to rounding errors. See text for fuller explanation and discussion of the rating scale.

Habitat assessments for slugs: None of the seven slug species associated with late-successional forests was judged to have 80 percent likelihood of achieving outcome A under any of the options (table IV-22 and fig. IV-11). All seven species were judged to have 50 percent or greater likelihood of achieving outcome A under Option 1. Three species were judged to have 50 percent or greater likelihood of outcome A under Option 3, and two species were rated at that level under all other options. Under Option 1, there is an 80 percent likelihood of achieving outcome B or better for all species except *Hemphilli glandulosa*. For Options 3, 4, 5, and 8, the 80 percent cumulative likelihood included outcome C. For Options 7 and 9, outcome D was also included in the 80 percent cumulative level.

Habitat assessments for freshwater snails and clams: Results for the 54 freshwater snails and three freshwater clams indicated that no species was judged at 80 percent likelihood of achieving outcome A under any of the options (table IV-22 and figure IV-12). Of the 57 species, 45 were judged to have 50 percent likelihood or better of achieving outcome A under Option 1; 22 species were judged to have 50 percent likelihood or better of achieving outcome A under Option 3; 36 species under Option 4; 5 species under Option 5; none under Option 7; 2 under Option 8; and 3 under Option 9. Under Option 1 all species have an 80 percent likelihood of achieving either outcome C or better or B or better (figure IV-12). Under all other options, there were species for which the 80 percent cumulative likelihood includes outcome D (extirpation). This included 12 species under Option 3; 2 species under Option 4; 4 species under Option 5; 44 species under Option 7; 12 species under Option 8; and 14 species under Option 9.

Discussion. The mollusk assessment suggests that the options considered here are less effective in providing for mollusks than for any of the other species groups (figure IV-13). According to the assessment, only Option 1 provides habitat to maintain any of the mollusk species well-distributed across federal lands with a likelihood of 80 percent or better. Assessments for Options 3 through 9 all indicate that a large number of species will have significant probabilities of being confined to refugia or extirpated. Differences among the options for land snails and slugs were based primarily on the total acres proposed for reserves, the locations of specific reserves, and the management proposed within reserves. The judgments for freshwater snails and clams responded primarily to the proposed forms of watershed protection. Options 1 and 4 contain the full riparian protections proposed by Thomas et al. (1993) and analysis shows that the freshwater species would fare better under these options.

High degrees of endemism, rareness and habitat specialization account, in part, for the low ratings assigned the mollusks. Many of the mollusk species are endemic to only one region or river drainage, and dispersal capabilities of this group of invertebrates is low. Several of the land and freshwater mollusks in the Pacific Northwest have highly limited geographic ranges, and most of these species are confined to a coastal belt that extends only from the crest of the Cascade Mountains to the Pacific Ocean. There are sizeable groups of endemic species in the land snail genera *Monadenia, Trilobopsis, Megomphix*, and *Vespericola*, and the slug genus *Hemphillia*. Geologic history, substrate, moisture requirements, and vegetative cover are the physical factors that limit their distribution. Because most land snails do not disperse far from their natal areas, areas are rarely repopulated following extirpation. For freshwater mollusks, endemic species are most notable for the genera *Juga, Lanx*, and *Fluminicola*. Species are often confined to single streams, particularly intermittent streams, springs, and seeps. For the species that have localized geographic ranges, potential exists for serious impacts from even

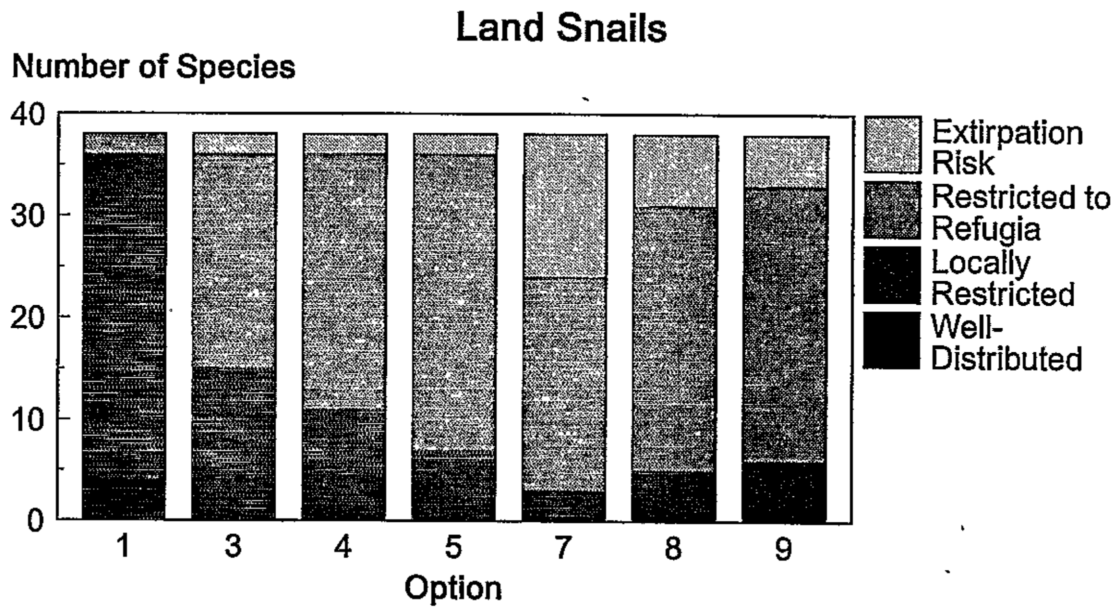

Figure IV-10. Outcomes for land snails under each land management option. Values shown are the number of species that had an 80 percent or greater likelihood of achieving at least the specified outcome (based on distribution of habitat).

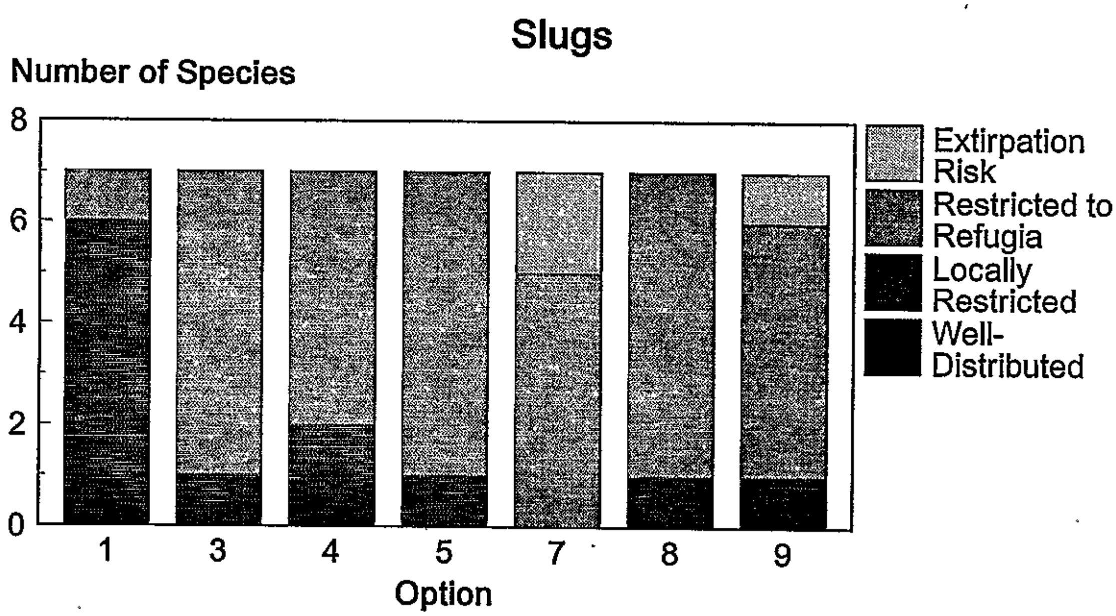

Figure IV-11. Outcomes for slugs under each land management option. Values shown are the number of species that had an 80 percent or greater likelihood of achieving at least the specified outcome (based on distribution of habitat).

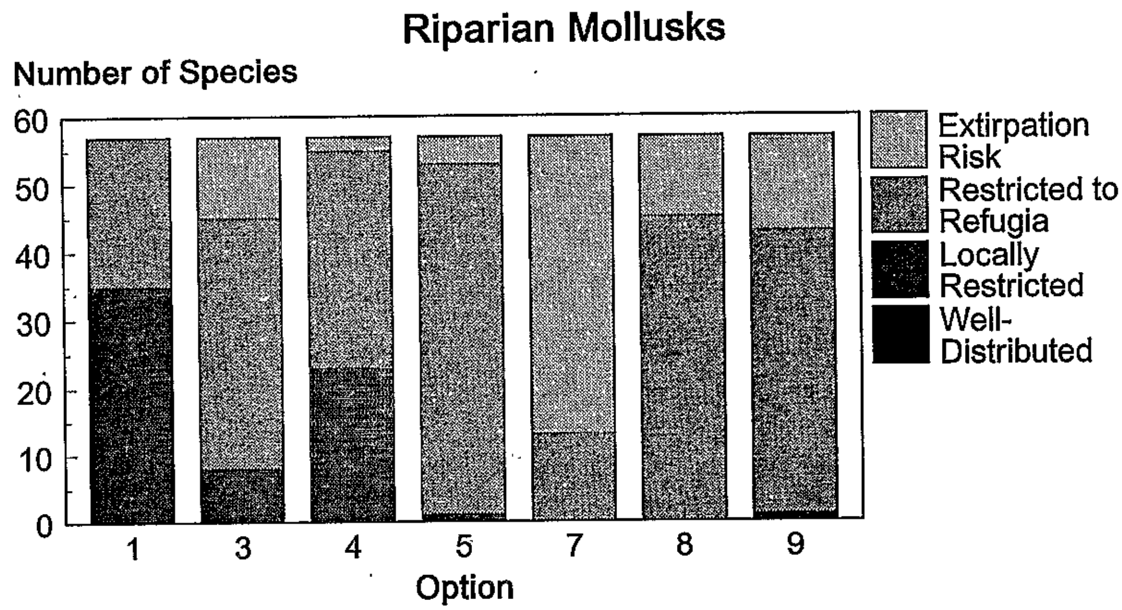

Figure IV-12. Outcomes for riparian mollusks under each land management option. Values shown are the number of species that had an 80 percent or greater likelihood of achieving at least the specified outcome (based on distribution of habitat).

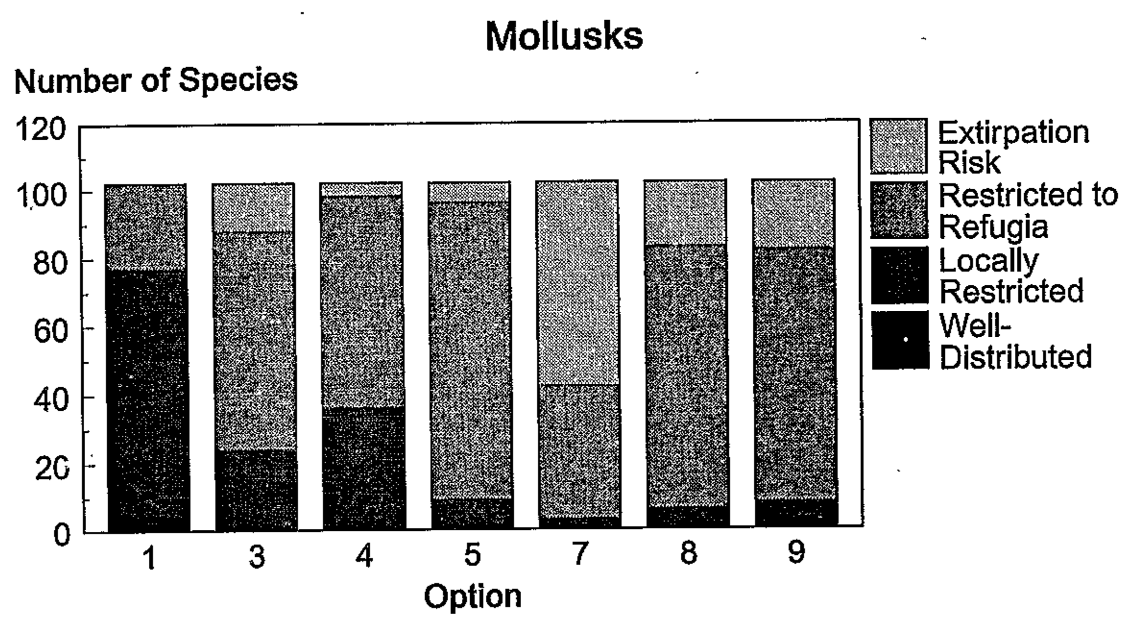

Figure IV-13. Outcomes for all mollusks under each land management option. Values shown are the number of species that had an 80 percent or greater likelihood of achieving at least the specified outcome (based on distribution of habitat).

small ground-disturbing activities or changes in stream conditions. This potential was reflected in the judgments for those species.

In addition to rarity, endemism, and habitat specialization, several other reasons can be cited for the low ratings given to habitat outcomes for mollusks:

1. The mollusk experts acknowledged that past agency performance was a consideration in their judgments. While this is not an inappropriate consideration, it is inconsistent with the effort to compare management options.
2. The experts also had difficulty separating the influence of state and private habitat management from federal management in their judgments. Again, this is not inappropriate but is inconsistent with a comparison of federal management options.

3. Those species currently confined to refugia because of habitat history and species life history were judged unlikely to expand their range and were rated accordingly. Therefore, in even the most favorable situations such species were judged unlikely to be well distributed.

4. All ground-disturbing activities, even those proposed for management inside reserves, were considered potential threats to the mollusks and caused ratings to be low. Thus, even species whose entire ranges were located inside Reserves received ratings with significant potential for isolation or extirpation.

In the team's judgment, the assessments for mollusks are quite conservative because of the above factors. The team believes that the options, implemented properly, would result in more favorable outcomes than indicated by these results. In addition, specific mitigation for many of the mollusk species could be relatively straightforward as discussed below.

Mitigation for Mollusks

Mitigation for the mollusk species is relatively straightforward: sites need to be identified through surveys and then protected from disturbances that would cause high levels of mortality. The following specific recommendations are made for mitigation:

1. Mollusks should be included in the watershed analysis for Riparian Reserves (see the section on Watershed Analysis). Protocols for surveying mollusks should be developed and standardized. For best efficiency, surveys should be focused on riparian features (i.e., springs and seeps) that are most likely to support mollusk populations. Because some mollusks and amphibians have similar habitat requirements and are associated with intermittent streams, springs, and seeps, there may be some sampling protocols that would sample both groups. When populations of mollusk species that may be at risk are found, they should be protected with buffers that are at least one site potential tree height in diameter.

2. In addition to surveys as part of the watershed analysis process, upland sites with high potential as mollusk habitat should be surveyed prior to ground disturbance. Talus and limestone areas are two priority habitat types for survey. Again, surveys may be designed to address mollusks along with other species such as salamanders. In addition, some of the amphibians may serve as indicator species of areas of high endemism for mollusks (Roth 1993) because endemic forms of both taxa occur in the

same area (e.g., limestone areas in the Shasta National Forest). When located, populations of mollusk species at risk should be protected with buffers that are at least one site potential tree height in width.

3. Surveys and protection for mollusks must be conducted inside Reserves when management activities are contemplated in the reserves.

4. Surveys should be prioritized to (1) known mollusk locations and (2) areas of high diversity or endemism as described below.

Areas of high diversity or endemism: Several areas of high diversity and endemism of mollusks occur within the range of the northern spotted owl. For land snails, species in the genera *Helminthoglypta, Monadenia, Tilobopsis, Megomphix, Vespericola,* and the slug genera *Prophysaon* and *Hemphilli* exhibit high endemism. The most significant endemic clusters of land snails and slugs occur in the following areas (Frest and Johannes 1993):

1. The southern half of the western Washington Cascades, the Olympic Mountains, and the extreme northwestern corner of the Oregon Coast Range.

2. The Columbia Gorge of Washington and Oregon.

3. Shasta River Canyon in northern California.

4. Salmon and Marble Mountains in Siskiyou County, California.

5. Trinity Mountains of northern California.

6. Mt. Shasta and vicinity, Shasta County, California.

For the freshwater species, endemic clusters are most common in the family *Hydrobiidae (Fluminicola, Lyogyrus, Pyrgulopsis)* and in the genus *Juga*. The family *Lancidae* is restricted solely to Western North America and is generally limited to coastal areas in southwestern Oregon and northwestern California. The following areas are likely to have endemic groups of species of freshwater mollusks (Frest and Johannes 1993):

1. The lower Columbia River from The Dalles, Oregon to its mouth.

2. Columbia River tributaries and springs in the Columbia Gorge.

3. The Rogue and Umpqua River systems of Oregon.

4. The Upper Klamath Lake region of Oregon and the west side of the lake.

5. The lower and middle stretches of the Klamath River and its tributaries and springs, including the Trinity and Smith Rivers, California and Oregon.

6. The upper Sacramento River system, Shasta County, California including the Pit and McCloud Rivers, Hat Creek, and their tributaries and springs.

The above areas of endemism and high diversity of mollusks were identified by Roth (1993) and Frest and Johannes (1993). They should be one focus of surveys and mitigation measures for mollusks.

Role of nonfederal lands. Nonfederal lands are an important consideration for the viability of some mollusks, particularly in southwestern Washington and northern California. Management of slug species needs to be addressed on nonfederal lands in southwestern Washington. Many endemic freshwater mollusks are also associated with a mixture of federal and nonfederal lands in northern California in the headwaters of the Shasta, Pit, and Sacramento Rivers. As more areas are surveyed for mollusks, conservation needs on federal and nonfederal lands will become more evident.

Research Needs. Inventory and research data for mollusks are not extensive. The most critical need is for improved surveys, particularly in areas where ground-disturbing activities are proposed. Survey techniques must be appropriate to mollusk species, and are somewhat different from methods for arthropod surveys (Frest and Johannes 1993). To improve conservation strategies, additional information is also needed on species life histories and ecological requirements.

Arthropods and Their Allies

Arthropods are a major source of biological diversity in late-successional forests in the Pacific Northwest. Olson (1992) estimated that about 7,000 species of arthropods inhabit these forests and assume numerous ecological roles that are important to ecosystem function.

Arthropods inhabit virtually every part of the coniferous forest system including coarse woody debris, litter and soil layer, understory vegetation, canopy foliage, tree trunks, snags, and the aquatic system. The litter and soil of the forest floor are the sites of some of the greatest biological diversity found anywhere. The soil under a square yard of forest may hold as many as 200,000 mites from a single taxonomic group, plus tens of thousands of other mites, beetles, centipedes, pseudoscorpions, springtails, and spiders. Many of these species are undescribed and poorly understood, but the structure and function [illegible]nperate forest soils may be determined by the dietary habits of the soil arthropo[illegible] (Lattin and Moldenke 1992). They are the basic consumers of the forest floor where they ingest and process massive quantities of organic litter and debris, from large logs to bits of moss (Lattin and Moldenke 1992). The richness of arthropod species in late-successional forests suggests a great number of different processes and functions, but little is known about how arthropods interact, survive, and contribute to ecosystem function.

Methods specific to arthropods. Assessment of the capability of habitat to support arthropod populations is complex for several reasons. First, scientists estimate that 20-30 percent of the species have not been described, resulting in a lack of information on specific habitat associations. Second, there have not been adequate surveys of the arthropods in the Pacific Northwest. Third, the diversity of arthropods is greater than any other class of organisms (Lattin and Moldenke 1992).

Given this complexity, the panelists aggregated the arthropods into 11 functional groups based on their ecological roles: (1) coarse wood chewers, (2) litter and soil dwellers, (3) understory and forest gap herbivores, (4) canopy herbivores, (5) epizootic forest species, (6) aquatic herbivores, (7) aquatic detritivores, (8) aquatic predators, (9) pollinators, (10) riparian herbivores, and (11) riparian predators.

Because there is a gradient of increasing species richness and endemicity of arthropods with decreasing latitude, groups 1-4 were rated separately in the southern and northern portions of the range of the northern spotted owl. Thus, a total of 15 arthropod groups or ranges were assessed (11 functional groups, four of which received ratings for both north and south portions of their range). The southern portion consisted of the Klamath Province of southern Oregon and northern California, the California Cascades, and the California Coast Range. The northern portion consisted of the eastern and western Oregon and Washington Cascades; the Oregon Coast Range; the Western Washington Lowlands; and the Olympic Peninsula.

Ratings were an expression of the likelihood that habitat to support functional groups would be maintained rather than on the viability of individual species. This approach emphasizes ecosystem function rather than a species by species analysis and was necessary because many of the species have not yet been identified and described. We do not know enough about the distribution or habitat associations of most species to make the assessment on a species by species basis.

Habitat and population assessments for arthropods should be viewed with caution because of the paucity of information on this group. Ratings should be considered preliminary and subject to modification as new understanding and scientific information become available.

Results. The panel reviewed lists of arthropods that are associated with or indicative of late-successional forests in the Pacific Northwest. (USDI 1992c; Thomas et al. 1993) A revised list of species was assembled but was not used because species were combined into functional groups. The revised list of arthropods associated with late successional forests is on file with the Forest Ecosystem Management Assessment Team's other unpublished documents and reports. The list includes 155 insects, 25 spiders, 25 millipedes, and 1 crustacean for a total of 206 species.

Habitat sufficiency for arthropods and allies: We assessed the sufficiency of habitat on federal lands to provide for well-distributed populations of the various functional groups. The ratings of these groups varied among the seven options (table IV-23). For Option 1, there was an 80 percent likelihood of achieving outcome A for all groups except aquatic herbivores and understory/gap herbivores (fig. IV-14). These latter two groups were judged to have at least an 80 percent likelihood for achieving at least outcome B. Populations of aquatic and understory/gap herbivores respond to sunlight, and panelists felt that Option 1 would result in a more closed canopy with less penetration of sunlight to the forest floor than other options. Thus, they rated Option 1 as less likely than others to provide habitat conditions of outcome A for these groups.

Table IV- 23. Projected future likelihoods of habitat outcomes for arthropods under land management options.

Arthropods	Option 1				Option 3				Option 4				Option 5				Option 7				Option 8				Option 9			
	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
Aquatic detritivores	88	11	1	0	86	14	0	0	81	19	0	0	80	20	0	0	74	26	0	0	70	29	1	0	75	25	0	0
Aquatic herbivores	76	21	3	0	84	14	3	0	81	18	1	0	80	19	1	0	81	18	1	0	81	18	1	0	84	16	0	0
Aquatic predators	81	16	3	0	85	15	0	0	81	19	0	0	80	20	0	0	79	21	0	0	78	21	1	0	83	18	0	0
Canopy herbivores (North range)	83	18	0	0	79	21	0	0	79	21	0	0	79	21	0	0	64	34	3	0	68	32	0	0	69	29	3	0
Canopy herbivores (South range)	84	16	1	0	74	26	1	0	76	21	2	1	74	24	2	1	71	24	5	1	58	28	11	4	66	29	4	2
Coarse wood chewers (North range)	90	10	0	0	86	13	1	0	76	21	1	1	76	21	1	1	75	21	3	1	65	23	9	4	76	20	3	1
Coarse wood chewers (South range)	80	16	4	0	80	16	4	0	70	20	8	3	70	20	8	3	68	19	10	4	54	23	15	9	65	21	10	4
Epizootic forest species	94	6	0	0	86	14	0	0	80	20	0	0	80	20	0	0	80	20	0	0	70	28	3	0	69	31	0	0
Litter & soil dwelling species (North range)	94	6	0	0	86	13	1	0	80	18	1	1	76	20	3	1	71	20	8	1	65	24	9	3	71	19	9	1
Litter & soil dwelling species (South range)	83	14	4	0	78	18	5	0	76	15	6	3	74	16	6	4	65	20	9	6	50	23	19	9	60	20	15	6
Pollinators	84	15	1	0	85	15	0	0	80	20	0	0	80	20	0	0	83	18	0	0	83	17	0	0	85	14	1	0
Riparian herbivores	81	19	0	0	80	20	0	0	78	23	0	0	76	24	0	0	70	28	1	0	71	21	6	1	85	15	0	0
Riparian predators	81	19	0	0	79	21	0	0	79	21	0	0	78	23	0	0	68	28	5	0	71	19	8	3	86	14	0	0
Understory & forest gap herbivores (North range)	75	25	0	0	74	26	0	0	69	31	0	0	69	31	0	0	70	29	1	0	58	38	5	0	63	36	1	0
Understory & forest gap herbivores (South range)	71	23	6	0	66	29	6	0	58	32	7	4	56	33	8	4	54	34	9	4	35	42	17	6	47	45	5	4

A-Well Distributed B-Locally Restricted C-Restricted to Refugia D-Extirpation

Likelihood values are expressed as percentages that total to 100 for a given species within an option. Number displayed may vary due to rounding errors. See text for fuller explanation and discussion of the rating scale.

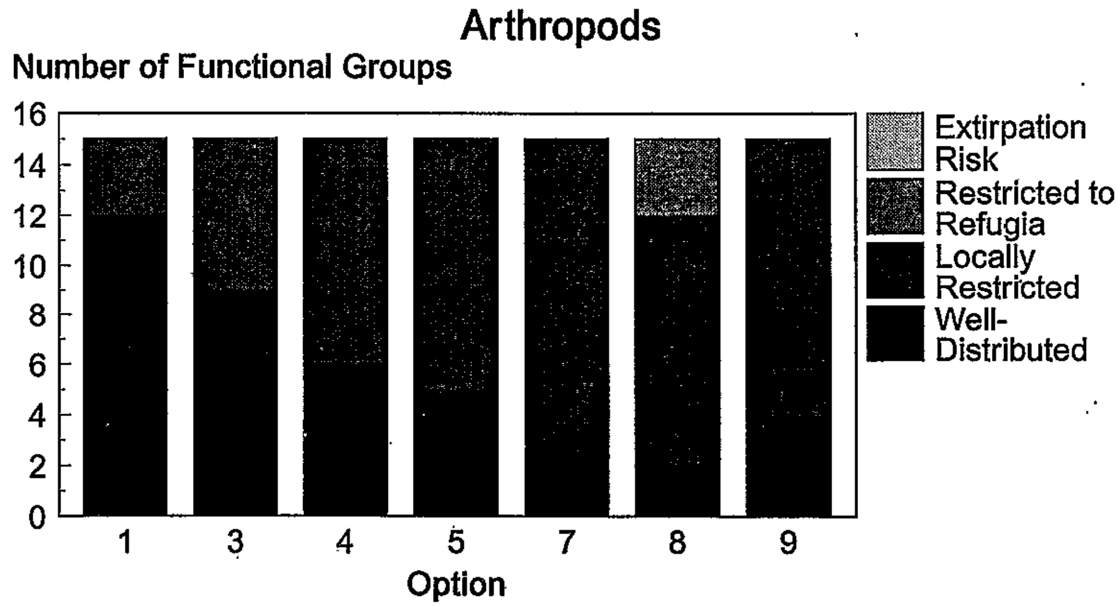

Figure IV-14. Outcomes for arthropod functional groups under each land management option. Values shown are the number of species that had an 80 percent or greater likelihood of achieving at least the specified outcome (based on distribution of habitat).

At the other extreme, Option 8 was judged to have less than an 80 percent likelihood of achieving at least outcome B for any functional group (fig. IV-14). Coarse wood chewers, litter and soil species, and understory/gap herbivores were considered to have an 80 percent likelihood of at least outcome C within the southern portions of their ranges. The decreased likelihoods of outcomes A or B for these groups generally resulted from concerns that greater management intensities would reduce levels of coarse woody debris, increase soil disturbance, and reduce the diversity of understory plants associated with late successional forests. As discussed below, there was a concern that southern groups were more sensitive to management because of high levels of endemism and specialized adaptation to specific plant communities and fire regimes.

For most functional groups, other options fell between the extremes of Options 1 and 8 (fig. IV-13). Most groups for most options were judged as having an 80 percent likelihood of achieving at least outcome B, with only Option 3 consistently rated at an 80 percent likelihood for outcome A.

Areas of high endemism and special concern: Several areas within the range of the northern spotted owl are high in endemism or are of special concern for arthropods. The California Coast Range and the Klamath Province are the areas of greatest endemism. In addition, Point Reyes, the Siskiyou Mountains, the Oregon Coast Range, and the Olympic Peninsula are areas with considerable numbers of endemic species. Richness and endemicity of arthropods increases with decrease in latitude and toward coastal regions. Of particular importance is the Siskiyou Mountain region of northern California and southern Oregon where there is high species richness and endemism. The entire area has a rich and complex geologic history coupled with great edaphic and climatic zonation that has contributed to the diversity of vegetation and arthropods.

Discussion. Arthropods in late-successional forests are of concern for several reasons. First, many species are flightless, which means that their dispersal capabilities are limited. In fact, little is known about the dispersal capabilities of many of the invertebrates. Second, the flightless condition is believed to reflect habitat stability and permanence over a long period. Third, many of the old-forest associates have disjunct distributions and are found only in undisturbed forests. Fourth, arthropods are key to ecosystem function and may serve as indicators of ecosystem conditions. They are key to nutrient cycling of downed logs, are major components of the litter and soil, are herbivores of the forest canopy, play important roles in aquatic systems, and are pollinators of flowering plants. Lastly, many of the species native to this region have not been described or named (Lattin and Moldenke 1992). For these reasons, conservation of the biodiversity of arthropods must be given consideration along with other taxonomic groups.

For the purposes of this discussion the viability of the groups of arthropods refers to the maintenance of the ecological functions of these groups across all federal lands. This does not imply that all species must be maintained across all of these areas because not all species have been identified. However, an appropriate goal should be to conserve biological diversity of arthropods, and all of the functional groups should be maintained across the landscape.

Outcome A should maintain the ecological functions of groups across the landscape, with outcome B resulting in gaps in the distribution of these groups and therefore loss of their function in some areas. Under outcome C, arthropod function would be lost in many portions of ecosystems across the range of the northern spotted owl.

For most functional groups, Options 1 and 3 provide the greatest likelihood that arthropod function will be maintained across federal lands. Twelve and nine of the 15 groups or ranges, respectively, were given an 80 percent likelihood of outcome A under these options. Options 4, 5, and 9 provide for a lower likelihood with 6, 5, and 5 groups, respectively, reaching an 80 percent likelihood of Outcome A. Options 7 and 8 provide for only minimal likelihood that arthropod function would be maintained on federal lands, with 3 and 2 groups, respectively, receiving an 80 percent rating for outcome A.

Although for many of the options, the likelihood of maintaining well-distributed functional groups across federal lands was less than 80 percent, most of the groups failing to achieve this level of likelihood received ratings of more than 70 percent (table IV-23). Understory/forest gap herbivores were an exception, especially in the southern portions of the range where only Option 1 received a 70 percent or greater likelihood of outcome A, with other options rated as low as 35 percent (Option 8). These low ratings reflect the significant levels of endemism in northern California and vulnerability to disturbance.

So little is known about a large portion of the forest-dwelling invertebrates that it is tempting to recommend that as much of the late-successional forest be preserved as possible. However, D. Murphy, P. Brussard and P. Erlich (1993, Personal communication) do not concur with such a position. They believe that sufficient information exists on the population biology of invertebrates that inhabit forest communities to allow several observations and recommendations that can be used as a basis for regional conservation planning. First, they consider it unrealistic and probably not helpful to demand that conservation planning be based on an extensive understanding of the autecology of individual invertebrate species. Adherence to a regional goal of protecting a substantial portion of all habitat types will be the most effective strategy for invertebrate conservation. Second, while the report of the Interagency Scientific Committee (Thomas et al. 1990) correctly indicates that narrow habitat corridors may not benefit species such as the spotted owl, this is not necessarily true for invertebrates. Reserves that support late-successional forests and are substantially interconnected by similar forests should provide for invertebrate dispersal necessary to allow gene flow and recolonization of habitat after local extirpation of species. Not only will greater watershed protection provide for greater protection of both terrestrial and aquatic invertebrates, it will provide for greater interconnectedness and dispersal between such conservation areas.

In summary, Murphy, Brussard and Ehrlich believe that a strategy such as that of the Interagency Scientific Committee (Thomas et al. 1990) will serve the conservation requirements of many but certainly not all invertebrates. At the landscape scale of regional planning, invertebrates are usually not useful tools in the context of the design of reserves. Instead conservation planning should endeavor to protect an adequate representation of all physiographic and vegetational features that are associated with late-succession forests. Where possible Reserves should be interconnected by landscape linkages, and riparian areas will likely serve this purpose quite well.

Mitigation for Arthropods

Panelists did not suggest specific mitigation measures that would increase the likelihood of achieving Outcome A for each option. Instead, they made general recommendations for improvement of habitat under most options.

Mitigation is not likely to greatly improve Option 8; rather, significant modification of this option would be required. For example, salvage would need to be limited, additional watershed protection would be required, and silvicultural manipulations within late-successional forests reduced. Most other options could be improved for arthropods by implementing a number of mitigating measures.

Coarse woody debris is especially important for arthropods. Guidelines in Options 1 and 3, if incorporated into other options, would likely improve habitats for coarse wood chewers and litter and soil dwelling species. In addition, the panel identified other measures for the forest Matrix that may be beneficial to arthropods including (1) providing a full spectrum of species and sizes of trees for retention of green trees and coarse woody debris and (2) cessation of burning as a means of site preparation after timber harvest. Burning often negatively impacts the arthropods that are associated with coarse woody debris and the litter and soil layers.

Existing small fragments of late-successional forests within the Matrix provide valuable habitat for arthropods, especially canopy herbivores in lowland areas. Relatively little remains of lowland late- successional forests, and these fragments provide refugia for arthropods. Therefore, protection of LS/OG3s (Johnson et al. 1991) or other such late-successional remnants in the Matrix, as under Option 1 and to some extent under Options 3 and 9, would greatly benefit arthropods.

The panelists were concerned that objectives for adaptive management areas in Option 9 were quite general, and therefore management should be conservative until knowledge and understanding is improved. Ratings for this option may have reflected the panelists' uncertainty. Although not actually a form of mitigation, the ratings for Option 9 may be improved with further development of objectives and guidelines.

Role of nonfederal lands. Most late-successional arthropod groups are likely to be maintained on federal lands without contributions from nonfederal lands. However, the potential exists for movement of epizootic species between federal and nonfederal ownerships. This is most likely to occur in the eastern and southern portions of the range of the northern spotted owl. Management responses will vary on a case by case basis, but epizootic species should be recognized as a natural part of the forest ecosystem.

Research needs. We have little information concerning arthropods and late successional forests, and a great need for surveys and research. This is exemplified by the number of new species of arthropods that are likely to be discovered in the future (Lattin and Moldenke 1992). Any assessment of their status and distribution will require considerable effort and should be approached through broad-scale inventories aimed at describing species composition and distribution. In addition, there is a lack of information about the taxonomy, distribution, and abundance of arthropods in different forest types throughout the Pacific Northwest. Many arthropods are sensitive to land-use practices that alter the microclimates upon which they depend. Given the lack of information about many species and the restricted geographic ranges, there are likely to be arthropod species whose ranges are not included in or adequately protected by some of the reserves. Surveys and research are needed to provide this information to determine if further conservation measures will be required. Additionally, arthropods should be monitored as indicators of forest ecosystem condition (i.e., as "canaries in the mine".)

Amphibians and Reptiles

The number of species of amphibians and reptiles in coniferous forests of the Pacific Northwest is not large compared to the number of birds and mammals. However, amphibians and reptiles compose a distinct and important component of the vertebrate fauna (Bury 1988). The amphibian fauna of the Pacific Northwest includes 13 species that are endemic to the range of the northern spotted owl (they occur nowhere else in the world). The Pacific Northwest supports the second highest number of amphibian species in the United States, second only to the Southeast (Nussbaum et al. 1983). Approximately 62 species of amphibians are found in the Pacific Northwest, but fewer are found in coniferous forests. Most forested areas support as many as 19 to 23 species of amphibians and reptiles (Nussbaum et al. 1983; Stebbins 1985). These vertebrate communities are ecologically important because of the high numbers and biomass they attain (Bury 1988). A total of 10 species of reptiles were evaluated by Thomas et al. (1993) for their association with late-successional forests, and none was found to be closely associated with this forest type. However, some reptiles, such as the sharp-tailed snake and northern alligator lizard, are associated with components of late-successional forests, including down logs and forest litter cover.

Amphibians are functionally significant components of coniferous forests in the Pacific Northwest. Any loss of amphibian diversity would have ecological consequences.

Amphibians, particularly salamanders, compose significant biomass in forest ecosystems as they can reach densities as high as 5,000 individuals per acre in suitable habitat. Aquatic larvae, terrestrial juveniles, and adults may function as predators or as the major food sources for other vertebrate species and aquatic invertebrates (Walls et al. 1992).

Amphibians are particularly sensitive to environmental change because their complex life cycle exposes them to hazards in both the aquatic and terrestrial environments. Most amphibians require cool, moist conditions to maintain respiratory function. Stream-dwelling species generally require cool water and are sensitive to sedimentation that can inhibit reproduction and foraging. Within locales in the Pacific Northwest, populations of several species of amphibians have been extirpated, and the ranges of numerous species have become drastically reduced (Blaustein and Wake 1990). Most declines have occurred in forest-dwelling species. Several species including Del Norte, Larch Mountain, Siskiyou Mountains, and Shasta salamanders, and western spotted, red-legged, and Cascades frogs, are candidates for listing (USDI 1992b). Therefore, we must understand their ecological requirements if we are to provide for their continued existence.

Many amphibians are highly specialized, including the predatory giant salamanders (*Dicamptodon* spp.) and the very primitive tailed frog. Most amphibians have specific habitat requirements such as association with headwater streams or with coarse woody debris. The clouded salamander, for example, is found most frequently in the space between the bark and sapwood of large-diameter downed logs. Twelve species of salamanders are associated with riparian areas, particularly headwater streams, springs, and seeps. Two species (Oregon slender and clouded salamanders) are closely associated with coarse woody debris. Some species have highly restricted geographic ranges, particularly the Larch Mountain, Siskiyou Mountains, and Shasta salamanders. The special natural history traits of salamanders include low mobility and dependency on moist environments for all phases of their life cycle; the loss of moist environments following timber harvest undoubtedly influences both their local abundance and distribution.

There is considerable genetic variability among and within species of amphibians, as exemplified by the recent subdivision of Pacific giant salamanders into three species and the Olympic salamanders into four species within the range of the northern spotted owl (Good 1989; Good and Wake 1992). Continuing research may result in other wide-ranging species being subdivided into separate species. This high degree of variability is probably a result of their specific habitat associations and limited mobility.

There is evidence of population declines and range reductions in a number of amphibian populations (Blaustein and Wake 1990; Welsh 1990). Their conservation should be promptly addressed because future activities will likely modify amphibian habitats, further limiting future conservation options.

Methods specific to amphibians. Thomas et al. (1993) listed 28 amphibian and 10 reptilian species for initial consideration as associates with late-successional forest. Following application of a set of screening criteria to identify species *closely* associated with such forests, this list was reduced to 19 species of salamanders and frogs (no reptiles were retained). During panel deliberations, we dropped one of these species (California slender salamander) from further consideration because it occurs on very few federal lands within the range of the northern spotted owl. Therefore, we evaluated 18 species

Table IV- 24. Projected future likelihoods of habitat outcomes for amphibians under land management options.

Amphibians	Option 1				Option 3				Option 4				Option 5				Option 7				Option 8				Option 9			
	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
Riparian																												
Black salamander	80	15	5	0	75	15	10	0	80	15	5	0	75	15	10	0	65	20	15	0	60	20	20	0	75	15	10	0
Cascade torrent salamander	85	15	0	0	70	24	5	1	85	15	0	0	70	24	5	1	23	41	34	3	34	39	25	3	70	24	5	1
Columbia torrent salamander	5	20	54	21	3	15	55	28	5	20	54	21	3	15	55	28	0	10	44	46	1	14	46	39	3	21	54	23
Cope's giant salamander	86	14	0	0	79	20	1	0	86	14	0	0	79	20	1	0	63	30	8	0	66	31	3	0	79	20	1	0
Dunn's salamander	91	9	0	0	81	18	1	0	91	9	0	0	81	18	1	0	71	26	3	0	66	30	4	0	81	18	1	0
Northwestern salamander	90	10	0	0	83	15	3	0	88	13	0	0	83	15	3	0	64	28	8	1	66	25	8	1	80	16	4	0
Olympic torrent salamander	86	13	1	0	81	16	3	0	86	13	1	0	81	16	3	0	74	21	5	0	71	24	5	0	81	16	3	0
Pacific giant salamander	93	8	0	0	86	13	1	0	93	8	0	0	86	13	1	0	68	30	3	0	70	28	3	0	84	14	3	0
Rough-skinned newt	94	6	0	0	89	10	1	0	94	6	0	0	89	10	1	0	73	25	3	0	81	16	3	0	88	11	1	0
Southern torrent salamander	81	19	0	0	74	23	3	1	79	21	0	0	74	23	3	1	41	36	20	3	48	31	19	3	74	23	3	1
Tailed frog	93	8	0	0	80	19	1	0	90	10	0	0	83	16	1	0	63	30	8	0	64	31	5	0	78	20	3	0
Van Dyke's salamander																												
(Cascades)	0	25	58	18	0	23	56	21	3	25	58	15	0	23	56	21	0	16	46	38	0	14	49	38	0	20	58	23
(Coastal, Oly. Penin.)	45	40	13	3	36	44	18	3	45	40	13	3	36	44	18	3	28	43	23	8	25	46	23	6	36	48	14	3
Terrestrial																												
Clouded salamander	93	6	1	0	91	8	1	0	81	18	1	0	81	18	1	0	71	26	3	0	74	24	3	0	81	18	1	0
Del Norte salamander	93	8	0	0	90	10	0	0	90	10	0	0	90	10	0	0	65	28	8	0	65	33	3	0	90	10	0	0
Larch Mountain salamander	80	20	0	0	70	25	5	0	70	25	5	0	65	25	10	0	45	30	20	5	45	30	20	5	75	20	5	0
Oregon Slender salamander	91	9	0	0	88	13	0	0	75	21	4	0	68	24	9	0	54	26	18	3	58	25	15	3	70	24	6	0
Shasta salamander	10	40	40	10	10	40	40	10	10	40	40	10	10	40	40	10	0	10	40	50	0	10	40	50	0	40	40	20
Siskiyou Mountains salamander	60	30	10	0	45	35	20	0	50	30	20	0	50	30	20	0	10	40	40	10	10	40	40	10	50	30	15	5

A-Well Distributed B-Locally Restricted C-Restricted to Refugia D-Extirpation

Likelihood values are expressed as percentages that total to 100 for a given species within an option. Number displayed may vary due to rounding errors. See text for fuller explanation and discussion of the rating scale.

(17 salamanders, 1 frog). In addition, we subdivided one species (Van Dyke's salamander) into two portions of its total range (Washington Cascades; Washington coast, including the Olympic peninsula) and evaluated habitat conditions separately within each portion.

We recognized two general groups, those species associated with riparian habitats and those associated with terrestrial or upland habitats (table IV-24). Within the riparian group, some species are found primarily in intermittent, headwater streams, (e.g., Van Dyke's and Dunn's salamanders, two species of giant salamanders, four species of torrent salamanders, and the tailed frog). Other riparian associates breed in ponds or streams but forage in terrestrial habitats (rough-skinned newt, northwestern salamander).

Results. Ratings for individual species were highly variable among options (table VI-24). Because of the preponderance of riparian-associated species, overall results of the viability assessment were strongly influenced by the level of riparian buffer protection along headwater and intermittent streams in each option. Options 1 and 4, which included the widest interim buffer widths on all intermittent streams and seeps, had the greatest number of species for which the likelihood was judged to be 80 percent or greater that habitat on federal lands would be sufficient to support well-distributed, stable populations over the next 100 years (fig. IV-15). Overall ratings for Options 3, 5, and 9 were similar, again reflecting their similar riparian standards. Options 7 and 8 had much lower overall ratings. No species had a likelihood greater than 80 percent of a stable, well-distributed population under Option 7, and only 1 species had such a likelihood under Option 8.

No option provides complete assurance of providing sufficient habitat on federal lands to ensure well-distributed, viable populations of all amphibian species. Table IV-25 shows that 11 of the 19 species or subpopulations occur as local endemics, restricted through habitat specialization and geographic subtleties to small, isolated populations. These small populations are at risk of local extirpation through either land management activity or large-scale habitat modification due to natural events. Three species, the Columbia torrent salamander, Shasta salamander, and Cascades population of Van Dyke's salamander were not rated with an 80 percent likelihood or greater for any outcome better than C (restricted to refugia) for any of the options (table IV-24, fig. IV-16).

Total number of species that were rated into the four viability-outcome classes varied among options. For Option 1, there is an 80 percent or greater likelihood that outcomes for 16 species would be B or better. Of these, 14 attained outcome A. In contrast, Options 3, 4, 5 and 9 also provide habitat conditions for 16 species resulting in likelihood levels of 80 percent or more for outcome B or better, but only half of these species were most likely to achieve outcome A. For Options 7 and 8, five species were rated as achieving 80 percent likelihood of habitat conditions of only outcome C or better. For three species, the 80 percent cumulative likelihood level includes some likelihood of extirpation.

Mitigation for Amphibians

Results of the assessment were based on the assumption that mitigation listed in the Scientific Analysis Team report (Thomas et al. 1993) would be implemented for all options we assessed except 7 and 8. These mitigations prescribe the designation and

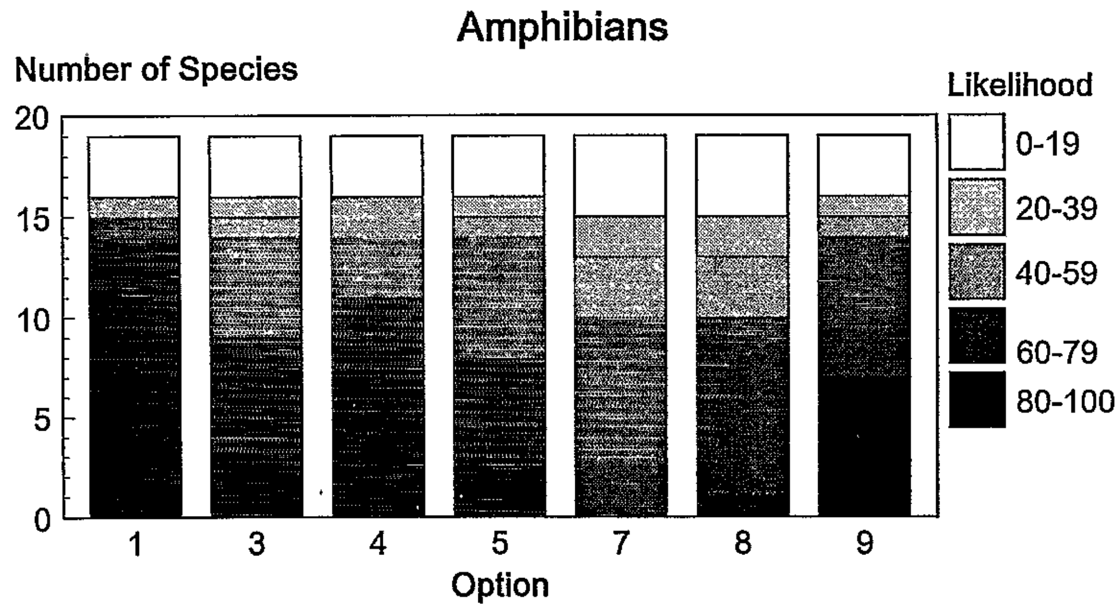

Figure IV-15. Summary of the numbers of amphibian species that are expected to achieve varying likelihoods of attaining stable, well-distributed populations in response to habitat conditions provided under land management options over the next 100 years.

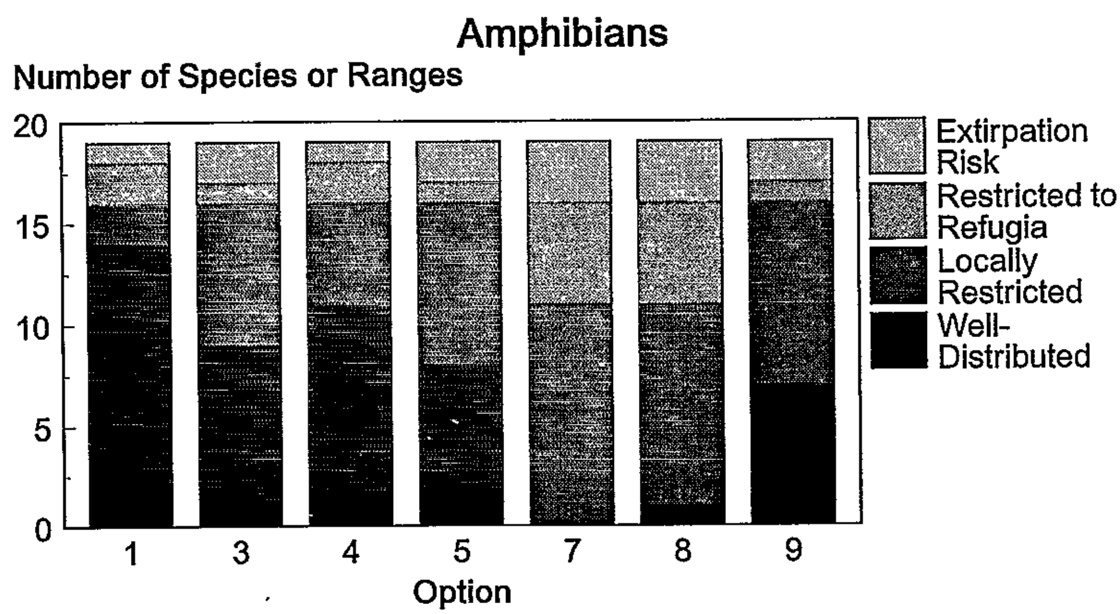

Figure IV-16. Outcomes for amphibians under each land management option. Values shown are the number of species/species ranges that had an 80 percent or greater likelihood of achieving at least the specified outcome (based on distribution of habitat).

protection of occupied sites for Del Norte salamander, Larch Mountain salamander, Siskiyou Mountains salamander, and Shasta salamander.

Additional mitigation will be required to bring ratings for most species up to an 80 percent likelihood level for outcome A (stable, well-distributed populations) for many of the options (table IV-25). For the riparian-associated species, mitigation generally involves prescribing buffer widths of at least two site-potential tree heights along portions of streams occupied by the species; mitigations are more variable for the terrestrial species (table IV-25). Although some mitigation may be possible for the Columbia torrent salamander, Van Dyke's salamander, Siskiyou Mountains, and Shasta salamander, none could be specified to achieve an 80 percent likelihood of outcome A.

Role of nonfederal lands. Most species of amphibians have less than 50 percent of their range on federal lands. This is especially true for riparian-associated species where only one species overlaps federal lands by more than 50 percent (tailed frog, table IV-25). Overlap of species ranges with federal lands vary from 44 percent to 78 percent for terrestrial species. Only 6 percent of the range of the Columbia torrent salamander (a riparian species), occurs on federal land, and thus land management practices on state and private lands are of particular concern for this species. Streamside protection measures on nonfederal lands will likely continue to have a strong influence on overall population viability of riparian associated amphibian species.

Research and information needs. Habitat requirements of amphibians in late-successional forests of the Pacific northwest have received some attention over the past 10 years (Raphael 1988; Ruggiero et al. 1991) but further work is needed to better understand how habitat variation affects population viability. Because so many of the species of amphibians are associated with riparian systems, understanding the relationships between riparian management and population dynamics is a high priority. A second high priority should be research on the dispersal ability of terrestrial species in relation to characteristics of forest stands, especially in the Matrix. Third, further work is needed to better understand the population dynamics of the rare and locally endemic species such as Shasta salamander, Van Dyke's salamander, and Columbia torrent salamander. Research on these species is a particularly high priority.

Mitigation measures proposed for any of the options that fail to meet high likelihoods of providing sufficient habitat to assure stable, well-distributed populations require surveys to determine occupied sites. Further research is needed to develop cost-effective survey protocols for these species that can be implemented over large areas. These protocols should be designed to be conducted within the watershed analysis procedure.

Northern Spotted Owl

Introduction. The life history and management of the northern spotted owl has been described in the section on Terrestrial Species of Special Political, Legal, and Biological Interest. Because this species is federally listed as a threatened species, and does not have a final recovery plan, it was paneled separately.

Methods specific to northern spotted owls. Methods used to assess the adequacy of different options were as described in the section on Methods for Assessing Effects of Options. The assessment panel consisted of three experts with many years of research experience on the spotted owl.

Table IV-25. Summary of mitigation measures required for an 80 percent or better likelihood of achieving habitat conditions to support stable, well distributed populations of amphibians on federal lands.

Species	Local endemic	Percent of range on federal lands	Option[a]	Mitigation
Riparian Associates				
Northwestern salamander		38	7,8	Riparian Reserve 1 around occupied sites.
Cope's giant salamander	X	44	3,5,7,8,9	Riparian Reserve 1 around occupied sites.
Pacific giant salamander		47	7,8	Riparian Reserve 1 around occupied sites.
Olympic torrent salamander	X	42	7,8	Riparian Reserve 1 around occupied sites.
Columbia torrent salamander	X	6	All[b]	None[c]
Southern torrent salamander		37	7,8	Riparian Reserve 1 around occupied sites.
Cascade torrent salamander	X	48	3,5,7,8,9	Riparian Reserve 1 around occupied sites.
Rough-skinned newt		37	7	Riparian Reserve 1 around occupied sites.
Dunn's salamander		38	7,8	Riparian Reserve 1 around occupied sites.
Van Dyke's salamander				
(Cascades)	X	48	All[b]	None[c]
(Coast, Olympic Peninsula)	X	40	All[b]	Riparian Reserve 1 around occupied sites.
Black salamander		25	3,5,7,8,9	Riparian Reserve 1 around occupied sites.
Tailed frog		56	7,8	Riparian Reserve 1 around occupied sites.
Terrestrial Associates				
Larch mountain salamander	X	63	3,4,5,7,8,9	Extend buffer to 2 tree heights on south-facing slopes.
Del Norte salamander	X	67	7,8	Add mitigation measures from Thomas et al. (1993).
Siskiyou Mountains salamander	X	78	All	Extend buffer to 2 tree heights on south-facing slopes.[c]
Clouded salamander		44	7,8	Retain logs >16 inches diameter at levels comparable to unmanaged stands.
Oregon slender salamander	X	62	4,5,7,8,9	Retain logs >16 inches diameter at levels comparable to unmanaged stands.
Shasta salamander	X	66	All	Extend buffers to 2 tree-heights on south-facing slopes.[c]

[a] Options are listed whenever a species' rating fell below an 80 percent h likelihood of achieving outcome A (habitat conditions to support a stable, well-distributed population over the next 100 years); see table IV-26 for source of ratings.

[b] No Option achieved an 80 percent likelihood of providing outcome A.

[c] No mitigation measures could assure an 80 percent or better likelihood of outcome A; where mitigations are listed, they will raise the likelihood at least to outcome B (viable population, but significant gaps in distribution).

Results. Options 1-6 and 9 all had a greater than 80 percent likelihood of achieving outcome A (table IV-26). Options 7, 8, and 10 received scores of 71, 65, and 73, respectively, for outcome A. No likelihood points were assigned to outcome D (extirpation on federal lands) for any of the seven options.

Total acres of currently available northern spotted owl habitat by allocation under each option is displayed in tables IV-27 to IV-35. A summary of the total acreage of spotted owl habitat on federal lands by option and allocation is shown in table IV-36. The number of confirmed spotted owls that are protected within Reserves under each option are also shown in table IV-36. Total acres within reserves, regardless of current suitability for spotted owls, is displayed for each option in table II-5. Number of sites occupied by spotted owls within Reserves areas and Matrix areas by option are shown in figure IV-17.

Discussion. There was some concern that the hands-off policy in the Reserve system under Option 1 (and several other options) could result in an elevated risk of catastrophic fire in reserves. This was why Option 1 received a 1 percent likelihood for outcome C. Option 8 was rated particularly low for outcome A for two reasons: (1) it did not ensure the adequacy of dispersal habitat in the Matrix, and (2) it allowed harvest in suitable owl habitat within reserves. Option 7 rated less than 80 percent likelihood for outcome A primarily because of the fact that Bureau of Land Management protection of the Matrix was less protective in the short term than the 50-11-40 prescription.

Mitigation for Northern Spotted Owls

Option 1 could be improved by increasing the emphasis on fire management within reserves. Prescribed fire, fuel breaks, and silviculture could be used to reduce risk of catastrophic fire. Prescribed fire or a silvicultural equivalent could be used to retain some types of late-successional/old-growth forest that would not persist without periodic episodes of low intensity fire.

Options 3 and 4 (and most other Options) could be improved by emphasizing retention of hardwoods in harvested areas in the Klamath Province. Option 4 could be improved by increasing green tree retention to include at least six of the largest trees per acre.

Land exchanges to consolidate federal ownership could reduce the amount of fragmentation in areas currently characterized by mixed federal and nonfederal ownership. All options require the development of a unified research design that will allow managers to learn from harvest treatments, regardless of whether those treatments occur in the Reserves, Matrix, or Adaptive Management Areas.

Role of nonfederal lands. We did not assess northern spotted owls on nonfederal lands. However, nonfederal lands are critical to the continued existence of the owl in some areas, especially in areas where federal lands are uncommon. Southwestern Washington, northwestern Oregon, and northern California are areas of particular concern (Thomas et al. 1990; USDI 1992c). The Final Draft Recovery Plan for the Northern Spotted Owl (USDI 1992c) identified other areas where the contribution of nonfederal lands was considered essential to recovery of the owl. These areas included the Oregon Coast Range, the northern portion of the Klamath Province in Oregon, the

California Cascades, and the corridor surrounding Highway I-90 in the Washington Cascades.

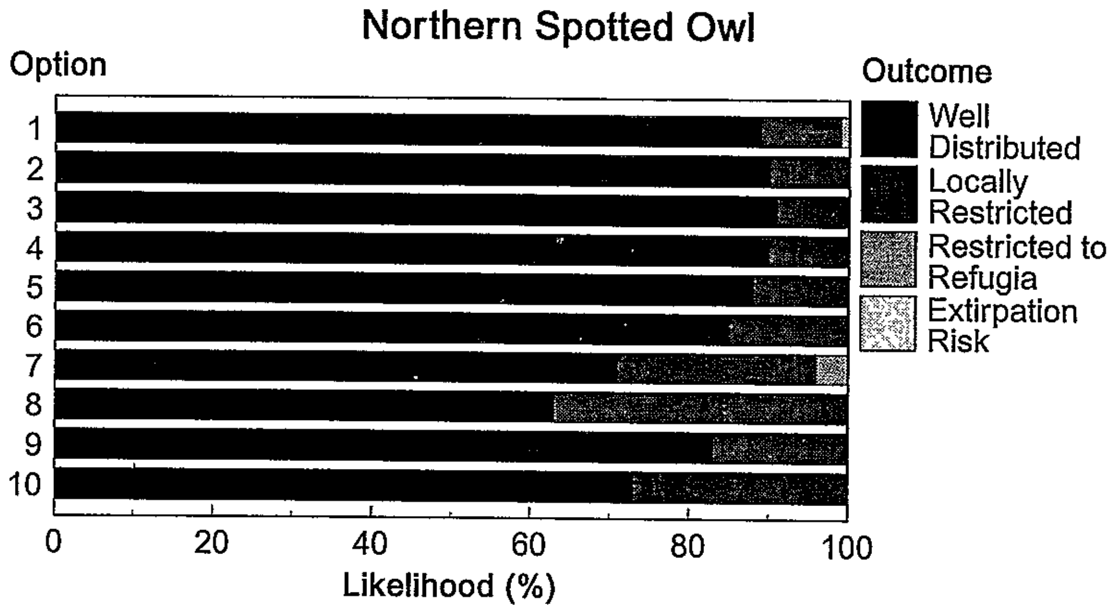

Figure IV-17. Number of currently confirmed sites occupied by northern spotted owls within Reserve Areas and Matrix areas by management option. For this comparison occupied sites in Managed Late-Successional Areas (Option 3) and Adaptive Management Areas (Option 9) were included in the count of sites in Reserves.

Research needs. Research needs for the spotted owl have been summarized by several sources (e.g., Thomas et al. 1990; USDI 1992c). The Final Draft Recovery Plan for the Northern Spotted Owl (USDI 1992c:233-252) provided a particularly detailed listing of the types of research and monitoring needed by geographic province. Priorities included better information on population size and trends, habitat requirements, factors affecting prey populations, dynamics of dispersal, and landscape level factors that influence numbers or distribution of owls. Other items identified as research priorities included the development and testing of silvicultural methods for creating spotted owl habitat and the development of more realistic population viability models that can be used to investigate population response to different management approaches.

Marbled Murrelet

Introduction. The life history and management of the marbled murrelet have been described in the section entitled "Terrestrial Species of Special Political, Legal, and Biological Interest." Because this species is federally listed as a threatened species, and has not been addressed in a recovery plan, it was paneled separately.

Although the Forest Ecosystem Management Assessment was designed to address only federal lands within the range of the northern spotted owl, the marbled murrelet is an example of a species whose life history requirements cannot be accommodated only on federal lands. The marbled murrelet is a seabird that nests inland and therefore is influenced by both marine and terrestrial environments. Its nesting range in the three-state area also includes land that is south of the range of the northern spotted owl. In addition, several areas that are considered key to the recovery of the marbled murrelet involve private and state lands. These limitations must be considered when analyzing the viability of the species on federal lands. However, this does not negate the substantial and important contribution of federal forest management to the continued existence of marbled murrelet nesting habitat. Habitat on federal lands is a key component of any marbled murrelet management strategy because the loss of nesting habitat was the principal reason the species was listed as threatened under the Endangered Species Act.

Methods specific to marbled murrelets. Two separate assessments were made for marbled murrelets. One assessment was based on how well the options provided for well-distributed nesting habitat on federal lands, as per the guidelines established by the marbled murrelet working team (see Development and Description of Terrestrial Options). The other assessment examined the probability of having a viable population of marbled murrelets on federal lands in 100 years, taking into account all the factors that influence murrelets in addition to the availability of suitable nesting habitat on federal lands. Because of the various biological factors that may affect the marbled murrelet in each of the three states, adequacy of habitat was analyzed separately for each state, then averaged to get an overall estimate. Possible outcomes for each option were as described in the section entitled Methods For Assessing Effects of Options.

Results. Total acres of currently available marbled murrelet nesting habitat within Reserves managed for marbled murrelets is displayed in tables IV-27 to IV-35 for all options developed by the Interagency Team. Total acres within reserves, regardless of current suitability for marbled murrelets, is displayed for each option in table II-5. Table IV-36 summarizes current information on the number of sites on federal lands known to be occupied by marbled murrelets during the 1986-1992 survey period. The number of occupied sites within Reserves will undoubtedly increase as further surveys are conducted.

Based on the assessment of habitat conditions, Options 1-6, 9, and 10 had an 80 percent or greater likelihood of achieving outcome A. Likelihoods of achieving outcome A under Options 7 and 8, were 26 and 29 percent, respectively (table IV-26, fig. IV-18).

The assessment of population viability indicated much greater risk to murrelets than the assessment based only on habitat. When all factors affecting the species are taken into account, including at-sea conditions and land ownership patterns, we believe there is only about a 60 percent likelihood (with a range of 50 to 75 percent) that the marbled murrelet population on federal lands will be stable and well distributed after 100 years, regardless of which option is selected.

Discussion. The greatest concern with marbled murrelets is maintaining the species over the next 50-100 years (see section on Short Term Effects). This concern relates to both inland nesting habitat and possible adverse impacts in the marine environment. An ecosystem plan constrained to federal lands contributes to only one aspect of the marbled murrelet's life history requirements. With the marbled murrelet, both the marine environment and the contribution of state and private lands for nesting habitat must be considered in any viability assessment on federal lands, even though those factors are mostly beyond the control of federal land managers.

Table IV- 26. Projected future likelihoods of habitat outcomes under land management options

Marbled Murrelet	Option 1				Option 3				Option 4				Option 5				Option 7				Option 8				Option 9			
	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
Marbled Murrelet California (long-term)	90	10	0	0	82	18	0	0	82	18	0	0	82	18	0	0	5	28	67	0	33	35	30	2	80	20	0	0
Marbled Murrelet Oregon (long-term)	90	10	0	0	83	17	0	0	83	17	0	0	83	17	0	0	3	25	70	2	25	39	33	3	80	20	0	0
Marbled Murrelet Washington (long-term)	97	3	0	0	87	13	0	0	87	13	0	0	87	13	0	0	63	37	0	0	30	47	23	0	80	20	0	0
Three State Average	92	8	0	0	84	16	0	0	84	16	0	0	84	16	0	0	26	30	44	0	29	40	29	2	80	20	0	0

	Option 2				Option 6				Option 10			
	A	B	C	D	A	B	C	D	A	B	C	D
Three State Average	84	16	0	0	84	16	0	0	80	20	0	0

Note - Likelihoods for Option 2,6, and 10 are internal assessments; these Options were not rated by expert panels.

Northern Spotted Owl	Option 1				Option 3				Option 4				Option 5				Option 7				Option 8				Option 9			
	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
Strix occidentalis caurina	89	10	1	0	90	10	0	0	91	9	0	0	88	13	0	0	71	25	4	0	65	35	0	0	83	18	0	0

	Option 2				Option 6				Option 10			
	A	B	C	D	A	B	C	D	A	B	C	D
Strix occidentalis caurina	90	10	0	0	85	15	0	0	73	27	0	0

Note - Likelihoods for Option 2,6, and 10 are internal assessments; these Options were not rated by expert panels.

A-Well Distributed B-Locally Restricted C-Restricted to Refugia D-Extirpation

Likelihood values are expressed as percentages that total to 100 for a given species within an option. Number displayed may vary due to rounding errors. See text for fuller explanation and discussion of the rating scale.

Table IV-27. Allocation of acres of habitat for northern spotted owls and marbled murrelets on federal lands in Option 1.

Physiographic province	Total acres spotted owl NRF* habitat	Total acres marbled murrelet nesting habitat	Congressionally Withdrawn Areas: Spotted owl NRF* habitat	Congressionally Withdrawn Areas: Marbled murrelet nesting habitat	Administratively Withdrawn Areas: Spotted owl NRF* habitat	Administratively Withdrawn Areas: Marbled murrelet nesting habitat	Acres of spotted owl NRF* habitat in: Late-Successional Reserves	Acres of spotted owl NRF* habitat in: Riparian Reserves	Acres of spotted owl NRF* habitat in: Matrix	Acres of marbled murrelet nesting habitat in: Late-Successional Reserves	Acres of marbled murrelet nesting habitat in: Riparian Reserves	Acres of marbled murrelet nesting habitat in: Matrix
Washington												
Eastern Cascades	713,100	6,600	213,500	3,300	15,000	0	400,700	32,600	51,400	2,500	0	0
Western Cascades	1,112,600	363,600	345,400	122,100	32,200	10,100	653,700	32,100	49,100	137,200	8,100	18,900
Western Lowlands	0	0	0	0	0	0	0	0	0	68,100	0	0
Olympic Peninsula	562,700	605,600	340,700	393,900	300	600	212,300	4,800	4,700	158,600	12,500	12,200
Total:	**2,388,400**	**975,800**	**899,600**	**519,300**	**47,500**	**10,700**	**1,266,700**	**69,500**	**105,200**	**366,400**	**20,600**	**31,100**
Oregon												
Klamath	802,500	530,800	76,700	72,400	10,300	8,600	655,200	26,200	34,100	348,200	18,900	22,100
Eastern Cascades	439,600	0	101,800	0	15,600	0	244,200	27,900	50,100	88,500	0	0
Western Cascades	2,066,100	900	243,700	0	24,400	0	1,502,700	127,100	168,100	900	0	0
Coast Range	529,200	434,300	13,000	13,000	500	400	468,900	26,000	20,800	371,300	17,200	11,000
Willamette Valley	5,700	600	0	0	0	0	2,900	1,300	1,500	21,900	0	0
Total:	**3,843,100**	**966,600**	**435,200**	**85,400**	**50,800**	**9,000**	**2,873,900**	**208,500**	**274,600**	**830,800**	**36,100**	**33,100**
California												
Coast range	7,700	31,600	1,300	13,500	200	100	5,900	100	200	10,200	700	1,400
Klamath	1,074,900	587,500	303,800	129,100	4,400	2,400	742,300	10,400	13,900	227,800	3,700	5,200
Cascades	75,400	0	800	0	1,800	0	66,700	2,500	3,500	225,000	0	0
Total:	**1,158,000**	**619,100**	**305,900**	**142,600**	**6,400**	**2,500**	**814,900**	**13,000**	**17,600**	**463,000**	**4,400**	**6,600**
Three-State Total:	**7,389,500**	**2,561,500**	**1,640,700**	**747,300**	**104,700**	**22,200**	**4,955,500**	**291,000**	**397,400**	**1,660,200**	**61,100**	**70,800**

* NRF = Nesting, roosting, and foraging

Table IV-28. Allocation of acres of habitat for northern spotted owls and marbled murrelets on federal lands in Option 2.

			Congressionally Withdrawn Areas		Administratively Withdrawn Areas		Acres of spotted owl NRF* habitat in:			Acres of marbled murrelet nesting habitat in:		
Physiographic province	Total acres spotted owl NRF* habitat	Total acres marbled murrelet nesting habitat	Spotted owl NRF* habitat	Marbled murrelet nesting habitat	Spotted owl NRF* habitat	Marbled murrelet nesting habitat	Late-Successional Reserves	Riparian Reserves	Matrix	Late-Successional Reserves	Riparian Reserves	Matrix
Washington												
Eastern Cascades	713,100	6,600	213,500	3,300	24,500	0	350,600	34,700	89,900	2,500	0	0
Western Cascades	1,112,600	363,600	345,400	122,100	55,000	17,700	583,700	38,900	89,600	116,900	10,600	36,600
Western Lowlands	0	0	0	0	0	0	0	0	0	60,400	0	0
Olympic Peninsula	562,700	605,600	340,700	393,900	500	700	209,800	4,900	6,900	155,400	11,600	16,300
Total:	2,388,400	975,800	899,600	519,300	80,000	18,400	1,144,100	78,500	186,400	335,200	22,200	52,900
Oregon												
Klamath	802,500	530,800	76,700	72,400	17,000	14,000	469,500	70,700	168,700	272,800	41,900	74,300
Eastern Cascades	439,600	0	101,800	0	22,200	0	220,600	23,000	71,900	83,200	0	0
Western Cascades	2,066,100	900	243,700	0	43,500	0	1,213,100	169,400	396,300	800	0	100
Coast Range	529,200	434,300	13,000	13,000	1,200	1,000	391,500	47,200	76,300	306,800	35,900	56,900
Willamette Valley	5,700	600	0	0	0	0	1,600	1,500	2,600	21,100	100	100
Total:	3,843,100	966,600	435,200	85,400	83,900	15,000	2,296,300	311,800	715,800	684,700	77,900	131,400
California												
Coast range	7,700	31,600	1,300	13,500	300	300	2,900	1,000	2,200	7,900	1,000	3,300
Klamath	1,074,900	587,500	303,800	129,100	91,400	60,600	478,000	64,600	137,200	123,600	35,200	77,700
Cascades	75,400	0	800	0	4,900	0	50,800	5,700	13,100	166,800	0	0
Total:	1,158,000	619,100	305,900	142,600	96,600	60,900	531,700	71,300	152,500	298,300	36,200	81,000
Three-State Total:	7,389,500	2,561,500	1,640,700	747,300	260,500	94,300	3,972,100	461,600	1,054,700	1,318,200	136,300	265,300

* NRF = Nesting, roosting, and foraging

Table IV-29. Allocation of acres of habitat for northern spotted owls and marbled murrelets on federal lands in Option 3.

Physiographic province	Total acres spotted owl NRF* habitat	Total acres marbled murrelet nesting habitat	Congressionally Withdrawn Areas: Spotted owl NRF* habitat	Congressionally Withdrawn Areas: Marbled murrelet nesting habitat	Administratively Withdrawn Areas: Spotted owl NRF* habitat	Administratively Withdrawn Areas: Marbled murrelet nesting habitat	Acres of spotted owl NRF* habitat in: Late-Successional Reserves	Acres of spotted owl NRF* habitat in: Managed Late-Successio Areas	Acres of spotted owl NRF* habitat in: Riparian Reserves	Acres of spotted owl NRF* habitat in: Matrix	Acres of marbled murrelet nesting habitat in: Late-Successional Reserves	Acres of marbled murrelet nesting habitat in: Managed Late-Successio Areas	Acres of marbled murrelet nesting habitat in: Riparian Reserves	Acres of marbled murrelet nesting habitat in: Matrix
Washington														
Eastern Cascades	713,100	6,600	213,500	3,300	22,200	0	375,400	0	31,500	70,500	2,500	0	0	0
Western Cascades	1,112,600	363,600	345,400	122,100	74,500	20,600	529,300	37,200	43,000	83,200	115,100	3,800	11,900	33,300
Western Lowlands	0	0	0	0	0	0	0	0	0	0	57,600	0	0	0
Olympic Peninsula	562,700	605,600	340,700	393,900	500	700	210,200	0	5,100	6,400	156,300	0	12,100	14,900
Total:	2,388,400	975,800	899,600	519,300	97,200	21,300	1,114,900	37,200	79,600	160,100	331,500	3,800	24,000	48,200
Oregon														
Klamath	802,500	530,800	76,700	72,400	25,800	18,500	398,600	63,000	72,300	166,200	248,800	25,000	42,000	73,200
Eastern Cascades	439,600	0	101,800	0	21,100	0	225,500	0	24,500	66,700	78,600	0	0	0
Western Cascades	2,066,100	900	243,700	0	71,100	0	895,400	290,200	190,900	374,800	800	0	0	100
Coast Range	529,200	434,300	13,000	13,000	1,500	1,100	400,400	1,300	44,600	68,400	315,600	700	33,400	49,900
Willamette Valley	5,700	600	0	0	0	0	1,500	100	1,500	2,600	21,000	0	100	100
Total:	3,843,100	966,600	435,200	85,400	119,500	19,600	1,921,400	354,600	333,800	678,700	664,800	25,700	75,500	123,300
California														
Coast range	7,700	31,600	1,300	13,500	300	300	2,900	0	1,200	2,000	7,900	0	1,300	3,100
Klamath	1,074,900	587,500	303,800	129,100	112,300	76,000	423,600	33,600	75,400	126,200	101,800	21,900	41,000	71,800
Cascades	75,400	0	800	0	4,900	0	50,800	0	5,700	13,100	151,400	0	0	0
Total:	1,158,000	619,100	305,900	142,600	117,500	76,300	477,300	33,600	82,300	141,300	261,100	21,900	42,300	74,900
Three-State Total	7,389,500	2,561,500	1,640,700	747,300	334,200	117,200	3,513,600	425,400	495,700	980,100	1,257,400	51,400	141,800	246,400

* NRF = Nesting, roosting, and foraging

Table IV-30. Allocation of acres of habitat for northern spotted owls and marbled murrelets on federal lands in Option 4.

Physiographic province	Total acres spotted owl NRF* habitat	Total acres marbled murrelet nesting habitat	Congressionally Withdrawn Areas: Spotted owl NRF* habitat	Congressionally Withdrawn Areas: Marbled murrelet nesting habitat	Administratively Withdrawn Areas: Spotted owl NRF* habitat	Administratively Withdrawn Areas: Marbled murrelet nesting habitat	Acres of spotted owl NRF* habitat in: Late-Successional Reserves**	Acres of spotted owl NRF* habitat in: Riparian Reserves	Acres of spotted owl NRF* habitat in: Matrix	Acres of marbled murrelet nesting habitat in: Late-Successional Reserves**	Acres of marbled murrelet nesting habitat in: Riparian Reserves	Acres of marbled murrelet nesting habitat in: Matrix
Washington												
Eastern Cascades	713,100	6,600	213,500	3,300	20,000	0	384,500	33,800	61,400	2,500	0	0
Western Cascades	1,112,600	363,600	345,400	122,100	50,200	13,800	592,400	53,400	71,300	129,600	10,800	23,700
Western Lowlands	0	0	0	0	0	0	0	0	0	64,400	0	0
Olympic Peninsula	562,700	605,600	340,700	393,900	200	300	212,800	4,600	4,500	159,600	12,000	11,700
Total:	2,388,400	975,800	899,600	519,300	70,400	14,100	1,189,700	91,800	137,200	356,100	22,800	35,400
Oregon												
Klamath	802,500	530,800	76,700	72,400	21,900	17,200	444,300	95,900	163,700	266,000	49,400	74,000
Eastern Cascades	439,600	0	101,800	0	28,700	0	192,900	40,600	75,700	79,900	0	0
Western Cascades	2,066,100	900	243,700	0	58,800	0	987,400	322,200	453,900	900	0	0
Coast Range	529,200	434,300	13,000	13,000	1,300	1,000	422,600	45,300	47,000	333,100	33,300	33,200
Willamette Valley	5,700	600	0	0	0	0	1,500	1,900	2,300	21,100	100	100
Total:	3,843,100	966,600	435,200	85,400	110,700	18,200	2,048,700	505,900	742,600	701,000	82,800	107,300
California												
Coast range	7,700	31,600	1,300	13,500	300	300	3,000	1,300	1,700	9,200	1,200	2,000
Klamath	1,074,900	587,500	303,800	129,100	92,000	62,100	451,800	100,900	126,400	103,300	57,100	76,100
Cascades	75,400	0	800	0	2,600	0	57,800	6,100	8,000	165,400	0	0
Total:	1,158,000	619,100	305,900	142,600	94,900	62,400	512,600	108,300	136,100	277,900	58,300	78,100
Three-State Total:	7,389,500	2,561,500	1,640,700	747,300	276,000	94,700	3,751,000	706,000	1,015,900	1,335,000	163,900	220,800

* NRF = Nesting, roosting, and foraging

** Includes 147,000 acres of Managed Late-Successional Areas.

Table IV-31. Allocation of acres of habitat for northern spotted owls and marbled murrelets on federal lands in Option 5.

Physiographic province	Total acres spotted owl NRF* habitat	Total acres marbled murrelet nesting habitat	Congressionally Withdrawn Areas: Spotted owl NRF* habitat	Congressionally Withdrawn Areas: Marbled murrelet nesting habitat	Administratively Withdrawn Areas: Spotted owl NRF* habitat	Administratively Withdrawn Areas: Marbled murrelet nesting habitat	Acres of spotted owl NRF* habitat in: Late-Successional Reserves**	Acres of spotted owl NRF* habitat in: Riparian Reserves	Acres of spotted owl NRF* habitat in: Matrix	Acres of marbled murrelet nesting habitat in: Late-Successional Reserves**	Acres of marbled murrelet nesting habitat in: Riparian Reserves	Acres of marbled murrelet nesting habitat in: Matrix
Washington												
Eastern Cascades	713,100	6,600	213,500	3,300	51,900	0	338,500	32,800	76,400	2,500	0	0
Western Cascades	1,112,600	363,600	345,400	122,100	62,600	15,200	533,200	64,300	107,200	126,500	10,200	27,300
Western Lowlands	0	0	0	0	0	0	0	0	0	63,000	0	0
Olympic Peninsula	562,700	605,600	340,700	393,900	200	300	212,800	4,000	5,000	159,600	10,700	13,000
Total:	**2,388,400**	**975,800**	**899,600**	**519,300**	**114,700**	**15,500**	**1,084,500**	**101,100**	**188,600**	**351,600**	**20,900**	**40,300**
Oregon												
Klamath	802,500	530,800	76,700	72,400	31,600	23,000	396,800	91,900	205,600	250,400	51,100	88,000
Eastern Cascades	439,600	0	101,800	0	48,100	0	115,600	45,100	129,000	74,100	0	0
Western Cascades	2,066,100	900	243,700	0	114,500	0	629,200	362,400	716,300	700	100	200
Coast Range	529,200	434,300	13,000	13,000	1,300	1,000	421,300	36,900	56,700	332,800	26,800	40,000
Willamette Valley	5,700	600	0	0	200	0	700	1,800	3,000	21,100	100	100
Total:	**3,843,100**	**966,600**	**435,200**	**85,400**	**195,700**	**24,000**	**1,563,600**	**538,100**	**1,110,600**	**679,100**	**78,100**	**128,300**
California												
Coast range	7,700	31,600	1,300	13,500	300	300	3,000	1,100	1,900	9,200	1,000	2,100
Klamath	1,074,900	587,500	303,800	129,100	107,200	68,300	387,600	101,700	174,600	81,700	55,200	99,500
Cascades	75,400	0	800	0	3,000	0	54,600	5,300	11,700	159,200	0	0
Total:	**1,158,000**	**619,100**	**305,900**	**142,600**	**110,500**	**68,600**	**445,200**	**108,100**	**188,200**	**250,100**	**56,200**	**101,600**
Three-State Total:	**7,389,500**	**2,561,500**	**1,640,700**	**747,300**	**420,900**	**108,100**	**3,093,300**	**747,300**	**1,487,400**	**1,280,800**	**155,200**	**270,200**

* NRF = Nesting, roosting, and foraging

** Includes 147,000 acres of Managed Late-Successional Areas.

Table IV-32. Allocation of acres of habitat for northern spotted owls and marbled murrelets on federal lands in Options 6 and 10.

Physiographic province	Total acres spotted owl NRF* habitat	Total acres marbled murrelet nesting habitat	Congressionally Withdrawn Areas: Spotted owl NRF* habitat	Congressionally Withdrawn Areas: Marbled murrelet nesting habitat	Administratively Withdrawn Areas: Spotted owl NRF* habitat	Administratively Withdrawn Areas: Marbled murrelet nesting habitat	Acres of spotted owl NRF* habitat in: Late-Successional Reserves	Acres of spotted owl NRF* habitat in: Riparian Reserves	Acres of spotted owl NRF* habitat in: Matrix	Acres of marbled murrelet nesting habitat in: Late-Successional Reserves	Acres of marbled murrelet nesting habitat in: Riparian Reserves	Acres of marbled murrelet nesting habitat in: Matrix
Washington												
Eastern Cascades	713,100	6,600	213,500	3,300	32,200	0	326,000	38,900	102,600	2,500	0	0
Western Cascades	1,112,600	363,600	345,400	122,100	74,500	20,600	529,300	52,800	110,500	115,100	11,300	37,700
Western Lowlands	0	0	0	0	0	0	0	0	0	57,600	0	0
Olympic Peninsula	562,700	605,600	340,700	393,900	500	700	210,200	4,700	6,700	156,300	11,200	15,800
Total:	2,388,400	975,800	899,600	519,300	107,200	21,300	1,065,500	96,400	219,800	331,500	22,500	53,500
Oregon												
Klamath	802,500	530,800	76,700	72,400	25,800	18,500	398,600	86,700	214,800	248,800	50,100	90,200
Eastern Cascades	439,600	0	101,800	0	36,600	0	171,300	31,700	98,200	78,600	0	0
Western Cascades	2,066,100	900	243,700	0	71,100	0	895,400	251,800	604,000	800	0	100
Coast Range	529,200	434,300	13,000	13,000	1,500	1,100	400,400	43,100	71,200	315,600	32,000	52,000
Willamette Valley	5,700	600	0	0	0	0	1,500	1,500	2,700	21,000	100	100
Total:	3,843,100	966,600	435,200	85,400	135,000	19,600	1,867,200	414,800	990,900	664,800	82,200	142,400
California												
Coast range	7,700	31,600	1,300	13,500	300	300	2,900	1,000	2,200	7,900	1,000	3,300
Klamath	1,074,900	587,500	303,800	129,100	112,300	76,000	423,600	74,700	160,500	101,800	41,500	93,200
Cascades	75,400	0	800	0	5,200	0	49,500	6,000	13,800	151,400	0	0
Total:	1,158,000	619,100	305,900	142,600	117,800	76,300	476,000	81,700	176,500	261,100	42,500	96,500
Three-State Total:	7,389,500	2,561,500	1,640,700	747,300	360,000	117,200	3,408,700	592,900	1,387,200	1,257,400	147,200	292,400

* NRF = Nesting, roosting, and foraging

Table IV-33. Allocation of acres of habitat for northern spotted owls and marbled murrelets on federal lands in Option 7.

Physiographic province	Total acres spotted owl NRF* habitat	Total acres marbled murrelet nesting habitat	Congressionally Withdrawn Areas: Spotted owl NRF* habitat	Congressionally Withdrawn Areas: Marbled murrelet nesting habitat	Administratively Withdrawn Areas: Spotted owl NRF* habitat	Administratively Withdrawn Areas: Marbled murrelet nesting habitat	Acres of spotted owl NRF* habitat in: Late-Successional Reserves**	Acres of spotted owl NRF* habitat in: Riparian Reserves	Acres of spotted owl NRF* habitat in: Matrix	Acres of marbled murrelet nesting habitat in: Late-Successional Reserves**	Acres of marbled murrelet nesting habitat in: Riparian Reserves	Acres of marbled murrelet nesting habitat in: Matrix
Washington												
Eastern Cascades	713,100	6,600	213,500	3,300	51,900	0	338,500	7,500	101,700	2,500	0	0
Western Cascades	1,112,600	363,600	345,400	122,100	78,700	23,100	499,100	15,300	174,200	116,400	2,600	45,100
Western Lowlands	0	0	0	0	0	0	0	0	0	55,000	0	0
Olympic Peninsula	562,700	605,600	340,700	393,900	2,700	2,300	184,500	2,900	31,900	137,800	3,800	41,600
Total:	**2,388,400**	**975,800**	**899,600**	**519,300**	**133,300**	**25,400**	**1,022,100**	**25,700**	**307,800**	**311,700**	**6,400**	**86,700**
Oregon												
Klamath	802,500	530,800	76,700	72,400	69,700	60,900	234,700	27,500	394,000	136,100	17,400	233,900
Eastern Cascades	439,600	0	101,800	0	48,100	0	114,300	9,900	165,500	36,200	0	0
Western Cascades	2,066,100	900	243,700	0	114,600	0	618,400	74,700	1,014,600	600	0	300
Coast Range	529,200	434,300	13,000	13,000	2,900	2,600	328,000	14,900	170,500	250,900	12,100	136,600
Willamette Valley	5,700	600	0	0	200	0	200	400	4,900	19,200	0	400
Total:	**3,843,100**	**966,600**	**435,200**	**85,400**	**235,500**	**63,500**	**1,295,600**	**127,400**	**1,749,500**	**443,000**	**29,500**	**371,200**
California												
Coast range	7,700	31,600	1,300	13,500	300	300	3,000	200	2,900	9,100	200	3,000
Klamath	1,074,900	587,500	303,800	129,100	133,100	94,100	308,500	23,400	306,100	28,500	14,100	193,900
Cascades	75,400	0	800	0	3,000	0	54,600	1,200	15,700	133,300	0	0
Total:	**1,158,000**	**619,100**	**305,900**	**142,600**	**136,400**	**94,400**	**366,100**	**24,800**	**324,700**	**170,900**	**14,300**	**196,900**
Three-State Total:	**7,389,500**	**2,561,500**	**1,640,700**	**747,300**	**505,200**	**183,300**	**2,683,800**	**177,900**	**2,382,000**	**925,600**	**50,200**	**654,800**

* NRF = Nesting, roosting, and foraging

** Includes 147,000 acres of Managed Late-Successional Areas.

Table IV-34. Allocation of acres of habitat for northern spotted owls and marbled murrelets on federal lands in Option 8.

Physiographic province	Total acres spotted owl NRF* habitat	Total acres marbled murrelet nesting habitat	Congressionally Withdrawn Areas: Spotted owl NRF* habitat	Congressionally Withdrawn Areas: Marbled murrelet nesting habitat	Administratively Withdrawn Areas: Spotted owl NRF* habitat	Administratively Withdrawn Areas: Marbled murrelet nesting habitat	Acres of spotted owl NRF* habitat in: Late-Successional Reserves	Acres of spotted owl NRF* habitat in: Riparian Reserves	Acres of spotted owl NRF* habitat in: Matrix	Acres of marbled murrelet nesting habitat in: Late-Successional Reserves	Acres of marbled murrelet nesting habitat in: Riparian Reserves	Acres of marbled murrelet nesting habitat in: Matrix
Washington												
Eastern Cascades	713,100	6,600	213,500	3,300	32,200	0	326,000	25,600	115,900	2,500	0	0
Western Cascades	1,112,600	363,600	345,400	122,100	74,500	20,600	529,300	36,500	126,800	115,100	7,600	41,400
Western Lowlands	0	0	0	0	0	0	0	0	0	57,600	0	0
Olympic Peninsula	562,700	605,600	340,700	393,900	500	700	210,200	3,800	7,700	156,300	8,900	18,100
Total:	2,388,400	975,800	899,600	519,300	107,200	21,300	1,065,500	65,900	250,400	331,500	16,500	59,500
Oregon												
Klamath	802,500	530,800	76,700	72,400	25,800	18,500	398,600	54,000	247,500	248,800	28,900	111,400
Eastern Cascades	439,600	0	101,800	0	36,600	0	171,300	19,400	110,500	78,600	0	0
Western Cascades	2,066,100	900	243,700	0	71,100	0	895,400	158,200	697,700	800	0	100
Coast Range	529,200	434,300	13,000	13,000	1,500	1,100	400,400	29,300	85,000	315,600	22,200	61,800
Willamette Valley	5,700	600	0	0	0	0	1,500	1,000	3,200	21,000	0	100
Total:	3,843,100	966,600	435,200	85,400	135,000	19,600	1,867,200	261,900	1,143,900	664,800	51,100	173,400
California												
Coast range	7,700	31,600	1,300	13,500	300	300	2,900	600	2,600	7,900	700	3,700
Klamath	1,074,900	587,500	303,800	129,100	112,300	76,000	423,600	51,100	184,100	101,800	28,600	106,100
Cascades	75,400	0	800	0	5,200	0	49,500	4,100	15,800	151,400	0	0
Total:	1,158,000	619,100	305,900	142,600	117,800	76,300	476,000	55,800	202,500	261,100	29,300	109,800
Three-State Total:	7,389,500	2,561,500	1,640,700	747,300	360,000	117,200	3,408,700	383,600	1,596,800	1,257,400	96,900	342,700

* NRF = Nesting, roosting, and foraging

Table IV-35. Allocation of acres of habitat for northern spotted owls and marbled murrelets on federal lands in Option 9.

			Congressionally Withdrawn Areas		Administratively Withdrawn Areas		Acres of spotted owl NRF* habitat in:				Acres of marbled murrelet nesting habitat in:			
Physiographic province	Total acres spotted owl NRF* habitat	Total acres marbled murrelet nesting habitat	Spotted owl NRF* habitat	Marbled murrelet nesting habitat	Spotted owl NRF* habitat	Marbled murrelet nesting habitat	Late-Successional Reserves	Adaptive Management Areas	Riparian Reserves	Matrix	Late-Successional Reserves	Adaptive Management Areas	Riparian Reserves	Matrix
Washington														
Eastern Cascades	713,100	6,600	213,500	3,300	50,900	0	270,000	38,800	46,200	93,700	2,500	0	0	0
Western Cascades	1,112,600	363,600	345,400	122,100	61,100	18,100	453,100	78,700	62,400	112,000	98,500	22,100	13,200	34,800
Western Lowlands	0	0	0	0	0	0	0	0	0	0	55,600	0	0	0
Olympic Peninsula	562,700	605,600	340,700	393,900	0	0	205,500	16,500	0	0	150,700	34,500	0	0
Total:	**2,388,400**	**975,800**	**899,600**	**519,300**	**112,000**	**18,100**	**928,600**	**134,000**	**108,600**	**205,700**	**307,300**	**56,600**	**13,200**	**34,800**
Oregon														
Klamath	802,500	530,800	76,700	72,400	26,200	24,700	338,700	72,000	95,600	193,500	215,500	11,300	63,400	101,200
Eastern Cascades	439,600	0	101,800	0	40,700	0	142,400	0	41,400	113,300	68,700	0	0	0
Western Cascades	2,066,100	900	243,700	0	89,200	0	774,300	134,100	256,600	568,200	0	0	300	600
Coast Range	529,200	434,300	13,000	13,000	1,400	1,100	345,100	63,400	39,500	66,900	288,300	34,300	31,500	52,600
Willamette Valley	5,700	600	0	0	100	0	300	100	1,900	3,300	13,800	0	100	200
Total:	**3,843,100**	**966,600**	**435,200**	**85,400**	**157,600**	**25,800**	**1,600,800**	**269,600**	**435,000**	**945,200**	**586,300**	**45,600**	**95,300**	**154,600**
California														
Coast range	7,700	31,600	1,300	13,500	200	300	3,200	0	1,100	1,900	9,200	0	1,000	2,100
Klamath	1,074,900	587,500	303,800	129,100	101,000	70,100	413,700	44,300	79,500	132,600	86,000	22,900	46,900	85,400
Cascades	75,400	0	800	0	4,800	0	54,100	0	4,800	10,900	152,500	0	0	0
Total:	**1,158,000**	**619,100**	**305,900**	**142,600**	**106,000**	**70,400**	**471,000**	**44,300**	**85,400**	**145,400**	**247,700**	**22,900**	**47,900**	**87,500**
Three-State Total	**7,389,500**	**2,561,500**	**1,640,700**	**747,300**	**375,600**	**114,300**	**3,000,400**	**447,900**	**629,000**	**1,296,300**	**1,141,300**	**125,100**	**156,400**	**276,900**

* NRF = Nesting, roosting, and foraging

Table IV-36. Summary of acreage for northern spotted owl and marbled murrelet habitat on various federal lands in the range of the northern spotted owl for each option. Number of sites occupied by spotted owls and marbled murrelets are indicated by land allocation for each option.

Habitat / species	Total on federal land	Congressional Withdrawn Areas	Option 1 Late-Successional Reserves	Option 1 Administrative Withdrawn	Option 1 Riparian Reserves	Option 2 Late-Successional Reserves	Option 2 Administrative Withdrawn	Option 2 Riparian Reserves	Option 3 Late-Successional Reserves	Option 3 Managed Late-Successional Areas	Option 3 Administrative Withdrawn	Option 3 Riparian Reserves
Spotted Owl nesting, roosting, and foraging habitat acres	7,389,400	1,640,700	4,955,700	104,600	291,100	3,972,000	260,500	461,500	3,513,400	425,400	334,300	495,700
Marbled Murrelet nesting habitat acres	2,561,500	747,300	1,660,200	22,200	61,000	1,318,300	94,300	136,400	1,257,400	51,400	117,200	141,800
Late-successional conifer												
acres small conifer:	5,768,900	1,619,400	2,377,700	333,200	580,600	225,300	335,000	475,700	2,096,500	181,800	368,300	489,400
Medium / large conifer												
acres Single story:	4,032,200	1,150,500	2,880,700	0	400	1,747,600	189,700	278,100	1,556,400	178,900	227,400	300,500
acres Multi-story:	4,498,400	1,300,300	3,180,000	0	6,600	2,030,100	241,700	283,200	1,779,500	217,200	290,400	308,700
Spotted Owl pairs:	2,772	273	2,211	26	-	1,856	88	-	1,581	247	128	-
Spotted Owl singles:	761	94	563	7	-	439	21	-	373	59	33	-
Occupied Murrelet sites:	577	44	533	0	-	533	0	-	533	0	0	-

Habitat / species	Total on federal land	Congressional Withdrawn Areas	Option 4 Late-Successional Reserves*	Option 4 Administrative Withdrawn	Option 4 Riparian Reserves	Option 5 Late-Successional Reserves*	Option 5 Administrative Withdrawn	Option 5 Riparian Reserves	Option 6 and Option 10** Late-Successional Reserves	Option 6 and Option 10** Administrative Withdrawn	Option 6 and Option 10** Riparian Reserves
Spotted Owl nesting, roosting, and foraging habitat acres	7,389,400	1,640,700	3,751,000	276,000	706,100	3,093,200	420,900	747,200	3,408,500	360,000	593,000
Marbled Murrelet nesting habitat acres	2,561,500	747,300	1,334,900	94,700	163,800	1,280,700	108,200	155,100	1,257,400	117,200	147,200
Late-successional conifer											
acres small conifer:	5,768,900	1,619,400	2,102,100	399,200	656,700	1,651,500	538,600	623,100	1,907,700	432,600	539,800
Medium / large conifer											
acres Single story:	4,032,200	1,150,500	1,657,500	202,700	414,700	1,330,700	286,000	414,200	1,479,700	249,700	337,500
acres Multi-story:	4,498,400	1,300,300	1,896,200	251,100	436,900	1,599,400	324,900	424,200	1,740,600	301,000	345,200
Spotted Owl pairs:	2,772	273	1,802	86	-	1,522	136	-	1,549	132	-
Spotted Owl singles:	761	94	401	27	-	324	44	-	366	34	-
Occupied Murrelet sites:	577	44	533	0	-	533	0	-	533	0	-

* Includes 147,000 acres of Managed Late-Successional Areas.
** Table information is the same for Option 6 and Option 10

Mitigation for Marbled Murrelets

In developing a strategy for marbled murrelet nesting habitat on federal lands, the key components were: (1) stabilization or improvement of nesting habitat through protection of all occupied sites (both current and future); (2) development of future habitat in large blocks (creating more interior habitat and possibly decreasing avian predation); and (3) improvement of distribution of habitat, thereby improving distribution of marbled murrelet populations.

Role of nonfederal lands. In some parts of the range of the marbled murrelet, private lands are key to maintaining the existing distribution of marbled murrelets and providing for potential recovery of the species. Areas where there are large gaps in federal ownership, and where contributions from private and state lands may be especially important include northern California, the area between the Siskiyou and Siuslaw National Forests in Oregon, and the area between the central Coast Ranges of Oregon and the Olympic Peninsula in Washington. In these areas, which are largely in private or state ownership, past harvest activities have produced a landscape dominated by young forests with isolated small tracts of late-successional/old-growth forest. Where gaps in federal ownership exist, management and development of murrelet habitat on private and state lands could provide for a higher viability rating and an increased likelihood that the ecosystem plan adopted on federal lands will maintain marbled murrelets for the long term. Federal agencies should actively encourage state and private landowners to join in cooperative management efforts for marbled murrelets.

Research needs. Virtually all aspects of the biology and ecology of the marbled murrelet need further research. Key areas that need more study include: (1) population ecology, including determination of age-specific birth and death rates, population trends, and population size; (2) determination of relative influence of factors affecting demographic rates, including nest site characteristics, forest fragmentation, prey populations, net fisheries, predation, and contaminants; (3) distribution and abundance by land ownership and geographic area; and (4) influence of habitat pattern on nest site selection. In addition, information is needed on the extent to which marbled murrelets are capable of moving to alternate nest sites when historical nest locations are lost to harvest or natural events such as fire or wind.

Other Birds

Introduction. We assessed 36 species of birds closely associated with late-successional and old-growth forests as identified in the "short list" of The Scientific Analysis Team Report (Thomas et al. 1993). The marbled murrelet and northern spotted owl were addressed in separate assessments because both were listed as threatened under the Endangered Species Act, because neither species had a final recovery plan, and because both species have been a major focus in the scientific, political, legal, and social controversy surrounding late-successional/old-growth forest management issues.

The bald eagle, which is federally listed as "threatened" under the Endangered Species Act in Oregon and Washington and "endangered" in California, is included in this assessment. All options incorporated the guidelines suggested in the U.S. Fish and Wildlife Service recovery plan for the bald eagle (USDI Fish and Wildlife Service 1986).

Table IV-36. (continued)

Habitat / species	Total on federal land	Congressional Withdrawn Areas	Option 7 Late-Successional Reserves*	Option 7 Administrative Withdrawn	Option 7 Riparian Reserves	Option 8 Late-Successional Reserves	Option 8 Administrative Withdrawn	Option 8 Riparian Reserves	Option 9 Late-Successional Reserves	Option 9 Adaptive Management Areas	Option 9 Administrative Withdrawn	Option 9 Riparian Reserves
Spotted Owl nesting, roosting, and foraging habitat acres	7,389,400	1,640,700	2,683,700	505,100	177,900	3,408,500	360,000	383,600	3,000,500	447,800	375,400	628,900
Marbled Murrelet nesting habitat acres	2,561,500	747,300	925,700	183,300	50,200	1,257,400	117,200	97,000	1,141,100	125,200	114,500	156,400
Late-successional conifer												
acres small conifer:	5,768,900	1,619,400	1,384,200	587,600	146,800	1,907,700	432,600	349,600	1,725,900	380,000	413,800	519,000
Medium / large conifer												
acres Single story:	4,032,200	1,150,500	1,220,500	305,100	94,900	1,479,700	249,700	215,400	1,370,900	258,600	218,700	334,600
acres Multi-story:	4,498,400	1,300,300	1,358,500	386,500	99,200	1,740,600	301,000	235,800	1,604,100	198,400	281,900	361,900
Spotted Owl pairs:	2,772	273	1,325	152	-	1,549	132	-	1,366	230	102	-
Spotted Owl singles:	761	94	268	52	-	366	34	-	326	50	31	-
Occupied Murrelet sites:	577	44	258	99	-	383	10	-	533	0	0	-

* Includes 147,000 acres of Managed Late-Successional Areas.

Table IV- 37. Projected future likelihoods of habitat outcomes for birds under land management options.

Birds	Option 1				Option 3				Option 4				Option 5				Option 7				Option 8				Option 9			
	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
Bald eagle	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0
Barred owl	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0
Barrow's goldeneye	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	80	20	0	0	100	0	0	0	100	0	0	0
Black-backed woodpecker	100	0	0	0	93	7	0	0	93	7	0	0	93	7	0	0	93	7	0	0	53	47	0	0	73	27	0	0
Brown creeper	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0
Bufflehead	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	87	13	0	0	100	0	0	0	100	0	0	0
Chestnut-backed chickadee	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0
Common merganser	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	93	7	0	0	87	13	0	0	100	0	0	0
Flammulated owl	100	0	0	0	93	7	0	0	93	7	0	0	93	7	0	0	93	7	0	0	70	30	0	0	93	7	0	0
Golden-crowned kinglet	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0
Great gray owl	93	7	0	0	90	10	0	0	90	10	0	0	83	17	0	0	80	20	0	0	73	27	0	0	83	17	0	0
Hairy woodpecker	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0
Hammond's flycatcher	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0
Harlequin duck	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	80	20	0	0	100	0	0	0	100	0	0	0
Hermit thrush	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0
Hermit warbler	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0
Hooded merganser	100	0	0	0	93	7	0	0	93	7	0	0	93	7	0	0	90	10	0	0	77	23	0	0	93	7	0	0
Northern flicker	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0
Northern goshawk	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	93	7	0	0	83	17	0	0	100	0	0	0
Northern pygmy-owl	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	80	20	0	0	100	0	0	0
Pileated woodpecker	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	93	7	0	0	100	0	0	0
Pygmy nuthatch	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	80	20	0	0	70	30	0	0	100	0	0	0
Red crossbill	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0
Red-breasted nuthatch	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0
Red-breasted sapsucker	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0
Three-toed woodpecker	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	80	20	0	0	100	0	0	0
Varied thrush	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0
Vaux's swift	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	93	7	0	0	83	17	0	0	100	0	0	0
Warbling vireo	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0
Western flycatcher (Pacific slope flycatcher)	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0

A-Well Distributed B-Locally Restricted C-Restricted to Refugia D-Extirpation

Likelihood values are expressed as percentages that total to 100 for a given species within an option. Number displayed may vary due to rounding errors. See text for fuller explanation and discussion of the rating scale.

Table IV- 37 (cont). Projected future likelihoods of habitat outcomes for birds under land management options.

Birds	Option 1				Option 3				Option 4				Option 5				Option 7				Option 8				Option 9			
	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
White breasted nuthatch	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	93	7	0	0	93	7	0	0	100	0	0	0
White-headed woodpecker	100	0	0	0	97	3	0	0	97	3	0	0	97	3	0	0	77	23	0	0	67	33	0	0	100	0	0	0
Williamson's sapsucker	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	80	20	0	0	67	33	0	0	100	0	0	0
Wilson's warbler	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0
Winter wren	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0
Wood duck	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	87	13	0	0	100	0	0	0	100	0	0	0

A-Well Distributed B-Locally Restricted C-Restricted to Refugia D-Extirpation

Likelihood values are expressed as percentages that total to 100 for a given species within an option. Numbers displayed may vary due to rounding errors. See text for fuller explanation and discussion of the rating scale.

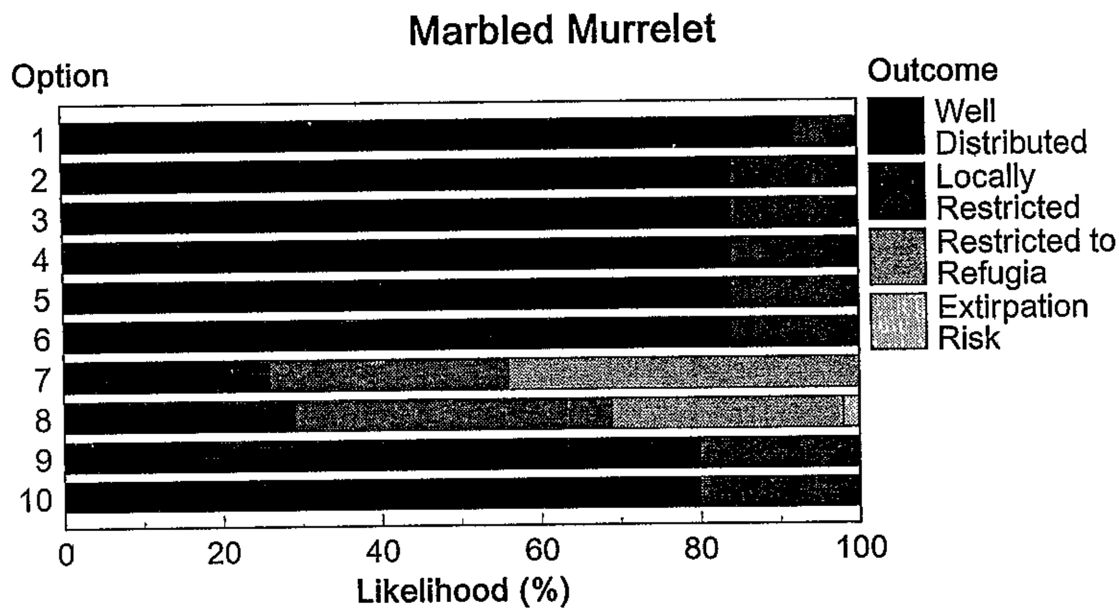

Figure IV-18. Outcomes for marbled murrelets under each management option. Values shown are the number of the species that had an 80 percent or greater likelihood of achieving at least the specified outcome.

Methods specific to other birds. Methods used to assess the effects of options on birds were the same as those described in the section on Methods of Assessing Effects of Options. Options 2,6, and 10 were not assessed for birds other than the northern spotted owl and marbled murrelet.

Results. For Options 1, 3, 4, and 5, we concluded that all 36 bird species had an 80 percent or greater likelihood of achieving outcome A (table IV-37, fig. IV-19). For Options 7 and 9, 35 species had an 80 percent or greater likelihood of achieving outcome A. For option 8, seven species were rated less than 80 percent likelihood of achieving outcome A, and one species (black-backed woodpecker) was rated less than 60 percent likelihood of achieving outcome A (table IV-37).

Discussion. Essential considerations for bird viability ratings were (1) provision of a system of large reserves, (2) provision of standards and guidelines for riparian protection and analysis as identified for watershed guidelines in the report of the Scientific Analysis Team (Thomas et al. 1993) report, and (3) provisions for retention of green trees, snags, and down woody material within the matrix. When one or more of these factors was judged inadequate in an option, some subset of the total species usually rated lower. For example, Option 7, which included rather narrow riparian buffers, rated lower for a number of waterfowl that nest adjacent to streams or lakes. Option 8, which allowed considerable salvage and harvest within reserves, rated lower than most other options for a number of woodpeckers and other cavity nesters that depend upon large snags. Options 7 and 8 also rated lower for a number of species because neither option

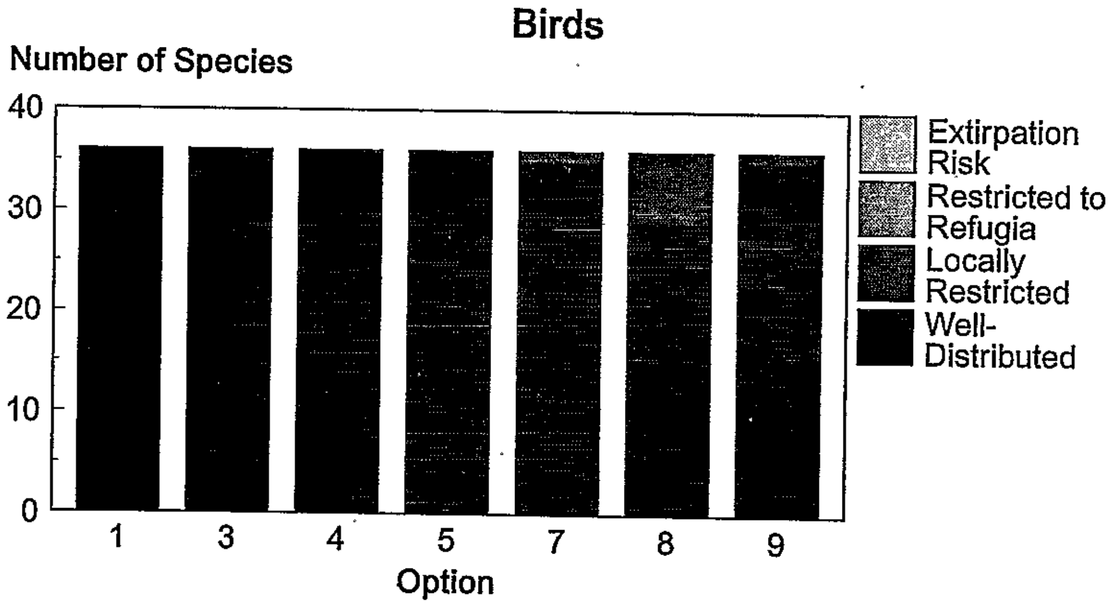

Figure IV-19. Outcomes for species of birds under each land management option. Values shown are the number of species that had an 80 percent or greater likelihood of achieving at least the specified outcome (based on distribution of habitat).

included the mitigation measures that were proposed by Thomas et al. (1993) for selected species that were thought to be at risk under the existing Forest Plans.

For 19 of the 36 bird species considered in this assessment, all seven options were rated as providing a 100 percent likelihood of achieving outcome A. Of the species that did not rate 100 percent likelihood of outcome A in all options, most need further study to better understand and address their habitat needs. In addition, the ranges of a number of species (e.g., Barrow's goldeneye, bufflehead, harlequin duck, great gray owl and flammulated owl) only slightly overlap the range of the northern spotted owl. Addressing these species on federal lands outside the range of the spotted owl is recommended as well. These species may also be affected by activities on nonfederal lands and within Canada (see below).

Because the common merganser occupies low elevation waterways often outside the influence of federal management, its viability cannot be adequately insured by any of the options considered here. The other waterfowl addressed in this assessment winter in lowland areas where they are subject to hunting and other forms of disturbance. The viability of these species is only partially a function of the quality of habitat on federal lands.

Mitigation for Other Birds

Those options that have reduced riparian protection (e.g., 7 and 8) could be improved for waterfowl by implementing wider riparian buffers. Three woodpeckers (black-backed, white-headed and Williamson's woodpeckers) rated less than 80 percent likelihood of achieving outcome A under one or more options. All three species are primarily located in the eastern Cascades Province. Mitigation for these three species could include adoption of more restrictive guidelines for salvage in the eastern Cascades Provinces.

There were two species of concern for which mitigation could increase their rating in Options 7 and 8. The northern goshawk could be mitigated by protecting occupied and key nesting and foraging habitat within the Matrix as per Thomas et al. (1993) or the U.S. Forest Service Regional guidelines (whichever are more protective). Mitigation for the flammulated owl could include surveys followed by protection of nesting locations. Flammulated owls often nest in loose aggregations or "clusters" of territorial pairs. Surveys and studies of this species may provide information to better understand their distribution patterns.

The pygmy nuthatch was rated a 70 percent likelihood of achieving outcome A under Option 8. Mitigation for this option would include adoption of the Thomas et al. (1993) mitigation measures for the pygmy nuthatch.

The great gray owl rated only 73 percent likelihood of achieving outcome A under Option 8. Mitigation for this species would include adoption of the Thomas et al. (1993) mitigation measures for the great gray owl. These measures included protection of forest buffers around meadows and other forest openings within the range of the species.

Role of nonfederal lands. All of the 36 birds in this assessment occur on both federal and nonfederal lands. Some (flammulated owl, Hammond's flycatcher, hermit warbler, warbling vireo, western flycatcher, Wilson's warbler, Vaux's swift) are neotropical migrants that spend the winter in Mexico or central America. All six of the waterfowl on the list winter on lowland ponds, bays, rivers, estuaries, or surf zones, where they are subject to hunting and other forms of disturbance. For all of these species, habitat on the winter range is critical for their well-being. In addition, for those waterfowl that are subject to hunting, state and federal regulatory mechanisms play a critical role in their population trends.

Research needs. Studies are needed to better understand habitat needs and population status for most of the 36 bird species that were assessed. Studies that result in a better understanding of population response relative to different levels of snag and coarse woody debris retention, riparian protection, and disturbance levels are recommended. Research is also needed to determine the effects of livestock grazing on prey utilized by great gray owls. Inventory and monitoring efforts for most of the 36 species will provide baseline data and a means for tracking changes in populations or habitat.

Mammals Other Than Bats

Temperate coniferous forests of the Pacific Northwest provide habitat for a diverse array of mammal species. Foliage- and fungi-eating mammals such as flying squirrels and red-backed voles have important functional roles in these coniferous forests (Trappe and Maser 1976; Ure and Maser 1982; Maser and Trappe 1985). Mycophagists such as northern flying squirrels and red-backed voles eat mostly fungi, including lichens, but they prefer truffles (Ure and Maser 1982). Spores of hypogeous fungi are primarily dispersed by small mammals in their fecal pellets. At least one study has shown that passage through the digestive tract of small mammals enhances spore germination (Cork and Kenagy 1989). Fecal pellets contain not only fungal spores, but also nitrogen-fixing bacteria and yeast that are deposited onto the forest floor. These mammals also serve an important role in physically distributing lichens throughout the forest (Rosentreter 1991).

Many small mammals are prey for larger animals within the forest community. Northern flying squirrels, woodrats, red tree voles, and red-backed voles are the primary prey of northern spotted owls throughout their range (Thomas et al. 1990). Microtine voles (*Microtus* spp.) and red-backed voles (*Clethrionomys* spp.) are prey for American martens (Strickland and Douglas 1987a). These small mammals depend on fir needles, fungi, and lichens in coniferous forests and in turn serve as food sources to predators that eat them.

Large, decayed logs and snags are important to many mammals. They are used by larger mammals, such as fishers and American martens, for resting and denning sites. The California red-backed vole uses logs for cover and forages on truffles which fruit mostly in rotten wood (Maser and Trappe 1984). Some species of shrews are abundant around fallen, decayed trees where their arthropod prey live. These species are all prey of larger animals, such as northern spotted owls, illustrating the interdependence of components within forests in the Pacific Northwest.

Methods specific to mammals other than bats. Fifteen mammals other than bats were identified as closely associated with late-successional forests (see appendix table IV-A-6). These included forest carnivores (fishers, American martens, lynx), rodents (several species of squirrels, mice, voles, and a woodrat), and insectivores (shrews and the shrew-mole).

There are some updates from the list of species of Thomas et al. (1993) and the Final Draft Recovery Plan for the Northern Spotted Owl (USDI 1992c). The vagrant shrew (*Sorex vagrans*) species complex (Jackson 1928) has been revised to include Baird's shrew (*S. bairdii*) and the fog shrew (*S. somonae*) as defined by Carraway (1990). Baird's shrew is closely related to *Sorex monticolus*, which is not associated with late-successional forests (Ruggiero et al. 1991); therefore, Baird's shrew was not included on the list of species. The Pacific shrew (*S. pacificus*) has been reclassified to exclude the fog shrew; therefore, the fog shrew, a new species, has been added to the list. Because field studies have not distinguished the habitat associations of fog and Pacific shrews, the two were rated as the Pacific/fog shrew complex. Two species of chipmunks were added to the list of species associated with late-successional forests: Allen's chipmunk (*Tamias senex*) and the Siskiyou chipmunk (*T. siskiyou*). But because there is currently no reliable information to separate habitat associations of *T. senex* and *T. siskiyou* from *T. townsendii*, the three species were rated as the Townsend's chipmunk complex.

The lynx was included on the list of species associated with late-successional forests in Thomas et al. (1993), but was dropped from our list. Therefore, we did not rate the species. While there is some indication that lynx use late-successional forests for denning, there are also indications that such habitat is not required.

Results. All seven options achieved an 80 percent or better likelihood of outcome A for all mammals except the red tree voles (*Phenacomys longicaudus* and *P. pomo*), American martens, and fishers (table IV-38; fig. IV-20). Nine species (deer mouse, dusky-footed woodrat, elk, forest deer mouse, northern flying squirrel, Senex chipmunk, Townsend's chipmunk, southern red-backed vole, Pacific shrew) were rated as having 90

Table IV- 38. Projected future likelihoods of habitat outcomes for mammals under land management options.

Mammals	Option 1				Option 3				Option 4				Option 5				Option 7				Option 8				Option 9			
	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
Deer mouse	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0
Douglas squirrel	98	2	0	0	97	3	0	0	97	3	0	0	93	7	0	0	83	15	2	0	88	12	0	0	88	12	0	0
Dusky-footed woodrat (Klamath Province)	98	2	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0
Elk	97	3	0	0	98	2	0	0	98	2	0	0	100	0	0	0	96	4	0	0	96	4	0	0	96	4	0	0
Fisher	85	15	0	0	82	18	0	0	73	27	0	0	70	30	0	0	67	33	0	0	63	37	0	0	63	37	0	0
Forest deer mouse	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0	100	0	0	0
Marten	83	17	0	0	73	23	3	0	77	23	0	0	67	27	7	0	57	33	7	3	67	30	3	0	67	27	3	3
Northern flying squirrel	100	0	0	0	100	0	0	0	100	0	0	0	98	2	0	0	90	10	0	0	90	10	0	0	93	7	0	0
Red tree vole (P.longicaudus)	98	2	0	0	95	5	0	0	95	5	0	0	82	18	0	0	58	33	8	0	60	35	5	0	73	25	2	0
Red tree vole (P.pomo)	100	0	0	0	95	5	0	0	93	8	0	0	88	13	0	0	68	30	3	0	75	25	0	0	78	23	0	0
Shrew-mole	100	0	0	0	100	0	0	0	100	0	0	0	96	4	0	0	84	16	0	0	96	4	0	0	98	2	0	0
Southern red-backed vole	100	0	0	0	98	2	0	0	100	0	0	0	98	2	0	0	96	4	0	0	98	2	0	0	98	2	0	0
Townsend's Chipmunk complex	100	0	0	0	100	0	0	0	100	0	0	0	98	2	0	0	97	3	0	0	97	3	0	0	98	2	0	0
Pacific/Fog shrew complex	100	0	0	0	100	0	0	0	100	0	0	0	98	2	0	0	92	8	0	0	96	4	0	0	96	4	0	0
Western red-backed vole	100	0	0	0	98	2	0	0	100	0	0	0	93	7	0	0	73	22	5	0	85	15	0	0	90	10	0	0

A-Well Distributed B-Locally Restricted C-Restricted to Refugia D-Extirpation

Likelihood values are expressed as percentages that total to 100 for a given species within an option. Numbers displayed may vary due to rounding errors. See text for fuller explanation and discussion of the rating scale.

percent or greater likelihood of achieving outcome A under all options. An additional three species (Douglas squirrel, shrew-mole, western red-backed vole) were rated as having 80 percent or greater likelihood for outcome A under all of the options.

Both species of red tree voles were rated as having greater than 80 percent likelihood of achieving outcome A under Options 1, 3, 4, and 5 (table IV-38). Ratings were progressively lower for Options 9, 8, and 7 where the likelihood of outcome A was rated at 58-78.

American martens were rated for the entirety of their range within the range of the northern spotted owl. They were rated as having greater than 80 percent likelihood of achieving outcome A under Option 1; Options 3 and 4 were rated 73-77 percent for outcome A. Ratings for Options 5, 8, and 9 were lower with approximately 67 percent likelihood assigned to outcome A. Option 7 rated lowest, with less than 60 percent likelihood of achieving outcome A.

Ratings for the fisher were similar to those for martens. Fishers were rated as having greater than 80 percent likelihood of achieving outcome A for Options 1 and 3 (table IV-38). Ratings for Options 4 and 5 were greater than 70 percent for outcome A. For Options 7, 8, and 9 fishers rated less than 70 percent for achieving outcome A. Ratings for fisher reflected a general uncertainty about the future welfare of this species regardless of the option.

Discussion. The amount and distribution of habitat for all mammals except red tree voles, martens, and fishers was generally rated above 80 percent likelihood under all of the options. Options 1, 3, 4, and 5 were rated as providing sufficient and well distributed habitat for red tree voles with greater than 80 percent likelihood. Options 1 and 2 for the fisher and only Option 1 for the marten rated 80 percent or better likelihood of providing sufficient habitat, well distributed to provide for viable populations. All other options had greater than 20 percent likelihood of outcome B, distributed with gaps.

Red tree voles have limited dispersal capabilities, and connectivity of older forests may be important to metapopulation function, at least for *P. longicaudus*. Therefore, red tree voles were rated as having medium to high risk of extirpation by the Scientific Analysis Team (Thomas et al. 1993) under options comparable to those in this document. In contrast, Options 1, 3, 4, and 5 were rated at least 80 percent likelihood of providing habitat for adequate, stable, well-distributed populations of red tree voles. Watershed guidelines of the Scientific Analysis Team (Thomas et al. 1993) as applied in this effort will likely provide for connectivity of forest stands under most options except 7 and 8. In addition, all of the options will provide adequate Late-Successional Reserves for abundant and well-distributed populations of these species. New information on the habitat relationships of *P. pomo* indicates that it is equally common in young and late-seral stages in northwestern California (Meiselman 1992); therefore, it may not be as closely associated with late-successional forests as *P. longicaudus*. However, *P. pomo* will be influenced by forest management on nonfederal lands because only a small proportion of its range occurs on federal lands. Recent information from radio-tagged *P. longicaudus* in Oregon indicates that individuals will travel across the forest floor at least as far as 1/4 mile (C. Meslow, 1993, personal communication, B. Biswell unpublished data). These new studies provide supporting evidence that habitat for red tree voles will be sufficient and well distributed under Options 1, 3, 4, and 5 but lower under Options 7, 8 and 9.

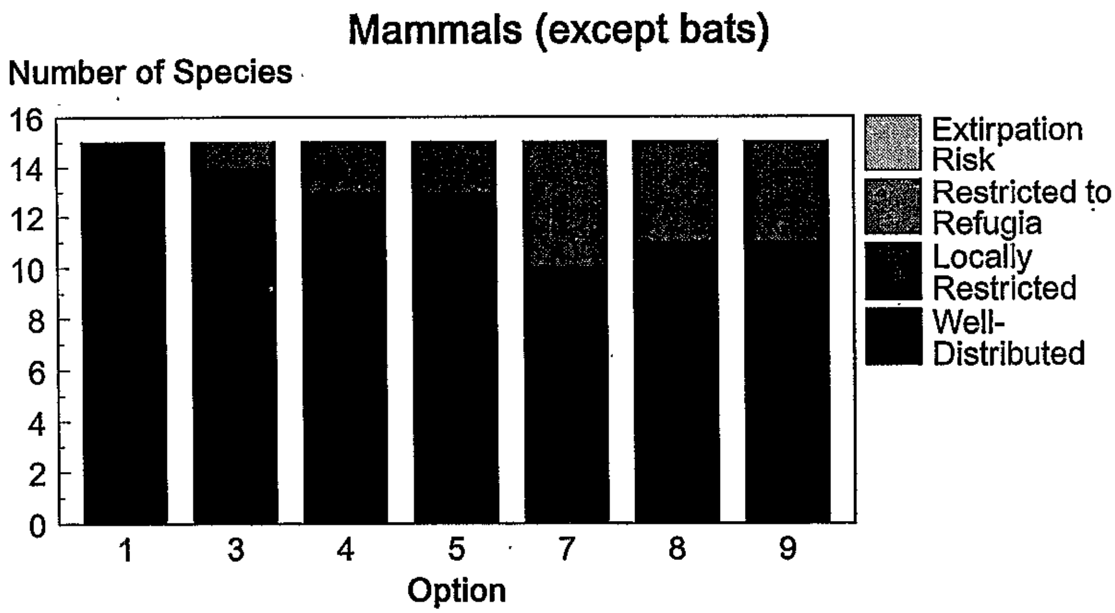

Figure IV-20. Outcomes for mammals, except bats, under each land management option. Values shown are the number of species that had an 80 percent or greater likelihood of achieving at least the specified outcome (based on distribution of habitat).

American martens occur at higher elevations than fishers, and their densities appear to be greatest in subalpine areas, which are higher in elevation than suitable spotted owl habitat. Populations of American marten are very low on the Olympic Peninsula and in the Oregon Coast Range; therefore, there is doubt that populations of martens will ever be well distributed throughout their range. Habitat of martens in this effort was rated as being sufficient and well distributed only under Option 1.

Riparian buffers provide potential habitat (including large snags and cover) for both fishers and American martens. Riparian areas are used for foraging and resting; martens select resting sites in large trees or in piles of woody debris in riparian areas (Jones and Raphael 1992). Large coarse woody debris and canopy cover are important for martens during winter because they have limited energy Reserves in winter and are not morphologically adapted to minimize heat loss (Buskirk et al. 1989). Winter habitat requirements include more than 30 percent overstory cover and subnivean (below snow) access to resting sites (Steventon and Major 1982; Buskirk 1984; Hargis and McCullough 1984; Corn and Raphael 1992). Martens have been found to rest more frequently and for longer periods where coarse woody debris formed all or part of the subnivean resting sites (Zielinski 1981; Spencer 1987). Structural features, including coarse woody debris (slash, stumps, or downfall), may also make subnivean prey more accessible to marten. Other resting sites for martens include cavities in large snags, hollow stumps, and under logs (Campbell 1979; Spencer 1987; Strickland and Douglas 1987a). Large old trees, snags, and large logs are important as den sites (Hauptman 1979; Simon 1980;

Hargis and McCullough 1984; Wynne and Sherburne 1984) and provide young with protection from thermal stress and predators.

Fisher populations are small and localized throughout most of the Pacific Northwest. Fishers tend to be associated with riparian areas and continuous forest canopy but not necessarily old-growth forests. We do not know the extent to which forest management practices influence fisher populations, but some evidence indicates forest fragmentation may have negative effects (Rosenberg and Raphael 1986). The greatest concern for fishers is the past population declines and the apparent inability of populations to rebound from low levels. There is also speculation that poisoning programs for predators and porcupines plus indiscriminate trapping may have influenced their populations. Concern has also been expressed for their elusive and secretive nature and that human disturbance, including roads and logging, may impact populations.

Options 1 and 3 rated highest for fishers. The ratings reflect some uncertainty about the future of this species, due to the paucity of information on habitat relationships of the species in the Pacific Northwest and their low populations. Studies from the Rocky Mountains and Eastern North America indicate that fishers use a wider range of habitats than martens. Fishers appear to select ecotones and edges, transition areas between different types of habitat, and dense riparian forests with a conifer understory in Eastern North America (Kelly 1977; Leonard 1980; Raine 1983; Johnson 1984). Forested riparian areas are used as travel corridors during both summer and winter (Buck 1982; Mullis 1985; Jones 1991). Fishers may select mature conifer forest with high canopy cover in areas with deep snow where their movements may be restricted (Clem 1977; Leonard 1980; Raine 1983; Rosenberg and Raphael 1986; Raphael 1988). Resting sites in California were associated with snags and downed logs 200-250 inches diameter at breast height (Buck et al. 1983). Requirements for natal den sites appear to be more restrictive than for resting sites (Banci 1989). Natal den sites are found in cavities of live or dead hardwood trees in other areas (Grinnell et al. 1937; Hamilton and Cook 1955; Kelly 1977; Leonard 1980; Powell 1982; Mullis 1985; Arthur 1987; Banci 1989). Therefore, there seems to be an association with components of late-successional forests (large snags for natal dens, coarse woody debris for foraging and resting) in the Pacific Northwest.

Mitigation for Mammals Other Than Bats

Following suggestions for mitigation in the Scientific Analysis Team (Thomas et al. 1993), we recommend closure of all federal lands to kill-trapping of martens (under all options) until incidental take of fishers is determined to be insignificant. The rate of incidental capture of fishers in the course of trapping other carnivores and effects of porcupine poisoning need to be evaluated. In addition, National Forests in California should finalize and implement their draft habitat capability model for fishers and American martens. National Forests in Oregon, Washington, and California should conduct more thorough surveys for both species. Retention of large snags and coarse woody debris in the forest matrix outside of Reserves could be important for both species. None of these measures however, are likely to significantly alter the ratings achieved for either martens or fishers.

Role of nonfederal lands. State and private lands should also be closed to kill-trapping of martens to avoid incidental take of fishers as stated above. Forest management on nonfederal lands in northwestern California and western Oregon could be important for both species of red tree voles.

Research and information needs. Most studies of fisher habitat associations and diet have been conducted in Eastern North America where fisher densities are higher than in the West (Powell 1982; Strickland and Douglas 1987b; Banci 1989). Few marten studies have been completed in the range of the northern spotted owl. Studies of habitat selection, home range size, and diet of both species need to be conducted in the Pacific Northwest. Habitat selection for denning sites, foraging areas, and prey need to be addressed. Studies are needed to determine effects of timber management practices on habitat use, home range sizes, and movement patterns of fishers and martens.

Monitoring efforts using track plates and remote cameras (to determine presence of forest carnivores) need to be standardized and expanded across forests in the Pacific Northwest. Regional monitoring needs to be developed and designed to detect changes in abundance over time, as recommended by the Interagency Lynx-Wolverine-Fisher Working Group (Weaver 1993). Surveys need to be conducted using an appropriate number of randomly selected sample units within biologically relevant strata, independent of timber sale or other management activity areas. These should be stratified by physiographic province, habitat, and elevation.

Little is known about the red tree vole. Studies are needed to better understand its basic ecology, including its habitat associations and dispersal capabilities. Further genetic research is needed to determine whether *P. pomo* and *P. longicaudus* are distinct species.

Bats

Bats are a diverse order of mammals. There may be more species of bats in some North American temperate forests than any other order of mammals (Cross 1976).. All forest-dwelling bats in the Pacific Northwest are insectivores. Bats that concentrate their foraging in riparian areas and fly to upland forests to roost may serve as dispersers of nutrients (Perkins and Cross 1988). Because of their large population numbers, bats may play an important role in nutrient cycling within forests (Christy and West 1993). Bats also serve an important role as predators of forest pest species because of the vast quantities of insects they consume (Whitaker et al. 1977).

Results. Eleven species of bats were identified as being associated with late-successional forests, including seven species of *Myotis*, the big brown, pallid, silver-haired, and hoary bats (see appendix, table IV-A-6).

Although consideration was given to Townsend's big-eared bat it was not included on the final list of 11 species. This species is not closely associated with late-successional forests for roosting, but the available data suggest they use forests and mature oak woodlands for foraging (Clark 1991; Brown et al. 1992; V. Dalton, 1993, personal communication; E. Pierson, unpublished data). Townsend's big-eared bat populations are probably declining primarily due to disturbance of roost sites in caves and mines. Most of the range of the coastal subspecies of Townsend's big-eared bat (*Plecotus townsendii townsendii*), a category 2 federal candidate, lies within the range of the northern spotted owl. The species was not added to the list for habitat assessment, but comments on appropriate management are included below.

The different options varied in their likelihoods of providing sufficient and well-distributed habitat on federal lands to ensure viability for bats. Options 1 and 3 were rated highest, and Options 7 and 8 rated lowest. All species rated more than 80 percent

Table IV- 39. Projected future likelihoods of habitat outcomes for bats under land management options.

Bats	Option 1				Option 3				Option 4				Option 5				Option 7				Option 8				Option 9			
	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D	A	B	C	D
Big brown bat	100	0	0	0	95	5	0	0	93	8	0	0	93	8	0	0	72	25	3	0	68	30	3	0	83	18	0	0
California myotis	100	0	0	0	100	0	0	0	95	5	0	0	95	5	0	0	75	25	0	0	74	26	0	0	85	15	0	0
Fringed myotis	97	3	0	0	87	13	0	0	77	23	0	0	70	30	0	0	33	57	10	0	33	53	10	3	47	47	5	2
Hoary bat	98	3	0	0	91	9	0	0	83	18	0	0	68	33	0	0	45	50	5	0	40	53	8	0	53	48	0	0
Keen's myotis	100	0	0	0	95	5	0	0	75	25	0	0	65	35	0	0	45	45	5	5	35	50	10	5	50	40	5	5
Little brown myotis	100	0	0	0	96	4	0	0	91	9	0	0	90	10	0	0	73	28	0	0	70	28	3	0	84	16	0	0
Long-eared myotis	98	3	0	0	93	8	0	0	80	20	0	0	68	33	0	0	50	45	5	0	48	48	5	0	64	35	1	0
Long-legged myotis	100	0	0	0	90	10	0	0	83	18	0	0	69	31	0	0	45	48	8	0	41	51	8	0	55	45	0	0
Pallid bat	100	0	0	0	96	4	0	0	85	15	0	0	73	25	3	0	48	41	9	2	45	44	10	2	63	35	3	0
Silver-haired bat	98	3	0	0	91	9	0	0	78	23	0	0	68	33	0	0	45	50	5	0	40	53	8	0	53	48	0	0
Yuma myotis	100	0	0	0	95	5	0	0	90	10	0	0	89	11	0	0	70	29	1	0	73	28	0	0	83	18	0	0

A-Well Distributed B-Locally Restricted C-Restricted to Refugia D-Extirpation

Likelihood values are expressed as percentages that total to 100 for a given species within an option. Number displayed may vary due to rounding errors. See text for fuller explanation and discussion of the rating scale.

likelihood for outcome A under Options 1 and 3 (table IV-39, fig. IV-20). For Option 4, eight species rated more than 80 percent likelihood for outcome A (all except Keen's myotis, fringed myotis, and silver-haired bats, which rated 75, 77, and 78 percent, respectively). Under Option 5, four species rated more than 80 percent likelihood for outcome A, and seven species rated 65-73 percent (fringed myotis, Keen's myotis, long-eared myotis, long-legged myotis, pallid bat, silver-haired bat, and hoary bat). For Option 9, four species rated more than 80 percent for outcome A, two species rated 60-70 percent (long-eared myotis, and pallid bat), and five species rated 45-55 percent (fringed myotis, Keen's myotis, long-legged myotis, silver-haired bat, and hoary bat). No species rated more than 80 percent for outcome A under Options 7 or 8, and seven species rated less than 60 percent under each of these options.

Large acreages of Late-Successional Reserves well distributed across the landscape were considered critical for bats because of the importance of large green trees and snags for roosting sites. Option 8 was consistently rated lower because it allowed salvage without special guidelines and harvest of stands up to 180 years old inside Late-Successional Reserves. There was concern that Options 7 and 8 would possibly result in disjunct bat populations due to smaller amounts of acreage in Reserves at low elevations.

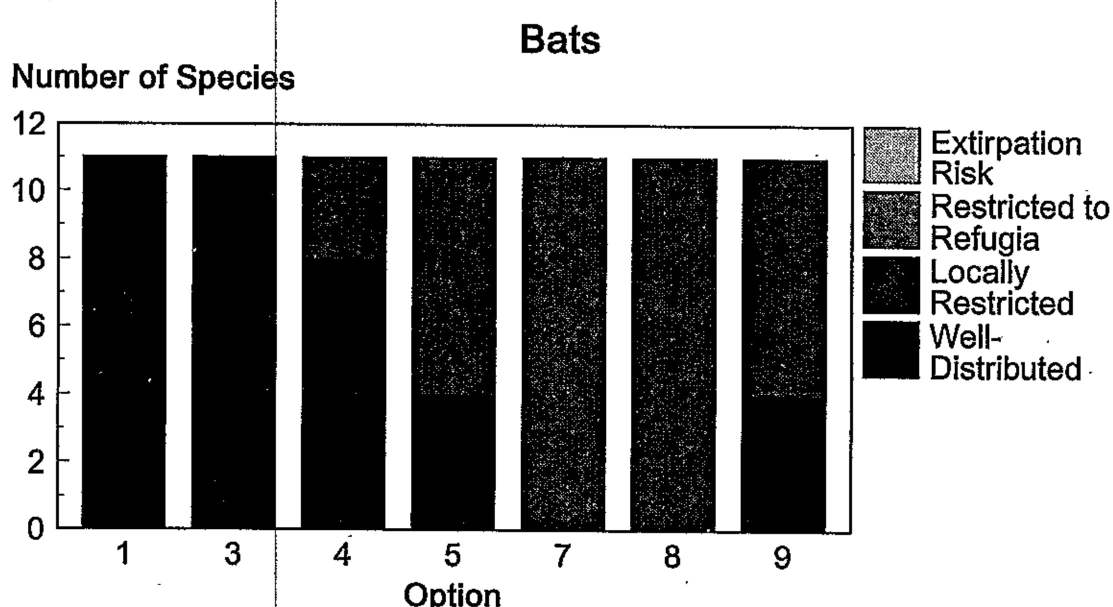

Figure IV-21. Outcomes for bats under each land management option. Values shown are the number of species that had an 80 percent or greater likelihood of achieving at least the specified outcome (based on distribution of habitat).

Proposed management for the forest Matrix was also a critical factor in the ratings, primarily due to density of snags. Option 3, which contained standards and guidelines developed by the Forest Ecosystem Management Assessment Team, was rated higher than options containing only the 50-11-40 rule with lower snag, log, and green tree retention standards. Leaving 10 percent of harvest areas in green tree islands, enough snags for 40 percent of the potential primary excavators, and all decay class 3-5 logs, as under Option 3, will provide better habitat conditions for bats in the forest Matrix. Options 7, 8, and 9 that did not contain the 50-11-40 rule were rated lower than the other options.

Options containing the Scientific Analysis Team (Thomas et al. 1993) watershed guidelines, protecting intermittent streams, Key Watersheds, and small lakes and ponds (less than 1 acre) with a full tree height were consistently rated higher than options containing watershed guidelines that protect permanent streams equally but protect intermittent streams with one-half (or less) a site potential tree height.

Keen's myotis was rated lower than other species because it has a geographic range largely restricted to low elevation, nonfederal lands on the Olympic Peninsula of Washington. It may rely entirely on forest roost sites (Thomas and West 1991), and forested habitat within its range has declined substantially due to urbanization around Puget Sound.

Fringed myotis was also rated lower than other species (except for Keen's myotis). Panelists thought this species was more vulnerable than other species because it is rare, occurs in a restricted elevation zone, and has strong site fidelity. For these reasons, fringed myotis populations may be more likely to become isolated when forests are fragmented. The silver-haired bat generally rated lower than most species due to its dependence on snags and trees for roost sites, most importantly maternity sites. Silver-haired and hoary bats are considered to be obligate tree roosters; all other species are facultative tree roosters that will also roost in other structures (e.g., rock crevices, buildings, caves, abandoned mines, under bridges).

Discussion. Large snags and large green trees are important because bats use them for maternity roosts, day roosts, temporary night roosts, and hibernacula (Barbour and Davis 1969; Kunz 1982; Rainey et al. 1992). Bats in the Pacific Northwest seem to prefer old forests, presumably due to more potential roost sites under bark, in crevices, or in hollows of large, old trees (Perkins and Cross 1988; Thomas and West 1991). Suitable roost sites require access to water (for drinking and foraging), protection from predators, and favorable temperature and moisture regimes (Christy and West 1993). Temperature regimes are important to bats (van Zyll de Jong 1985; Fenton and Barclay 1980), and thermal stability may be influenced by structural characteristics within large snags or trees. According to Christy and West (1993:12), "Structural characteristics of old, live trees, such as cracks and crevices in thick bark, bark pulling away from the trunk which forms crevices, and holes in the bole where limbs have been shed, offer potential roosting sites. Snags with cracks, peeling bark, bird holes, and hollow interiors provide ideal sites for maternity colonies that Myotis bats commonly form."

The hoary bat is the only foliage-roosting bat (Constantine 1966; Barclay 1985) on the list of species associated with late-successional forests. Hoary bats are not very maneuverable during flight and need tall trees with foliage high from the ground so they can drop to gain momentum for flight (Perkins and Cross 1988).

Large snags and large green trees should be well distributed throughout the Matrix to maximize benefits to bats. Density of snags outside of Late-Successional Reserves is critical for bats for several reasons: (1) an individual bat colony may use several roosts during a season as temperature and other weather conditions change; (2) migrating bats may roost under bark in small groups (Barclay 1984); (3) bats are competing for snags with other species that use cavities; and (4) in addition to day roost sites, bats use short-term night roosts. Bats commonly forage for a short time and then rest in a night roost while eating or digesting prey. Night roosts are generally at sites different from day roosts and are often used by several species.

Numbers of snags or green trees per acre that would be optimal for bats is unclear, but in southern Oregon captures of both the big brown and silver-haired bats were most frequent in areas of high snag density and forest cover (Cross 1976). Acoustic detections of bats were significantly higher in old-growth stands than in younger stands (Thomas and West 1991). Roost site availability may play a major role in determining population sizes and distributions (Kunz 1982).

Large logs with loose bark may also be used by Yuma myotis and little brown bats for roosting. However, bats generally seek height for roosting, where predation risks may be lower and ambient temperatures higher. Therefore, snags are likely to be more important than logs.

Bats use riparian areas for foraging and less frequently for roosting. Thomas and West (1991) found that feeding rates (as measured by acoustic detectors) are significantly higher over water than within forest stands in the Pacific Northwest. Many species of bats forage over streams and in adjacent riparian habitat (Barbour and Davis 1969; Fenton and Barclay 1980; Kunz 1982; Barclay 1986; Manning and Jones 1989; Brigham 1991; Brigham et al. 1992). They use drainages as travel corridors to reach foraging sites, and some species feed in drainages of small, intermittent streams (e.g., long-legged myotis). Wide and diverse riparian zones accommodate the differing foraging habits of different species that feed over water, in marginal thickets, on flood plains, and in adjacent timber stands. The pallid bat has been radio-tracked foraging along stream drainages and in a broad riparian zone up to 1550 feet from water (Brown 1982; Pierson and Rainey 1992, unpublished data). Long-eared myotis has been netted over streams and in mature oak woodlands 1550 feet upslope from rivers in northern California (E Pierson, 1993, personal communication). The distribution of breeding populations of many bat species is limited by elevation and proximity to water. Greater diversity and abundances are found at low to mid-elevations in association with larger river drainages. Many species also forage in forests, often over clearings and along edges, and when gleaning insects, some species may feed within or above the canopy (Black 1974; Whitaker et al. 1977; Kunz and Martin 1982; Barclay 1985; Christy and West 1993). Bat species such as long-eared myotis that feed by gleaning arthropods from foliage may be especially susceptible to pesticide spraying.

Distances bats travel between roosting and foraging sites vary among species, from less than 0.6 mile up to 25 miles (Barclay 1984). Ambient temperature and other microhabitat parameters (e.g., size of crevice or cavity) undoubtedly influence roost selection, and insect availability presumably governs choice of foraging areas. Roosting and foraging areas may be geographically separate. Little brown myotis have been observed foraging 1.3-3.1 miles from day roosts (Thomas and West 1991), and big brown bats are known to travel up to 2.5 miles to forage (Brigham and Fenton 1986). Distances bats travel and foraging microhabitat may vary with bat age, reproductive condition, and local species diversity (Barclay 1984; Adams 1990; Brigham et al. 1992;

Kalcounis 1992). Tree corridors may be important for bats traveling between roosting and foraging areas (Tuttle 1979).

Biologists suspect that bat populations have been declining, but few data exist to document such a trend. Population declines that have been documented worldwide are attributed to loss of habitat and disturbance of maternity colonies and hibernacula (Mohr 1948; Edgerton et al.1966; Cockrum 1969; Tuttle 1979; McCracken 1988).

Mitigation for Bats

Species that use caves and mines for breeding, maternity sites, or hibernacula are vulnerable to human disturbance. Under all options, bat colonies in caves and abandoned mines need to be identified and protected. Logging should be regulated near caves and abandoned mines that are used by bats. The Federal Cave Resources Protection Act of 1988 requires that cave systems be inventoried and considered in forest planning on federal lands. Sediment and debris from logging and road construction can clog portions of cave systems; decomposition of organic material can cause large accumulations of carbon dioxide; and logging residues may cause siltation and deplete oxygen concentrations in water flowing through these systems (Stringer et al. 1991). Clearing vegetation near cave entrances may reduce concealment and increase vulnerability to both human disturbance and predation en route to foraging areas. At least one species, the gray bat (*Myotis grisescens*) on the East Coast, appears to limit its foraging activities to forested areas near caves during cold weather (Tuttle 1979). Road construction near cave and mine roosts can introduce recreational activities and lead to permanent abandonment of roosts. For instance, recreational caving in the Mother Lode area of California has led to the disappearance of most historically known roosts and an 82 percent decline in mean colony size for the few known remaining colonies of Townsend's big-eared bat (Pierson and Rainey 1992). When bats are disturbed while hibernating in caves, they may come out of torpor, causing them to loose weight and decreasing their chances of survival (Davis and Hitchcock 1965).

Examples of buffer widths around caves are 450 feet on the Deschutes National Forest and 0.25 mile on the Daniel Boone National Forest. No timber management should occur within these buffer zones, and road access should be closed. Site-specific analyses should be done to determine species using the structure, approximate size of the colony, and whether it is a hibernaculum, maternity, or bachelor colony. An example of process and priorities for site protection is described by Tuttle (1979) and Tuttle and Stevenson (1978). Cave entrances should be gated in such a way that air flow patterns are maintained (Tuttle 1977), people are excluded, and bats can freely enter and exit. If these mitigation measures were implemented and enforced, assessments for the group of bats that roost in both trees and other structures could be improved.

Bat boxes (artificial roost sites) may be of some value in mitigating for loss of tree roosting sites. However, use of such structures by the species of greatest concern has not been clearly demonstrated. Employment of bat boxes should only be considered as a short-term measure to be used during the rejuvenation of natural sites associated with old living trees and snags.

Role of nonfederal lands. Keen's myotis is found exclusively in the Pacific Northwest and occupies a restricted range within western Washington, western British Columbia, and southeastern Alaska. In Washington, it is found primarily on nonfederal lands.

This species most likely has a strong association with late-successional forests; it was included in the group of *Myotis* species that were judged to be associated with old-growth forests by Thomas and West (1991). Forested habitat within the range of this species has declined substantially due to urbanization in lowland areas around Puget Sound.

The northern California coast has few federal lands and state parks. Bat diversity and numbers are higher on the California coast than the Oregon coast (Maser et al. 1981), and bat populations here are of concern.

Mature oak woodlands are important for bats in California near the southern end of the northern spotted owl's range, especially for pallid bats. The pallid bat is often found in agricultural areas (e.g., on the margins of the Central Valley) and in open oak woodlands (e.g., in Marin County), but has shown marked declines in areas where there has been a loss of oak woodlands. Presence of mature oak woodlands seems to be important to maintaining pallid bat viability, and private lands play a key role.

Research and information needs. Mitigating for effects of timber management activities on bats is difficult due to a lack of knowledge about the basic ecology of bats. Recent advances in miniaturization of radiotelemetry equipment create the potential to examine roosting and foraging habitat associations. Automated ultrasonic detectors may be useful to assess bat activity in relation to the varied forest stand and age characteristics created by logging.

Surveys to document distribution and estimate population sizes need to be continued and expanded (Cross 1976; Maser and Cross 1981; Perkins 1983). Studies to estimate species composition and relative abundances of bats in different habitats need to be done. General surveys to locate caves, mines, and buildings that are used as roosts or hibernacula are sorely needed. Keen's myotis should be given high priority because it is so poorly known and occupies a restricted range (Thomas and West 1991).

Characteristics of roosts and patterns of use by bats need to be determined. Studies are needed to assess the importance of roost microclimate and structure of snags/trees in relation to seasonal use of roost sites and roost fidelity. Habitat preferences for maternity roosts should be given highest priority.

Research is needed on patterns of habitat use, diet, intraspecific and interspecific variation in foraging patterns, and effects of age, sex, and season on foraging behavior. The role of bats as predators on forest pests such as bark beetles and other insects needs study.

Short Term Habitat Trends -- The Transition Period

Because some spotted owls occur outside Late-Successional Reserves and use forests younger than 80 years old, at least some of their habitat inevitably will be harvested no matter which option is chosen. Thus, habitat for spotted owls will likely continue to decline in the near future. Over the long term, most of the options will eventually produce substantially more suitable habitat for northern spotted owls and marbled murrelets than currently exists, and that habitat will be in larger blocks than at present. The current landscape is characterized by highly fragmented blocks of late-successional forest interspersed with young, managed stands that are mostly less than 50 years of age.

These young, managed stands will require considerable time to develop into suitable nesting habitat for marbled murrelets.

The period of recovery to a new stable equilibrium has been termed the "transition period." For all options assessed by the Forest Ecosystem Management Assessment Team, the discrepancy between the existing conditions and the projected equilibrium conditions in Reserves is most pronounced during the first 50 years after implementation (see previous section in this chapter, Amounts of Late Successional and Old-growth Forest; fig. IV-2).

One concern that has been expressed regarding the spotted owl and marbled murrelet is that existing levels of fragmentation within Late-Successional/Old-Growth Reserves, together with high rates of habitat loss in the Matrix, could result in such rapid population declines during the transition period that populations will not be able to stabilize at a new equilibrium level once habitat within the Reserves is regenerated. For the northern spotted owl and marbled murrelet the critical transition period will likely occur during the first 50-150 years after a management plan is implemented (Thomas et al. 1990; McKelvey 1992; McKelvey et al. 1993). After that time, most cutover areas within Reserves will have assumed old-forest characteristics, and levels of fragmentation will have been greatly reduced.

Of the seven options for which we did full assessments, Options 1, 3, 4, 5, and 9 included more protection of Riparian Reserves and Late-Successional/Old-Growth Reserves than in previous plans proposed for the northern spotted owl (Thomas et al. 1990). These additional levels of protection should provide additional habitat for spotted owls, reducing the magnitude of any demographic or habitat "bottleneck" that might occur during the transition period.

Spotted Owl Population Status and Trends

Although most biologists seem to agree that spotted owl populations are declining, exact rates of decline are unclear. An analysis by Anderson and Burnham (1992) indicated that populations of adult female northern spotted owls on five study areas in Washington, Oregon, and California were declining at an average rate of 7.5 percent per year. The analysis also suggested that female survival rates were declining over time. The declining female survival rate was considered alarming because it could indicate a population that had passed some demographic threshold and was on an accelerating trajectory toward extinction (Harrison 1992; Karieva 1992; Orions 1992). This interpretation was challenged by Thomas et al. (1993), who argued that such a conclusion should not be drawn from data collected during a period of transition from one habitat level to another. Thomas et al. (1993) suggested that it was highly unlikely that the owl population had declined below any demographic threshold, except possibly in some isolated and heavily cutover areas such as southwestern Washington. Dr. David Anderson (personal communication, 1993) challenged this conclusion, and the issue appears unresolved.

Options 1, 2, 3, 4, 5, 6, and 9 were all rated as having an 80 percent or greater likelihood of providing sufficient habitat for a well-distributed population of northern spotted owls on federal lands over the next 100 years. An obvious question is how any option could have been rated this optimistically when the existing demographic information was taken into consideration. Our rationale was two-fold. First, we question whether rates of population decline are as steep as is indicated by Anderson and Burnham (1992). The banding data that were analyzed by Anderson and Burnham are potentially subject to a number of biases. Our main concern is that emigration of adult and juvenile females may be causing female survival rates to be underestimated, which would result in an underestimate of the population growth rate. Second, it is questionable whether demographic rates estimated during a period of declining habitat can or should be used to evaluate whether a population will eventually stabilize at some new equilibrium (Thomas et al. 1990, 1993).

Because of the above concerns regarding the interpretation of current demographic data, we believe that evaluation of efficacy of a particular option must be based largely on theoretical grounds relative to (1) the known size and distribution of existing populations (Thomas et al. 1990, USDI 1992c, Thomas et al. 1993), (2) the expected size and distribution of the future population under the proposed management scheme, and (3) the amount and distribution of habitat expected to be present during the transition period, including habitats other than old growth (e.g., table IV-11; figure IV-2). These factors were the basis for our evaluation of habitat sufficiency.

While there is concern about the transition period, that concern is partially alleviated by the fact that the current owl population is still relatively large, despite 100 years of timber harvest within the range of the owl. We conclude that, as long as an extensive network of late-successional forests is protected, there will be little risk that the spotted owl population will drop below a viable level during the transition period. We readily admit that this conclusion cannot be proven. It is professional opinion, based upon our review of the evidence.

Several other recent efforts to develop management guidelines for northern spotted owls have been criticized because they lacked formal, quantitative risk assessments. These included the report of Thomas et al. (1990) and the adoption of that report by the Forest Service (USDA 1992). These challenges assert that, without a formal risk analysis, there is no demonstration that the management plans will provide for conservation or recovery of the species. These challenges deserve attention. A formal, quantitative risk assessment would help to determine whether the options presented here would ultimately be successful.

Despite the potential value of a risk assessment, it is unlikely that a truly compelling assessment could be produced any time in the near future, if ever. A valid, quantitative assessment would require complete knowledge about owl responses to a full spectrum of habitat and landscape conditions. Some of these conditions are not currently observable within the owl's range, so their study is not possible. A risk assessment would also require full knowledge of owl population responses to dynamic landscapes. Complete knowledge in this area is years or decades away. Full understanding of habitat trends, including responses to management and projections of catastrophic events, would also be required.

Even with all this information, there would still be substantial challenges in the development of a reliable risk assessment. All of this information would have to be synthesized, most likely by bringing it together in a modeling framework. Assumptions in the model, and the overall model structure, would require validation. These requirements make the development of a robust model, and a truly quantitative risk analysis, problematic. However, models can still be useful. They can contribute to the understanding of implications of a variety of assumptions, and they can help generate new research hypotheses. They also can help us simulate the possible responses of owls to the dynamics of future landscapes. The results of modeling efforts could make a substantial contribution to risk assessments, even if the final assessment is ultimately dependent on professional judgment.

We recommend that a variety of modeling efforts continue, and that their results, in conjunction with other research and monitoring efforts, be considered in ongoing assessments of risk. Modeling and risk assessment must play a key role in adaptive management. Modeling efforts that should continue include further assessments of the demographic data and its analysis; further work on models that simulate owl population dynamics in response to landscape dynamics; and efforts to improve the ability to project future habitat conditions in managed and unmanaged situations.

While risk assessments will continue to rely on professional judgments into the foreseeable future, results of modeling efforts will help to improve those professional judgments.

Marbled Murrelet Population Status

Based on current estimates of population sizes for Washington, Oregon, and California, the three-state area has considerably lower numbers of murrelets than other areas within the species' range (e.g., British Columbia and Alaska). During the last century, there has been a substantial reduction of old-growth forests within the range of the marbled murrelet, especially at lower elevations in the coastal lowlands of Washington, Oregon, and California. Anecdotal evidence of concurrent declines in the murrelet population in some areas includes relatively low numbers of marbled murrelet counted in recent years, compared to historical reports which referred to marbled murrelets as common, or even abundant. Because historical information was extremely qualitative, however, exact rates of decline in the murrelet population are unknown. At-sea surveys of marbled murrelets are continuing in Washington, Oregon, and California to obtain better estimates of population size, distribution, and productivity.

The low estimates of population numbers and juvenile recruitment, and the likely time before current habitat conditions for the marbled murrelet improve, emphasize the concern for the species over the next 50-150 years. A number of factors (e.g., nesting habitat, marine environments, mortality associated with net fisheries and contaminants, prey population conditions) must be factored into any assessment of population status. In 1992, the Forest Service initiated a conservation assessment of the marbled murrelet throughout its range; the process is ongoing. The Marbled Murrelet Recovery Team is also working with the conservation assessment group to help determine the population status and recovery objectives for marbled murrelets in Washington, Oregon, and California.

Summary and Conclusions

The options assessed in this report were all designed to respond to immediate biological problems exemplified by declining late-successional habitats and species, while rebuilding resilient late-successional ecosystems over the long term. The need for these actions has developed over many decades as a result of forest harvesting and road building. These activities have reduced the amount of late-successional forest historically present on federal lands by about one-half. Late-successional forests have been nearly eliminated on many nonfederal lands.

Our assessments underscore the complexity of Pacific Northwest forest ecosystems and the difficulty of developing a comprehensive management strategy for them. The changes in management proposed in all of the options are dramatic. These changes appear necessary if we are to maintain species and processes associated with late-successional forests.

The options developed for this report share common components of an ecosystem strategy. Assessments in this chapter have aided our understanding of how those components may function, both from a species perspective and an ecosystem perspective.

Essential Components of an Ecosystem Strategy

The 10 management options are based on principles of conservation that have become broadly accepted. The primary components of these options are large Late-Successional Reserves, management guidelines for forests within the intervening Matrix, and riparian protection provided by buffers or Reserves along both permanent and intermittent bodies of water.

The Late-Successional Reserve systems in the different options vary in the size of individual reserves, distribution of the Reserves across the landscape, total acreage included in reserves, and the management proposed for forests inside reserves. Management of forests in the Matrix also varies among options, including different prescriptions for retention of green trees, logs, and snags in individual harvest units; and various landscape level controls such as the 50-11-40 rule. Riparian protection varies among options with the size of Reserves proposed (i.e., buffer widths), and the stream classes or wetlands that will be protected.

None of these components, taken individually, constitutes an adequate conservation strategy. Each of them has important influences on species and ecosystem responses. Through the expert panel process we attempted to evaluate responses by a broad range of organisms to components of different conservation strategies for late-successional forest ecosystems.

Response of Species to Components

Reserves

A system of Late-Successional Reserves was the central feature of all options considered. The extent of the reserve system, i.e., its total acreage, was the single most distinguishing feature across the array of options. Species across all taxa responded positively to increasing total area within Reserves (fig. II-7).

The appropriate size for individual Reserves is a function of several considerations. First, the reserve size must reach a threshold that maintains the integrity of the reserve itself; blocks as small as 50-80 acres begin to offer some significant area with interior forest conditions. Second, the reserve must be adequate to support the requisite numbers of individuals of the desired species or community of organisms. All options included Reserves designed to accommodate about 20 pairs of northern spotted owls (30,000 to 100,000 acres). Because of the large home range of spotted owls these Reserves are believed to be adequate to accommodate self-sustaining populations of many other organisms; exceptions are the large, mobile predators, migratory species, and rare, local endemic species which may not occur in the large reserves.

Reserve distribution must reflect the dispersal abilities of the organisms the system is designed to accommodate. Organisms with limited dispersal capabilities require relatively close spacing of patches of suitable habitat. The spacing of 6-12 miles between Reserves in the options considered was designed to accommodate dispersal capabilities of juvenile northern spotted owls. Scattered smaller Reserves of late-successional forest within the Matrix facilitate dispersal and enhance distribution of organisms with more restricted dispersal capabilities and smaller home ranges.

The placement of Reserves was often dictated by the occurrence of late-successional forests. In the future, Reserve locations may "migrate" across the landscape as conditions evolve, to provide a more effective distribution. In all options, Reserves were designed to include representative late-successional ecosystems from a broad range of elevational and geographical distributions. However, because a large proportion of lands at low elevation is privately owned, late-successional forests at low elevation are not as well represented within any of the options as those at higher elevations.

An important lesson learned through the expert panels was to attempt to incorporate locations of locally endemic species within Reserves planned for other species or objectives. This effort will require special attention to surveys for a wide variety of organisms which are often cryptic, poorly understood, and otherwise difficult to locate. It seems appropriate to begin such surveys during watershed analysis.

Connectivity among components of the late-successional forest ecosystem may be provided by a system of corridors or by a Matrix which is permeable, if not entirely hospitable, to late-successional forest organisms. The Riparian Reserves included in all options link the Late-Successional Reserves via riparian corridors to various degrees. Corridors are especially important for late-successional forest habitat specialists that have limited mobility or dispersal capabilities (e.g., fungi, plants, flightless insects, amphibians, mollusks). The demand for continuous connectivity provided by an actual corridor declines as the mobility of the organisms increase. For example, many birds can easily fly over short distances of inhospitable habitat that might pose a challenge to many amphibians or small mammals, and be a virtual barrier to mollusks or flightless insects.

Management intervention within Reserves may hasten restoration of late-successional conditions where disturbance has set back succession. Active management seems most appropriate where past human activity has created conditions that jeopardize old forest conditions within reserves. For instance, fire suppression for the last several decades has led to conditions in the Eastern Washington and Oregon Cascades Provinces where the threat of landscape scale alterations caused by insects and fire is imminent. Management intervention to reduce such risk seems warranted. Likewise, it may be appropriate to treat plantations that are now within reserves, to enhance their development toward late-successional forest conditions. All management activities that involve the removal of wood from Late-Successional Reserves should truly advance the objectives of the reserve, and provide for the retention of components of the previous stand as a legacy for the future stand. Road construction and soil compaction should be minimized during any management activity.

Matrix

The Matrix should not be treated solely as a wood fiber production area. While timber is an important product of the Matrix, many other values must be accommodated to maintain forest function and health.

Dispersal of organisms among Reserves and patches within the Matrix is essential to the maintenance of a functional ecosystem. In addition to, or in place of actual connecting links of late-successional forest, dispersal can be facilitated by a Matrix that provides conditions at least adequate for organisms to survive while moving between reserves. The 50-11-40 rule, which was designed specifically to accommodate dispersal of the spotted owl, is an example of how the Matrix can be managed to facilitate dispersal by providing a juxtaposition of stands of various ages.

Retention of small patches of late-successional forest in the Matrix, as well as green trees, snags, and logs, provides a diverse mosaic of stand conditions and habitat for dispersing organisms. The least mobile organisms should dictate the spatial scale of these elements. For sedentary species, greater numbers of patches, spaced closely together, will provide better dispersal habitat. Retention of about 15 percent of late-successional cover within cutting units, as small patches and green trees, seems to be a reasonable objective.

Although an important function of the Matrix is to provide for dispersal of organisms, perhaps of greater importance is the maintenance of organisms with key functional roles in the forest ecosystem. Taxa such as fungi, nitrogen-fixing organisms, and arthropods influence natural succession, nutrient cycling, and other ecosystem processes. Maintenance of populations of these organisms in the Matrix is essential to long-term forest productivity, as well as biodiversity.

Old forest patches as small as only a few acres can also provide important refugia for sedentary organisms which can tolerate less than interior forest conditions. Lichens, fungi, bryophytes, mollusks, arthropods, vascular plants, and the less mobile vertebrates were consistently identified during the expert panel process as benefitting from even small fragments of old forest. Panelists consistently reiterated the important functional roles played by these organisms. Panelists highlighted the necessity of maintaining these organisms well-distributed throughout the ecosystem, not just confined to reserves. Patches of green trees of various sizes, ages, and species will promote species diversity of fungi, lichens, plants, and arthropods. Single trees provide a less protected microclimate than trees in small patches. Many of these organisms require moist, cool microclimates and do not tolerate exposed conditions. Maintaining well-distributed, functional groups of non-vertebrate taxa is an especially important challenge faced by ecosystem managers. The options that maintained patches of old forest distributed throughout the landscape (Options 1, 3, and 9) consistently received positive evaluation or comment by the expert panelists.

Landscape controls, such as the 50-11-40 rule, serve to regulate human disturbance of the landscape to establish desired patterns. Many landscape controls are initiated to preserve scenic values. Others are regulatory in nature and directed at establishing specific spatial configurations of stands of various ages. Landscape guidelines could be effectively employed to mimic the pattern of natural succession within a watershed. The edge-to-area ratios within a watershed, for instance, can be manipulated to achieve desired interior forest area, thus favoring late-successional and interior forest species. Longer rotations for some stands within the Matrix would contribute to habitat diversity and provide for organisms which enter stands later in succession. These stands would also provide for a renewable source of structural components and biological legacies.

Riparian Reserves

Riparian Reserves, especially those that provide buffers equal to a site potential tree height on intermittent streams, provide ribbons of connectivity across landscapes. Just as importantly, for the many non-riparian organisms, they serve as additional acreage of Late-Successional Reserves. In fact, where stream density is high, as in the Oregon Coast Range, Riparian Reserves can probably effectively replace the 50-11-40 rule as a landscape control prescription for the northern spotted owl. Most vertebrates regularly use riparian zones for at least part of their activities; thus Riparian Reserves will also provide habitat for vertebrates associated with late-successional forests. Riparian Reserves will also protect wet micro-sites, seeps, and springs, that are important for maintaining aquatic associated arthropods, mollusks, bryophytes, vascular plants, and amphibians. Options 1 and 4, which have the largest riparian buffers, were consistently rated as most favorable for many of the species in these groups.

Role of Nonfederal Lands

The assessment presented in this chapter has focused on the management of federal forests. However, virtually all species inhabiting late-successional federal forests have significant portions of their range on non-federal lands. This can be illustrated by data on mammal, bird, and amphibian species ranges within the range of the owl (see Appendix IV-C). For many of these species, more than half of their range is on nonfederal land. Nonfederal land also assumes significance because it generally occurs at lower elevations and in different ecological zones than much of the federal land.

For nearly all the species groups discussed in this report, nonfederal lands can have potentially important roles. In some cases, these lands may be crucial to species conservation. The role of nonfederal lands in riparian conservation and in the recovery of threatened and endangered species should be priorities.

Summary of Mitigation Measures Having Broad Benefits

During the assessments of viability for the various taxa, a number of general mitigation measures were identified that would provide for a broad range of late-successional species, processes and functions. These general mitigating measures were:

(1) Retain adequate levels of large down logs for arthropods, fungi, bryophytes, amphibians, and small mammals within the Matrix. A full spectrum of tree species and sizes should be retained to promote a diversity of these species, including those that are host or substrate specific.

(2) Retain enough large snags to support up to 100 percent of potential populations of species that use cavities within the Matrix (birds and mammals). These snags should be well distributed across the landscape.

(3) Provide for sustained recruitment of large down logs and snags within the Matrix. This can best be accomplished by retaining some green trees through multiple rotations to allow them to grow to large size. These trees should be retained singly and in patches.

(4) Retain small patches of late-successional or old-growth forest within the Matrix. These small patches can provide important habitat for arthropods, fungi, lichens, bryophytes, vascular plants, mollusks, small mammals, amphibians, and bats. Species that are poor dispersers, narrow in their habitat requirements, have restricted geographic ranges and are sensitive to variation in microclimates will benefit most from retention of these patches of late-successional forest.

(5) Provide riparian buffers with widths equal to at least a site potential tree for streams occupied by amphibians and cavity-nesting waterfowl, and those used by bat populations of concern.

(6) Survey upland sites for rare, endemic or sensitive organisms prior to any disturbance caused by management. Protect sites where these organisms occur (e.g., special habitats such as serpentine barrens, wetlands, rock outcrops).

(7) Include terrestrial species in the watershed analysis for Riparian Reserves. Provide full riparian buffers where rare, endemic or sensitive species are found.

Ecosystem management

In our view, the objective of an ecosystem management plan for late-successional forests should be to maintain the full range of biological diversity, process and function that is typical of these forests. We acknowledge that our concept of ecosystem management is only partially developed, and that we have much to learn about managing ecosystems. For example, it is not clear how well the strategy of Reserves will provide for late-successional ecosystem attributes in the long-term, under a changing climate, altered disturbance regime, and increasing human populations. The role of active management in producing and maintaining late-successional ecosystems is controversial and we need to proceed cautiously. Adaptive Management Areas may provide valuable information, allowing us to modify the selected ecosystem strategy in the future to maintain late-successional values as well as provide higher levels of ecosystem production for humans. Although we are only beginning to conduct ecosystem management, we believe that options 1, 3, 4, 5, and 9 better provide for important late-successional ecosystem functions and processes than do options 7 and 8.

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Appendix A -

Lists of Common and Scientific Names for Species in the Report

Appendix B -

Species, Expert Viability Panels

Appendix C -

Amounts of Species Ranges Included in Late-Successional Reserves for the Options

Appendix Table IV-A-1. Fungi closely associated with late-successional or old-growth forests within the range of the northern spotted owl. An asterisk (*) denotes species that are endemic to the Pacific Northwest.

MYCORRHIZAL

Boletes (13 species)

Boletus chrysenteron
* *Boletus coniferarum*
Boletus edulis
* *Boletus mirabilis*
Boletus rubripes
* *Boletus smithii*
Boletus subtomentosus
Boletus truncatus
* *Boletus zelleri*
* *Gastroboletus subalpinus*
Gastroboletus turbinatus
Phylloporus rhodoxanthus
* *Suillus punctatipes*

Boletes, low elevation (2 species)

Boletus piperatus
* *Tylopilus pseudoscaber*

Rare Boletes (3 species)

* *Boletus haematinus*
* *Boletus pulcherrimus*
* *Gastroboletus ruber*

Rare Bolete/False Truffles (3 species)

* *Gastroboletus imbellus*
* *Octavianina macrospora*
* *Octavianina papyracea*

False Truffles (10 species)

* *Alpova trappei*
Choiromyces alveolatus
* *Endoptychum depressum*
* *Gautieria pterosperma*
* *Leucogaster citrinus*
Mycolevis siccigleba
* *Nivatogastrium nubigenum*
Rhizopogon atroviolaceus
Rhizopogon truncatus

False Truffles (continued)

Thaxterogaster pingue

Uncommon False Truffles (4 species)

* *Macowanites chlorinosmus*
* *Martellia maculata*
* *Martellia variabilispora*
* *Rhizopogon exiguus*

Rare False Truffles (23 species)

* *Alpova alexsmithii*
Alpova olivaceotinctus
Arcangeliella crassa
* *Arcangeliella lactarioides*
Chamonixia caespitosa
* *Destuntzia fusca*
* *Destuntzia rubra*
Gautieria magnicellaris
Gautieria otthii
* *Leucogaster microsporus*
* *Macowanites lymanensis*
Macowanites mollis
Martellia fragrans
Martellia idahoensis
* *Martellia monticola*
Rhizopogon abietis
Rizopogon atroviolaceus
Rhizopogon brunneicolor.
Rhizopogon evadens var. subalpinus
Rhizopogon flavofibrillosus
Rhizopogon inquinatus
* *Sedecula pulvinata*
* *Zelleromyces oregonensis*

Undescribed Taxa, Rare (29 species)

* *Alpova* sp. nov., Trappe # 9730[a]
* *Alpova* sp. nov., Trappe #1966
* *Arcangeliella* sp. nov., Trappe # 12383

[a] #9730 designates collection number of specimen.

MYCORRHIZAL (continued)

Undescribed Taxa, Rare (continued)
* *Arcangeliella* sp. nov., Trappe #12359
* *Chamonixia* sp. nov., Trappe #12768
* *Elaphomyces* sp. nov., Trappe #1038
* *Gastroboletus* sp. nov., Trappe #2897
* *Gastroboletus* sp. nov., Trappe #7515
* *Gastrosuillus* sp. nov., Trappe #7516
* *Gastrosuillus* sp. nov., Trappe #9608
* *Gymnomyces* sp. nov., Trappe # 4703, 5576
* *Gymnomyces* sp. nov., Trappe # 5052
* *Gymnomyces* sp. nov., Trappe #1690, 1706, 1710
* *Gymnomyces* sp. nov., Trappe #7545
* *Hydnotrya* sp. nov., Trappe #787, 792
* *Hydnotrya* sp. nov., Trappe 1861
* *Martellia* sp. nov., Trappe # 649
* *Martellia* sp. nov., Trappe #1700
* *Martellia* sp. nov., Trappe #311
* *Martellia* sp. nov., Trappe #5903
* *Octavianina* sp. nov., Trappe #7502, 11172
* *Picoa* sp. nov., Trappe # 12658
* *Picoa* sp. nov., Trappe # 13027
* *Rhizopogon* sp. nov., Trappe #9432
* *Thaxterogaster* Trappe #4867, 6242,7427,7962,8520
* *Tuber* sp. nov., Trappe #11643
* *Tuber* sp. nov., Trappe #2302
* *Tuber* sp. nov., Trappe 12493
* Unnamed new genus & species, Trappe # 7654

Truffles (5 species)

Elaphomyces granulatus
Elaphomyces muricatus
Geopora cooperi f. *cooperi*
Hydnotrya cerebriformis
* *Hydnotrya variiformis* var. *pallida* Trappe var. nov.

Rare Truffles (6 species)

Balsamia nigra
Choiromyces venosus
Elaphomyces anthracinus
Elaphomyces subviscidus
Genea verrucosa
Tuber rufum

Chanterelles (3 species)

Cantharellus cibarius
Cantharellus subalbidus
Cantharellus tubaeformis

Chanterelles - Gomphus (4 species)

Gomphus bonarii
Gomphus clavatus
Gomphus floccosus
Gomphus kauffmanii

Rare Chanterelle (2 species)

* *Cantharellus formosus*
Polyozellus multiplex

Coral Fungi (50+ species)

Ramaria spp.

Phaeocollybia (13 species)

* *Phaeocollybia attenuata*
* *Phaeocollybia californica*
* *Phaeocollybia carmanahensis*
* *Phaeocollybia fallax*
* *Phaeocollybia gregaria*
* *Phaeocollybia kauffmanii*
* *Phaeocollybia olivacea*
* *Phaeocollybia oregonensis*
* *Phaeocollybia piceae*
* *Phaeocollybia pseudofestiva*
* *Phaeocollybia scatesiae*
* *Phaeocollybia sipei*
* *Phaeocollybia spadicea*

Gilled Mushrooms (125 species)

* *Amanita constricta*
Amanita farinosa
*Amanita francheti*Tuber rufum
Amanita gemmata
Amanita inaurata
Amanita muscaria var. *formosa*

MYCORRHIZAL (continued)

Gilled Mushrooms (continued)

* *Amanita pachycolea*
Amanita pantherina
Amanita porphyria
* *Amanita smithiana*
Chroogomphus tomentosus
Cortinarius acutus
Cortinarius adalberti
Cortinarius allutus
Cortinarius anomalus
Cortinarius arquatus
Cortinarius badiovinaceus
Cortinarius callisteus
Cortinarius calochrous
Cortinarius camphoratus
Cortinarius caninus
Cortinarius clandestinus
Cortinarius collinitus var. *collinitus*
Cortinarius collinitus var. *olympianus*
Cortinarius crassus/subaustralis
Cortinarius delibutus
Cortinarius evernius
Cortinarius flexipes
Cortinarius gentilis
Cortinarius glaucopus
Cortinarius griseoviolaceus
Cortinarius guttatus
Cortinarius herpeticus/montanus
Cortinarius infractus
Cortinarius junghuhnii
Cortinarius laniger
Cortinarius limonius
Cortinarius miniatopus
* *Cortinarius mutabilis*
Cortinarius obtusus
Cortinarius paleaceous
Cortinarius paragaudis
Cortinarius pinetorum sensu kauffman
Cortinarius pseudoarquatus
Cortinarius renidens
Cortinarius rubicundulus
Cortinarius salor
Cortinarius scutulatus
Cortinarius traganus
Cortinarius vanduzerensis
Cortinarius venetus var. *montanus*
Cortinarius vibratilis

Gilled Mushrooms (continued)

Cortinarius violaceus
Cortinarius zinziberatus
Dermocybe crocea
* *Dermocybe idahoensis*
Dermocybe malicoria
* *Dermocybe phoenicea* var. *occidentalis*
Dermocybe sanguinea
Dermocybe semisanguinea
Dermocybe zakii
Hebeloma crustuliniforme
Hygrophorus amarus
* *Hygrophorus bakerensis*
Hygrophorus camarophyllus
Hygrophorus chrysodon
Hygrophorus discoideus
Hygrophorus eburneus
Hygrophorus erubescens
Hygrophorus inocybiformis
Hygrophorus megasporus
Hygrophorus olivaceoalbus
Hygrophorus tephroleucus
Inocybe agglutinata
Inocybe calamistrata
Inocybe fuscodisca
Inocybe hirsuts var. *maxima*
Inocybe lanuginosa
Inocybe obscura
Inocybe praetervisa
Inocybe sororia
Inocybe whitei
Laccaria amethysteo-occidentalis
Laccaria bicolor
Laccaria laccata
Lactarius alnicola
Lactarius deliciosus var. *deliciosus*
* *Lactarius deliciosus* var. *olivaceosordidus*
Lactarius fallax var. *concolor*
Lactarius fallax var. *fallax*
Lactarius kauffmanii
Lactarius olivaceoumbrinus
Lactarius olympianus
Lactarius pallescens
Lactarius pseudomucidus
Lactarius scrobiculatus
Lactarius subviscidus

MYCORRHIZAL (continued)

Gilled Mushrooms (continued)

Limacella glioderma
Rozites caperata
Russula aeruginea
Russula albonigra
Russula bicolor
Russula brevipes var. *acrior*
Russula crassotunicata
Russula decolorans
Russula nigricans
Russula occidentalis
Russula olivascens
Russula pelargonia
Russula rosacea
Russula variata
Russula xerampelina
Tricholoma davisiae
Tricholoma flavovirens
Tricholoma focale
Tricholoma imbricatum
Tricholoma inamoenum
Tricholoma magnivelare
Tricholoma pessundatum
Tricholoma portentosum
Tricholoma saponaceum
Tricholoma sejunctum
Tricholoma squarrulosum
Tricholoma vaccinum
Tricholoma virgatum

Uncommon Gilled Mushrooms (15 species)

Catathelasma ventricosa
Cortinarius azureus
* *Cortinarius boulderensis*
Cortinarius cyanites
* *Cortinarius magnivelatus*
* *Cortinarius olympianus*
Cortinarius spilomius
Cortinarius tabularis
Cortinarius valgus
* *Dermocybe humboldtensis*
* *Hebeloma olympiana*
* *Hygrophorus caeruleus*
Hygrophorus karstenii

Uncommon Gilled Mushrooms (continued)

* Hygrophorus vernalis
Russula mustelina

Rare Gilled Mushrooms (7 species)

* *Chroogomphus loculatus*
Cortinarius canabarba
* *Cortinarius rainierensis*
Cortinarius variipes
* *Cortinarius verrucisporus*
* *Cortinarius wiebeae*
Tricholoma venenatum

Ecto-Polypore

Coltrichia perennis

Uncommon Ecto-Polypores, (2 species)

Albatrellus ellisii
Albatrellus flettii

Rare Ecto-Polypores (3 species)

Albatrellus avellaneus
Albatrellus caeruleoporus
Polyporoletus sublividus

Tooth Fungi (5 species)

Hydnum repandum
Hydnum umbilicatum
Phellodon atratum
Sarcodon fuscoindicum
Sarcodon imbricatus

Ecto-Resupinate Fungi (3+ species)

Amphinema byssoides
Piloderma bicolor
Tomentella spp.

Appendix Table IV-A-1. (continued)

MYCORRHIZAL (continued)

Ecto-Puffballs (2 species)

Lycoperdon nigrescens
Lycoperdon pyriforme

Rare Zygomycetes (3 species)

Endogone acrogena
* *Endogone oregonensis*
Glomus radiatum

SAPROBES (DECOMPOSERS)

Gilled Mushrooms (80 species)

* *Caulorhiza umbonata*
Chrysomphalina aurantiaca
Clitocybe avellaneialba
Clitocybe clavipes
Clitopilus prunulus
Collybia acervata
Collybia butyracea
Collybia maculata var. *maculata*
Collybia maculata var. *occidentalis*
Collybia maculata var. *scorzonerea*
Galerina mammillata
Galerina siderioides
Galerina stylifera
Gymnopilus bellulus
Gymnopilus hybridus
Gymnopilus spectabilis
Hemimycena delectabilis
Hygrocybe conica
Hygrocybe laeta
Hygrophoropsis aurantiaca
Hypholoma capnoides
Hypholoma dispersum
Kuhneromyces lignicola
Kuhneromyces mutabilis
Lyophyllum semitale
Marasmiellus papilatus
Marasmiellus pluvius
Marasmius pallidocephalus
Marasmius quercophilus
Marasmius salalis
* *Melanotus textilis*
Micromphale perforans
Micromphale sequiaea

Gilled Mushrooms (continued)

Mycena amabilissima
Mycena amicta
Mycena aurantiidisca
Mycena aurantiomarginata
Mycena capillaripes
Mycena elegantula/purpureofusca
Mycena epipterygia
Mycena filopes
Mycena galopus
Mycena longiseta
Mycena robromarginata
Mycena strobilinoides
Mycena epipterygia
Mycena galericulata (syn. *M. rugulosiceps*)
Mycena leptocephala
Mycena maculata
Mycena rosella
Mycena sanguinolenta
Mycena viscosa
Nolanea staurospora
Nolanea cathionis
Nolanea cetrata
Nolanea cuneata
Nolanea stricta
Omphalina epichysium
Panellus longiquus
Paxillus atrotomentosus
Paxillus panuoides
Pholiota flavida
Pholiota lubrica
Pholiota astragalina
Pholiota decorata
Pholiota flammans
Pholiota scamba
Pleurocybella porrigens
Rhodocybe trachyospora var. *purpureoviolaceum*
Resinomycena montana
Resupinatus applicatus
Stropharia hornemannii
Tricholomopsis decora
Tricholomopsis flavissima
Xeromphalina campanelloides

Appendix Table IV-A-1. (continued)

SAPROBES (DECOMPOSERS) (continued)

Uncommon Gilled Mushrooms (17 species)

Xeromphalina cauticinalis
Xeromphalina cirris
Xeromphalina cornui
Xeromphalina fulvipes
* *Xeromphalina orickiana*
Baeospora myriadophylla
Chrysomphalina grossula
* *Collybia bakerensis*
Fayodia gracilipes (rainierensis)
* *Gymnopilus puntifolius*
Marasmius applanatipes
* *Mycena quinaultensis*
Mycena tenax
* *Mycena hudsoniana*
Mycena lilacifolia
Mycena marginella
Mycena monticola
Mycena overholtsii
Mythicomyces corneipes
* *Neolentinus kauffmanii*
Pholiota albivelata
Stagnicola perplexa

Rare Gilled Mushrooms (6 species)

Clitocybe subditopoda
Clitocybe senilis
Neolentinus adherens
Rhodocybe (Entoloma) nitida
* *Rhodocybe speciosa*
* *Tricholomopsis fulvescens*

Polypores (10 species)

Ganoderma oregonense
Ganoderma tsugae
Ischnoderma resinosum
Jahnoporus hirtus
Laetiporus sulfureus
Oligoporus guttulatus
Ostenia obducta
Polyporus melanopus
Pycnoporellus alboluteus
Pycnoporellus fulgens

Noble Polypore (rare and endangered)

* *Oxyporus nobilissimus*

Other Polypore

Bondarzewia mesenterica

Resupinate Fungi (14 species)

Aleurodiscus grantii
Aleurodiscus peniciallatus
Coniophora arida
Grandinia alutaria
Grandinia aspera
Grandinia breviseta
Hericium abietis
Leucogyrophana mollusca
Phlebia tremellosa
Phlebiella vaga
Resinicium furfuraceum
Stromatoscypha fimbriata
Trechispora farinacea
Trechispora mollusca

Rare Resupinates and Polypores (6 species)

Aleurodiscus farlowii
Dichostereum granulosum
Grandinia microsporella
Phlebia diffusa
Postia rennyii
Scytinostroma cf. *galatinum*

Cup Fungi (15 species)

Cudonia circinans
Cudonia monticola
Gyromitra californica
Gyromitra esculenta
Gyromitra infula
Gyromitra melaleucoides
Gyromitra montana (syn. *G. gigas*)
Otidea leporina
Otidea onotica
Otidea smithii
Plectania melastoma

Appendix Table IV-A-1. (continued)

SAPROBES (DECOMPOSERS) (continued)

<u>Cup Fungi (continued)</u>

Podostroma alutaceum
Sarcosoma mexicana
Sarcosphaera eximia
Spathularia flavida

<u>Rare Cup Fungi (14 species)</u>

Aleuria rhenana
Bryoglossum gracile
Gelatinodiscus flavidus
Helvella compressa
Helvella crassitunicata
Helvella elastica
Helvella maculata
Neournula pouchetii
Pithya vulgaris
* *Plectania latahensis*
* *Plectania milleri*
* *Psedaleuria quinaultiana*
Sarcoleotia globosa
Trichophaeopsis tetraspora

<u>Branched Coral Fungi (3 species)</u>

Clavulina cinerea
Clavulina cristata
Clavulina ornatipes

PARASITES

<u>Common Parasitic Fungi (2 species)</u>

Hypomyces aurantium
Hypomyces lactifluorum

<u>Parasitic Fungi (7 species)</u>

Asterophora lycoperdoides
Asterophora parasitica
Collybia racemosa
Cordyceps capitata
Cordyceps ophioglossoides

Parasitic Fungi (continued)

Hypomyces luteovirens
Scytinostroma cf. *galatinum*

<u>Cauliflower Mushroom</u>

Sparassis crispa

OTHER FUNGI

<u>Moss Dwelling Mushrooms (7 species)</u>

Cyphellostereum laeve
Galerina atkinsoniana
Galerina cerina
Galerina heterocystis
Galerina sphagnicola
Galerina vittaeformis
Rickenella setipes

<u>Club Coral Fungi</u>

Clavariadelphus spp.

<u>Jelly Mushroom</u>

Phlogoitis helvelloides

<u>Mushroom Lichen</u>

Phytoconis ericetorum

NOT RATED

Clavaria americana
Clavulinopsis (Ramariopsis) laeticolor and relatives
Calocera furcata
Clavivorona avellanea
Hypocreales
Laboulbeniales
Pleosporales

Appendix Table IV-A-2. Lichens closely associated with late-successional or old-growth forests within the range of the northern spotted owl, arranged by ecological groups. An asterisk (*) denotes species that are endemic to the Pacific Northwest or Western North America.

<u>Rare Forage Lichen (arboreal)</u>

Bryoria tortuosa

<u>Forage Lichens (arboreal) (10 species)</u>

Alectoria lata
Alectoria sarmentosa
* *Alectoria vancouverensis*
Bryoria capillaris
Bryoria friabilis
Bryoria glabra
* *Bryoria pikei*
* *Bryoria pseudofuscescens*
Usnea filipendula
Usnea scabrata

<u>Rare Leafy (arboreal) Lichens (2 species)</u>

Hypogymnia duplicata
Tholurna dissimilis

<u>Arboreal Leafy Lichens (17 species)</u>

* *Ahtiana sphaerosporella*
Cavernularia hultenii
Cavernularia lophyrea
Cetraria subalpina
* *Hypogymnia metaphysodes*
* *Hypogymnia rugosa*
Melanelia subelegantula
Parmelia kerguelensis
Parmelia squarrosa
Parmotrema arnoldii
Parmotrema chinense
Parmotrema crinitum
* *Platismatia herrei*
Platismatia norvegica
* *Platismatia stenophylla*
Sphaerophorus globosus
* *Tuckermannopsis pallidula*

<u>Rare Nitrogen-fixing Lichens (6 species)</u>

Dendriscocaulon intricatulum
Lobaria hallii
Lobaria linita
* *Nephroma occultum*
Pannaria rubiginosa
* *Pseudocyphellaria rainierensis*

<u>Nitrogen-fixing Lichens (20 species)</u>

* *Lobaria oregana*
Lobaria pulmonaria
Lobaria scrobiculata
Nephroma bellum
Nephroma helveticum
Nephroma laevigatum
Nephroma parile
Nephroma resupinatum
Pannaria leucostictoides
Pannaria mediterranea
Pannaria saubinetii
Peltigera collina
Peltigera neckeri
* *Peltigera pacifica*
* *Pseudocyphellaria anomala*
* *Pseudocyphellaria anthraspis*
Pseudocyphellaria crocata
* *Sticta beauvoisii*
Sticta fuliginosa
Sticta limbata

<u>Pin Lichens (16 species)</u>

Calicium abietinum
Calicium adaequatum

Appendix Table IV-A-2. (continued)

Pin Lichens (continued)

Calicium adspersum
Calicium glaucellum
Calicium viride
Chaenotheca brunneola
Chaenotheca chrysocephala
Chaenotheca ferruginea
Chaenotheca furfuracea
Chaenotheca subroscida
Chaenothecopis pusilla
Cyphelium inquinans
Microcalicium arenarium
Mycocalicium subtile
* *Stenocybe clavata*
Stenocybe major

Decaying Wood (8 species)

Cladonia bacillaris
Cladonia bellidiflora
Cladonia cenotea
Cladonia macilenta
Cladonia umbricola
Icmadophila ericetorum
Xylographa abietina
Xylographa vitiligo

Tree Boles (14 species)

Buellia penichra
Dimerella lutea
Dimerella pineti
Hypocenomyce friesii
Lecanactis megaspora
Lopadium pezizoideum
Mycoblastus alpinus
Mycoblastus sanguinarius
Ochrolechia androgyna
Ochrolechia oregonensis
Parmeliopsis hyperopta
Pertusaria amara
Protoparmelia ochrococca
Thelotrema lepadinum

Soil occurring Lichens (8 species)

Baeomyces rufus
Epilichen scabrosus

Soil occurring Lichens (continued)

* *Pannaria cyanolepra*
Pannaria pezizoides
Peltigera horizontalis
Peltigera leucophlebia
Peltigera neopolydactyla
Peltigera venosa

Rare Rock Lichens (2 species)

* *Pilophorus nigricaulis*
Sticta arctica

Rock Lichens (4 species)

Leptogium gelatinosum
Pilophorus acicularis
Pilophorus clavatus
Psoroma hypnorum

Riparian Lichens (9 species)

Cetrelia cetrarioides
Collema nigrescens
Leptogium burnetiae var. *hirsutum*
Leptogium cyanescens
Leptogium saturninum
Leptogium teretiusculum
Platismatia lacunosa
Ramalina thrausta
Usnea longissima

Aquatic Lichens (3 species)

Dermatocarpon luridum
* *Hydrothyria venosa*
Leptogium rivale

Rare Oceanic Influenced Lichens (12 species)

Bryoria pseudocapillaris
Bryoria spiralifera
Bryoria subcana
* *Buellia oidalea*
Erioderma sorediatum
Hypogymnia oceanica
Leioderma sorediatum
Leptogium cephalota

Appendix Table IV-A-2. (continued)

<u>Rare Oceanic Influenced Lichens (continued)</u>

* *Niebla cephalota*
Pseudocyphellaria mougeotiana
Teloschistes flavicans
Usnea hesperina

<u>Oceanic Influenced Lichens (4 species)</u>

* *Cetraria californica*
Heterodermia leucomelos
* *Loxospora sp nov. "corallifera"* (*Brodo* in edit)
Pyrrhospora quernea

<u>Species Not Rated (7 species)</u>

Cladonia norvegica
* *Heterodermia sitchensis*
Hyptogymnia vittata
Hypotrachyra revoluta
* *Nephroma isidiosum*
Ramalina pollinaria
Sulcaria badia

Appendix Table IV-A-3. Bryophytes closely associated with late-successional or old-growth forests within the range of the northern spotted owl, arranged by ecological groups. An asterisk (*) denotes species that are endemic to the Pacific Northwest.

Canopy Exterior (2 species)

* *Ulota megalospora*
* *Ulota obtusiuscula*

Canopy Interior (2 species)

Antitrichia curtipendula
Douinia ovata

Tree Boles/Decaying Wood (3 species)

Dicranum fuscescens
* *Hypnum circinale*
* *Scabania bolanderi*

Tree Boles/Understory - (5 species)

* *Pseudoleskea baileyi*
* *Pseudoleskea stenophylla*
Pterigynandrum filiforme
* *Ptilidium californicum* (OR & WA)
* *Radula bolanderi*

Shaded Mineral Soil (5 species)

* *Ditrichum schimperi*
* *Fissidens pauperculus*
* *Pohlia pacifica*
Pseudotaxiphyllum elegans
Trichodon cylindricus

Shaded rock outcrops with thin soil (7 species)

* *Bryum gemmascens*
Heterocladium dimorphum
Heterocladium macounii
* *Heterocladium procurrens*
Plagiothecium piliferum
Timmia austriaca
Timmia megapolitana

Wet Shaded Humic Soil (5 species)

Calypogeia azurea
Calypogeia fissa
Calypogeia muelleriana
Isopterygiopsis pulchella

Humic Soil (continued)

Plagiochila asplenioides complex

Shaded Duff/Humic Soil (3 species)

* *Brachythecium hylotapetum*
* *Rhytidiopsis robusta*
* *Roellia roellii*

Decaying wood - Abundant (15 species)

Blepharostoma trichophyllum
Calypogeia neesiana
Cephalozia bicuspidata sp. *lammersiana*
Cephalozia connivens
Cephalozia lunulifolia
Lepidozia reptans
Lophocolea bidentata
Lophocolea cuspidata
Lophocolea heterophylla
Lophozia incisa
Lophozia ventricosa
Plagiothecium undulatum
* *Rhizomnium glabrescens*
Riccardia latifrons
Tetraphis pellucida

Decaying Wood - less common (11 species)

Bazzania ambigua
Bazzania denudata
Bazzania tricrenata
* *Buxbaumia piperi*
Buxbaumia viridis
Calypogeia suecica
Geocalyx graveolens
Herzogiella seligeri
Lophozia longiflora
Riccardia palmata
Scapania umbrosa

Table IV-A-3. (continud)

Aquatic (submerged) (3 species)

Chiloscyphus polyanthos
* *Fissidens ventricosus*
Scapania undulata

Splash Zone (5 species)

Dichodontium pellucidum
Jungermannia atrovirens
Racomitrium aciculare
Schistidium rivulare
Scouleria aquatica.

Flood Plain (13 species)

Apometzgeria pubescens
Conocephalum conicum
Dicranella palustris
Hookeria lucens
Metzgeria conjugata
Pellia epiphylla
Pellia neesiana
* *Plagiomnium insigne*
* *Porotrichum bigelovii*
* *Racomitrium obesum*
* *Rhizomnium nudum*
Rhytidiadelphus subpinnatus
Schistidium agassizii

Species Rated Individually (3 species)

Fontinalis howellii
Kurzia makinoana
* *Thamnobryum neckeroides*

Rare Species (8 species)

* *Blindia flexipoda*
Diplophyllum plicatum
Marsupella emarginata var. aquatica
* *Pseudoleskeella serpentinense*
* *Ptilidium californicum* (CA only)
Racomitrium pacificum
Schistostega pennata
Tritomaria exsectiformis

Species Not Rated (16 species)

Bartramiopsis lescurii
* *Brotherella roelli*
Diplophyllum albicans
* *Encalypta brevicolla* var. *crumiana*
Herbertus aduncus
Herbertus sakuraii
Iwatsukiella leucotricha
Orthodontium gracile
Plagiochila satoi
Plagiochila semidecurrens
* *Pleuroziopsis ruthenica*
Racomitrium aquaticum
Radula brunnea
* *Scouleria marginata*
Tetraphis geniculata
Tritomaria quinquedentata

Appendix table IV-A-4. Vascular plants closely associated with late-successional or old-growth forests within the range of the northern spotted owl. Federal status based on USDI (1990b). An asterisk (*) denotes species added since Scientific Analysis Team report (Thomas et al. 1993).

	Species name	Common name	Family	Rare Endemic	Federal Status
*	*Abies lasiocarpa* (California only)	subalpine fir	Pinaceae	R	
	Achlys triphylla	vanilla leaf	Berberidaceae		
	Adenocaulon bicolor	trail plant	Asteraceae		
*	*Adiantum jordanii*	Jordan's maidenhair fern	Polypodiaceae		
	Adiantum pedatum	northern maidenhair fern	Polypodiaceae		
	Allotropa virgata	candy stick	Ericaceae	R	
	Anemone deltoidea	threeleaf anemone	Ranunculaceae		
	Angelica tomentosa	California angelica	Apiaceae		
	Apocynum pumilum	mountain dogbane	Apocynaceae		
*	*Aralia californica*	California aralia	Araliaceae		
	Arceuthobium tsugense	dwarf mistletoe	Loranthaceae		
	Arnica latifolia	mountain arnica	Asteraceae		
	Asarum caudatum	wild ginger	Aristolochiaceae		
	Asarum hartwegii	Hartweg's wild ginger	Aristolochiaceae		
*	*Asarum marmoratum*	marbled wild-ginger	Aristolochiaceae	E	
	Asarum wagneri	green-flowered wild ginger	Aristolochiaceae	E	
*	*Aster vialis*	wayside aster	Asteraceae	E	C2
	Bensoniella oregana	bensoniella	Saxifragaceae	E	C2
	Berberis pumila	dwarf mahonia	Berberidaceae		
	Boschniakia strobilacea	ground cone	Orobanchaceae		
	Botrychium minganense	mingan moonwort	Ophioglossaceae	R	
	Botrychium montanum	mountain moonwort	Ophioglossaceae	R	
*	*Botrychium virginanum*	Virginia grape-fern	Ophioglossaceae	R	
	Calypso bulbosa	fairy slipper	Orchidaceae		
	Chamaecyparis lawsoniana	Port Orford cedar	Cupressaceae		
	Chamaecyparis nootkatensis	Alaska yellow cedar	Cupressaceae		
	Chimaphila menziesii	pipsissewa	Ericaceae		
	Chimaphila umbellata	common pipsisiwa	Ericaceae		
	Cimicifuga elata	tall bugbane	Ranunculaceae	E	
*	*Cimicifuga laciniata*	cut-leaved bugbane	Ranunculaceae	E	
*	*Clintonia andrewsiana*	Redwood beadlily	Liliaceae	E	
	Clintonia uniflora	queen cup beadlily	Liliaceae		
*	*Collomia mazama*	bristle-flowered collomia	Polemoniaceae	E	C2
	Coptis asplenifolia	spleenwort-leaved goldthread	Ranunculaceae	R	
	Coptis laciniata	goldthread	Ranunculaceae		
*	*Coptis trifolia*	threeleaflet goldthread	Ranunculaceae		
	Corallorhiza maculata	Pacific coralroot	Orchidaceae		
	Corallorhiza mertensiana	western coralroot	Orchidaceae		
*	*Corallorhiza striata*	striped coralroot	Orchidaceae		

Table IV-A-4. (continued).

	Cypripedium fasciculatum	clustered ladyslipper	Orchidaceae	R	
	Cypripedium montanum	mountain ladyslipper	Orchidaceae	R	
	Dentaria californica	toothwort	Brassicaceae		
	Disporum hookeri	fairy-bell	Liliaceae		
*	*Disporum smithii*	fairy lantern	Liliaceae		
	Dryopteris austriaca	mountain woodfern	Polypodiaceae		
	Eburophyton austiniae	phantom orchid	Orchidaceae		
	Erythronium montanum	avalanche lily	Liliaceae		
*	*Frasera umpquaensis*	Umpqua swertia	Gentianiaceae	E	C2
	Galium kamtschaticum	boreal bedstraw	Rubiaceae	R	
*	*Galium oreganum* (Klamath)	Oregon bedstraw	Rubiaceae		
	Gaultheria humifusa	western wintergreen	Ericaceae		
	Gaultheria ovatifolia	Oregon wintergreen	Ericaceae		
	Goodyera oblongifolia	rattlesnake plantain	Orchidaceae		
	Gymnocarpium dryopteris	oak fern	Polypodiaceae		
	Habenaria obtusata	small northern bog-orchid	Orchidaceae	R	
	Habenaria orbiculata	large round-leaved rein-orchid	Orchidaceae	R	
	Habenaria saccata	slender bog-orchid	Orchidaceae		
	Habenaria unalascensis	Alaska rein-orchid	Orchidaceae		
	Hemitomes congestum	gnome plant	Ericaceae	R	
	Hieracium scouleri	wooly-weed	Asteraceae		
*	*Hierochloe occidentalis*	California vanillagrass	Poaceae		
	Hypopitys monotropa	pinesap	Ericaceae		
*	*Isopyrum hallii*	Hall's rue-anemone	Ranunculaceae		
	Lathyrus polyphyllus	leafy peavine	Fabaceae		
	Listera borealis	twinflower	Orchidaceae	R	
	Listera caurina	western twayblade	Orchidaceae		
	Listera convallarioides	broad-lipped twayblade	Orchidaceae		
	Listera cordata	twayblade	Orchidaceae		
	Luzula hitchcockii	smooth woodrush	Juncaceae		
*	*Lycopodium selago*	fir clubmoss	Lycopodiaceae	R	
	Lysichiton americanum	skunk cabbage	Araceae		
	Melica subulata	Alaska oniongrass	Poaceae		
	Menziesia ferruginea	fool's huckleberry	Ericaceae		
	Mitella breweri	Brewer's mitrewort	Saxifragaceae		
*	*Mitella caulescens*	star-shaped mitrewort	Saxifragaceae		
*	*Mitella ovalis*	oval-leaved mitrewort	Saxifragaceae		
*	*Mitella pentandra*	five-stamened mitrewort	Saxifragaceae		
*	*Mitella trifida*	Pacific mitrewort	Saxifragaceae		
	Monotropa uniflora	Indian pipe	Ericaceae		
	Oxalis oregana	Oregon wood-sorrel	Oxalidaceae		
*	*Oxalis trilliifolia*	trillium-leaved woodsorrel	Oxalidaceae		
*	*Pedicularis howellii*	Howell's lousewort	Scrophulariaceae	E	C2

Table IV-A-4. (continued).

Phlox adsurgens	woodland phlox	Polemoniaceae	
Picea breweriana	Brewer's spruce	Pinaceae	E
Pityopis californica	pinefoot	Ericaceae	R
Pleuricospora fimbriolata	fringed pinesap	Ericaceae	
Poa laxiflora	loose-flowered bluegrass	Poaceae	E
* *Polystichum californicum* (Cascades)	California swordfern	Polypodiaceae	R
Pterospora andromedea	woodland pinedrops	Ericaceae	R
Pyrola asarifolia	alpine pyrola	Ericaceae	
Pyrola chlorantha	greenish pyrola	Ericaceae	
Pyrola dentata	toothleaf pyrola	Ericaceae	
Pyrola picta	white vein pyrola	Ericaceae	
Pyrola secunda	side-bells pyrola	Ericaceae	
Pyrola uniflora	single flowered pyrola	Ericaceae	
Rubus lasiococcus	dwarf bramble	Rosaceae	
Rubus nivalis	snow bramble	Rosaceae	
Rubus pedatus	five-leaved bramble	Rosaceae	
Sarcodes sanguinea	snow plant	Ericaceae	
Satureja douglasii	yerba buena	Lamiaceae	
Scoliopus bigelovii	Bigelove's slink lily	Liliaceae	E
Scoliopus hallii	slink lily	Liliaceae	
Selaginella oregana	Oregon selaginella	Selaginellaceae	R
Smilacina racemosa	solomon's seal	Liliaceae	
Smilacina stellata	star-flowered solomon's plume	Liliaceae	
Streptopus amplexifolius	clasping-leaved twisted stalk	Liliaceae	
Streptopus roseus	rosy twisted stalk	Liliaceae	
Streptopus streptopoides	twisted stalk	Liliaceae	
Synthyris schizantha	fringed synthyris	Scrophulariaceae	R
Taxus brevifolia	Pacific yew	Taxaceae	
Thuja plicata	western redcedar	Cupressaceae	
Tiarella trifoliata	trefoil foamflower	Saxifragaceae	
Tiarella unifoliata	coolwort foamflower	Saxifragaceae	
Trillium ovatum	wake-robin	Liliaceae	
Trillium ovatum ssp. *oettingeri*	Salmon Mountain wakerobin	Liliaceae	
Vaccinium alaskaense	Alaska huckleberry	Ericaceae	
Vaccinium membranaceum	thin-leaved huckleberry	Ericaceae	
Vaccinium ovalifolium	oval-leaf huckleberry	Ericaceae	
Vaccinium parvifolium	red huckleberry	Ericaceae	
Vancouveria hexandra	inside-out flower	Berberidaceae	
Vancouveria planipetala	small-flowered vancouveria	Berberidaceae	E
Vicia americana var. *villosa*	American vetch	Fabaceae	
Viola glabella	pioneer violet	Violaceae	
Viola orbiculata	round-leaved violet	Violaceae	
Viola renifolia	kidney-leaved violet	Violaceae	
Whipplea modesta	yerba de selva	Hydrangeaceae	

Xerophyllum tenax (Olympic) beargrass Liliaceae

Appendix Table IV-A-5. Mollusks closely associated with late-successional or old-growth forests within the range of the northern spotted owl.

Land Snails

Ancotrema voyanum	hooded lancetooth
Cryptomastix devia	Puget oregonian
Cryptomastix hendersoni	Columbia oregonian
Helminthoglypta arrosa monticola	mountain shoulderband
Helminthoglypta hertleini	Oregon shoulderband
Helminthoglypta talmadgei	Klamath shoulderband
Megomphix californicus	California megomphyx
Megomphix hemphilli	Oregon megomphyx
Monadenia callipeplus	no common name
Monadenia chaceana	Chace sideband
Monadenia churchi	Klamath sideband
Monadenia fidelis celeuthia	traveling sideband
Monadenia fidelis flava	green sideband
Monadenia fidelis klamathica	no common name
Monadenia fidelis leonina	tawny sideband
Monadenia fidelis minor	Dalles sideband
Monadenia fidelis ochromphalus	yellow-base sideband
Monadenia fidelis salmonensis	Salmon River sideband
Monadenia rotifer	wheel sideband
Monadenia scottiana	Scott River sideband
Monadenia setosa	Trinity bristlesnail
Monadenia troglodytes troglodytes	Shasta sideband
Monadenia troglodytes wintu	Wintu sideband
Oreohelix n. sp.	Chelan mountainsnail
Pristiloma articum crateris	Crater lake tightcoil
Punctum (Toltecia) hannai	Hanna spot
Trilobopsis roperi	Shasta chaparral
Trilobopsis tehamana	Tehama chaparral
Vertigo n. sp.	Hoko vertigo
Vespericola depressa	Dalles hesperian
Vespericola euthales	large hesperian
Vespericola karokorum	Karok hesperian
Vespericola pressleyi	Pressley hesperian
Vespericola shasta	Shasta hesperian
Vespericola sierrana	Siskiyou hesperian
Vespericola undescribed #1	Sasquatch hesperian
Vespericola undescribed #2	Reeves Bar hesperian
Vespericola undescribed #3	Klamath hesperian

Appendix Table IV-A-5. (continued)

Slugs

Deroceras hesperium	evening fieldslug
Hemphillia burringtoni	Burrington jumping-slug
Hemphillia glandulosa	warty jumping-slug
Hemphillia malonei	Malone jumping-slug
Hemphillia pantherina	panther jumping-slug
Prophysaon coeruleum	blue-gray tail-dropper
Prophysaon dubium	Papillose tail-dropper

Riparian

Anodonta californiensis	California floater
Anodonta wahlametensis	Willamette floater
Fisherola nuttalli nuttalli	shortface lanx
Fluminicola columbiana	Columbia pebblesnail
Fluminicola n. sp. 1	Klamath pebblesnail
Fluminicola n. sp. 2	tall pebblesnail
Fluminicola n. sp. 3	Klamath Rim pebblesnail
Fluminicola n. sp. 4	nerite pebblesnail
Fluminicola n. sp. 5	toothed pebblesnail
Fluminicola n. sp. 6	diminutive pebblesnail
Fluminicola n. sp. 7	topaz pebblesnail
Fluminicola n. sp. 8	Fall Creek pebblesnail
Fluminicola n. sp. 9	lunate pebblesnail
Fluminicola n. sp. 10	Keene Creek pebblesnail
Fluminicola n. sp. 11	Fredenburg pebblesnail
Fluminicola n. sp. 12	Umpqua pebblesnail
Fluminicola n. sp. 13	Sacramento pebblesnail
Fluminicola n. sp. 14	Potem pebblesnail
Fluminicola n. sp. 15	flat-top pebblesnail
Fluminicola n. sp. 16	Shasta pebblesnail
Fluminicola n. sp. 17	disjunct pebblesnail
Fluminicola n. sp. 18	globular pebblesnail
Fluminicola n. sp. 19	umbilicate pebblesnail
Fluminicola n. sp. 20	Lost Creek pebblesnail
Fluminicola seminalis	nugget pebblesnail
Helisoma newberryi newberryi	Great Basin rams-horn
Juga (C.) *acutifilosa*	scalloped juga
Juga (C.) *occata*	topaz juga
Juga (J.) n. sp. 1	brown juga
Juga (J.) n. sp. 3	tall juga
Juga (O.) n. sp. 1	no common name
Juga (O.) n. sp. 2	no common name
Juga (O.) n. sp. 3	no common name
Juga (Oreobasis) chacei	Chace juga
Juga (Oreobasis) orickensis	redwood juga
Juga hemphilli dallesensis	Dalles juga
Juga hemphilli hemphilli	barren juga
Juga hemphilli n. subsp. 1	no common name

Lanx alta	highcap lanx

Appendix IV-A-5. (continued)

Lanx klamathensis	scale lanx
Lanx patelloides	kneecap lanx
Lanx subrotundata	rotund lanx
Lyogyrus n. sp. 1	Columbia duskysnail
Lyogyrus n. sp. 2	Washington duskysnail
Lyogyrus n. sp. 3	canary duskysnail
Lyogyrus n. sp. 4	Klamath duskysnail
Lyogyrus n. sp. 5	nodose duskysnail
Lyogyrus n. sp. 6	mare's egg duskysnail
Physella columbiana	rotund physa
Pisidium (C.) *ultramontanum*	montane peaclam
Pyrgulopsis archimedis	Archimedes pyrg
Pyrgulopsis intermedia	Crooked Creek springsnail
Pyrgulopsis n. sp. 1	lake pyrg
Vorticifex klamathensis klamathensis	Klamath rams-horn
Vorticifex klamathensis sinitsini	Sinitsin rams-horn
Vorticifex n. sp. 1	knobby rams-horn
Vorticifex neritoides	nerite rams-horn

Appendix table IV-A-6. Common and scientific names of vertebrates mentioned in this report.

Amphibians and Reptiles	
Ambystoma gracile	Northwestern salamander
Aneides ferreus	Clouded salamander
Aneides flavipunctatus	Black salamander
Ascaphus truei	Tailed frog
Batrachoseps attentuatus	California slender salamander
Batrachoseps wrighti	Oregon slender slamander
Contia tenuis	Sharp-tailed snake
Dicamptodon copei	Cope's giant salamander
Dicamptodon tenebrosus	Pacific giant salamander
Elgaria coerula	Northern alligator lizard
Hydromantes shastae	Shasta salamander
Plethodon dunni	Dunn's salamander
Plethodon elongatus	Del Norte salamander
Plethodon larselli	Larch Mountain salamander
Plethodon stormi	Siskiyou Mtn. salamander
Plethodon vandykei	Van Dykes salamander
Rana pretiosa	Western spotted frog
Rana cascadae	Cascades frog
Rhyacotriton cascadae	Cascade torrent salamander
Rhyacotriton kezeri	Columbia torrent salamander
Rhyacotriton olympicus	Olympic torrent salamander
Rhyacotriton variegatus	Southern torrent salamander
Taricha granulosa	Rough-skinned newt
Mammals	
Antrozous palidus	Pallid bat
Canis lupus	Gray wolf
Cervus elephus	Elk
Clethrionomys californicus	Western red-backed vole
Clethrionomys gapperi	Southern red-backed vole
Eptesicus fuscus	Big brown bat
Glaucomys sabrinus	Northern flying squirrel
Lasiurus cinereus	Hoary bat
Lasionycterus noctivagans	Silver-haired bat
Lynx canadensis	Lynx
Martes americana	American marten
Martes pennanti	Fisher
Myotis californicus	California myotis
Myotis ciliolabrum	Small-footed myotis
Myotis evotis	Long-eared myotis

Appendix table IV-A-6. (continued.)

Myotis grisecens	Gray bat
Myotis keenii	Keen's myotis
Myotis lucifugus	Little brown myotis
Myotis thysanodes	Fringed myotis
Myotis volans	Long-legged myotis
Myotis yumanensis	Yuma myotis
Neotoma fuscipes	Dusky-footed woodrat
Neurotrichus gibbsii	Shrew-mole
Peromyscus maniculatus	Deer mouse
Peromyscus oreas	Forest deer mouse
Phenacomys longicaudus	Red tree vole
Phenocomys pomo	Red tree vole (CA)
Sorex bairdii	Baird's shrew
Sorex monticolus	Montane shrew
Sorex pacificus	Pacific shrew
Sorex sonomae	Fog shrew
Sorex vagrans	Vagrant shrew
Tamiasciurus douglasii	Douglas' squirrel
Tamias townsendii	Townsend's chipmunk
Tamias senex	Allen's chipmunk
Tamias siskiyou	Siskiyou chipmunk
Ursus arctos	Grizzly bear
<u>Birds</u>	
Accipiter gentilis	Northern goshawk
Aix sponsa	Wood duck
Brachyramphus marmoratus	Marbled murrelet
Bucephala albeola	Bufflehead
Bucephala islandica	Barrow's goldeneye
Catharus guttatus	Hermit thrush
Certhia americana	Brown creeper
Chaetura vauxi	Vaux's swift
Colaptes auratus	Northern flicker
Corvus corax	Common raven
Corvus	Common crow
Dendroica occidentalis	Hermit warbler
Dryocopus pileatus	Pileated woodpecker
Empidonax difficilis	"Western" flycatcher
Empidonax hammondii	Hammond's flycatcher
Falco peregrinus annatum	American peregrine falcon

Appendix table IV-A-6. (continued.)

Glaucidium gnoma	Northern pygmy-owl
Haliaeetus leucocephalus	Bald eagle
Histrionicus histrionicus	Harlequin duck
Ixoreus naevius	Varied thrush
Lophodytes cucullatus	Hooded merganser
Loxia curvirostra	Red crossbill
Mergus merganser	Common merganser
Otus flammeolus	Flammulated owl
Parus rufuscens	Chestnut-backed chickadee
Picoides albolarvatus	White-headed woodpecker
Picoides arcticus	Black-headed woodpecker
Picoides tridactylus	Three-toed woodpecker
Picoides villosus	Hairy woodpecker
Regulus satrapa	Golden-crowned kinglet
Sitta canadensis	Red-breasted nuthatch
Sitta carolinensis	White-breasted nuthatch
Sitta pygmaea	Pygmy nuthatch
Sphyrapicus ruber	Red-breasted sapsucker
Sphyrapicus thyroideus	Williamson's sapsucker
Strix nebulosa	Great gray owl
Strix occidentalis caurina	Northern spotted owl
Strix varia	Barred owl
Troglodytes troglodytes	Winter wren
Vireo gilvus	Warbling vireo
Wilsonia pusilla	Wilson's warbler

Appendix IV-B. Species expert viability panels.

Amphibians

Robert Anthony, panel leader, USDI Fish & Wildlife Service
Martin Raphael, panel leader, USDA Forest Service
Keith Aubrey, USDA Forest Service
Steve Corn, USDI Fish & Wildlife Service
Deanna Olson, USDA Forest Service
Hartwell Welsh, USDA Forest Service

Arthropods

Bruce Marcot, panel leader, USDA Forest Service
Ed Starkey, panel leader, USDI National Park Service
Robert Gara, University of Washington
Jack Lattin, Oregon State University
Andy Moldenke, Oregon State University
David Olson, World Wildlife Fund, Washington, D.C.

Bats

Cynthia Zabel, panel leader, USDA Forest Service
Steve Cross, So. Oregon State College
Elizabeth Pierson, private consultant, Berkeley, CA
Mark Perkins, private consultant, Portland, OR
Steve West, University of Washington

Birds

Bruce Marcot, panel leader, USDA Forest Service
Charles Meslow, panel leader, USDI Fish & Wildlife Service
Charles Bruce, Corvallis, OR
Eric Forsman, USDA Forest Service
David Marshall, Portland, OR
Bill McComb, Oregon State University

Bryophytes

Robin Lesher, panel leader, USDA Forest Service
Roger Rosentreter, USDI Bureau of Land Management
John Christy, The Nature Conservancy
Dan Norris, Oregon State University
David Wagner, University of Oregon

Fungi

Robin Lesher, panel leader, USDA Forest Service
Joe Ammirati, University of Washington
Bill Denison, Oregon State University
Jim Trappe, Oregon State University

Lichens
Roger Rosentreter, panel leader, USDI Bureau of Land Management
Bill Denison, Oregon State University
Sherry Pittam, Oregon State University
Bruce McCune, Oregon State University
Fred Rhoades, Western Washington University

Mammals, other than bats
Cynthia Zabel, panel leader, USDA Forest Service
Robert Anthony, panel leader, USDI Fish & Wildlife Service
Keith Aubrey, USDA Forest Service
Steve Cross, So. Oregon State College
Tom Kucera, private consultant, Berkeley, CA
Bruce Marcot, USDA Forest Service
Charles Meslow, USDI Fish & Wildlife Service
Dan Rosenberg, Oregon State University
Steve West, University of Washington

Marbled Murrelets
Gary Miller, panel leader, USDI Fish & Wildlife Service
Charles Meslow, panel leader, USDI Fish & Wildlife Service
Eric Forsman, USDA Forest Service
Tom Hamer, private consultant, Sedro Wooley, WA
Ian Jones, University of British Columbia
Kathy Kuletz, USDI Fish & Wildlife Service
David Manuwal, University of Washington
S. Kim Nelson, Oregon State University

Mollusks
Bob Anthony, panel leader, USDI Fish & Wildlife Service
Richard Holthausen, panel leader, USDA Forest Service
Terrence Frest, Deixis Consultants, Seattle, WA
Edward Johaness, Deixis Consultants, Seattle, WA
Barry Roth, private consultant, San Francisco, CA

Northern Spotted Owl
Charles Meslow, panel leader, USDI Fish & Wildlife Service
Eric Forsman, USDA Forest Service
Alan Franklin, Colorado State University
Grant Gunderson, USDA Forest Service
Larry Irwin, NCASI, Corvallis, OR
Joe Lint, USDI Bureau of Land Management
Gary Miller, USDI Fish & Wildlife Service
Barry Mulder, USDI Fish & Wildlife Service

Old-Growth

Tom Spies, panel leader, USDA Forest Service
Jim Agee, University of Washington
Tom Atzet, USDA Forest Service
Nancy Diaz, USDA Forest Service
Jerry Franklin, University of Washington
Everett Hansen, Oregon State University
Mark Harmon, Oregon State University
Bruce Marcot, USDA Forest Service
Reed Noss, consultant, Corvallis, OR
David Perry, Oregon State University
Dale Thornburgh, Humboldt State University
Phil Weatherspoon, USDA Forest Service

Vascular Plants

Nancy Fredricks, panel leader, USDA Forest Service
Kenton L. Chambers, Oregon State University
Jan Henderson, USDA Forest Service
Russ Holmes, USDI Bureau of Land Management
David Imper, consultant, Sacramento, CA
Jimmy Kagan, Oregon Natural Heritage Program
Robert Meinke, Oregon Department of Agriculture
Julie Nelson, USDA Forest Service
Nancy Wogen, USDI Bureau of Land Management

Appendix Table IV-C-1. Species ranges, percentage of range on federal land, and percentage of range by allocation on federal land for Option 1.

Species	season	Total range (acres)	% of range on federal land	Percent of range in: Congress-ionally reserved	Late-Sucessional Reserves	Adminstrative Withdrawn Areas	Matrix
Amphibians							
Northwestern salamander		37,175,600	38	32	49	3	16
Clouded salamander		20,723,400	45	16	61	3	20
Black salamander		8,179,700	27	8	59	7	26
Tailed frog		33,462,800	56	33	47	5	16
Oregon slender salamander		3,392,200	62	18	59	3	20
Cope's giant salamander		5,618,400	43	32	48	4	16
Pacific giant salamander		36,745,300	47	26	51	4	19
Shasta salamander		248,500	66	0	70	7	23
Dunn's salamander		12,763,000	38	11	65	2	22
Del Norte salamander		4,064,300	69	29	56	4	12
Larch Mountain salamander		1,209,500	64	22	58	6	14
Siskiyou Mountains salamander		353,000	78	2	71	8	18
Van Dyke's salamander		2,776,700	48	40	44	2	14
Cascade torrent salamander		4,863,900	49	15	61	3	21
Columbia torrent salamander		2,641,500	3	0	55	2	44
Olympic torrent salamander		3,611,400	42	64	28	0	8
Southern torrent salamander		10,448,000	37	17	62	3	17
Rough-skinned newt		49,530,400	37	23	53	4	20
Birds							
Northern goshawk		35,636,600	61	31	46	5	18
Wood duck	summer	50,733,600	39	28	49	4	19
Wood duck	winter	32,889,400	31	22	54	3	21
Bufflehead	summer	1,055,700	98	40	32	13	15
Bufflehead	winter	57,104,800	42	29	47	4	19
Barrow's goldeneye	summer	9,108,200	79	44	35	7	14
Barrow's goldeneye	winter	6,538,800	10	12	54	6	28
Hermit thrush		33,937,300	27	14	59	3	24
Brown creeper		56,443,500	43	29	47	4	19
Vaux's swift	summer	56,431,900	43	29	48	4	19
Northern flicker		57,104,800	42	29	47	4	19
Hermit warbler	summer	34,483,300	48	22	53	4	21
Pileated woodpecker		56,120,900	43	29	48	4	19
Western flycatcher	summer	54,810,800	42	30	47	4	18
Hammond's flycatcher	summer	38,867,200	55	30	47	5	18
Northern pgymy-owl		56,854,800	42	29	47	4	19
Bald eagle	summer	41,765,400	42	21	54	4	21
Bald eagle	winter	57,106,100	42	29	47	4	19
Harlequin duck	summer	10,805,400	78	51	32	5	11
Varied thrush		55,825,300	42	29	47	4	19
Hooded merganser	summer	37,300,400	40	34	46	4	17
Red crossbill		54,743,000	44	29	48	4	19
Common merganser		56,581,200	42	29	47	4	19
Flammulated owl	summer	15,405,800	57	20	50	6	23
Chestnut-backed chickadee		51,370,500	42	31	47	4	17
White-headed woodpecker		13,298,500	61	20	50	5	24
Black-backed woodpecker		11,927,900	65	24	50	6	20
Three-toed woodpecker		7,827,600	87	53	30	6	11
Hairy woodpecker		56,662,800	43	29	47	4	19
Golden-crowned kinglet		57,104,800	42	29	47	4	19
Red-breasted nuthatch		57,058,300	43	29	47	4	19

Appendix Table IV-C-1. Option 1 continued

Species	season	Total range (acres)	% of range on federal land	Percent of range in: Congress-ionally reserved	Late-Sucessional Reserves	Adminstrative Withdrawn Areas	Matrix
Birds (continued)							
White-breasted nuthatch		28,432,300	47	17	53	5	25
Pygmy nuthatch		9,674,900	43	13	46	6	34
Red-breasted sapsucker		50,882,900	42	29	49	4	18
Williamson's sapsucker		6,259,100	58	32	40	5	23
Great gray owl		1,589,300	88	37	39	7	17
Barred owl		45,896,500	43	31	47	4	17
Winter wren		54,152,700	43	30	47	4	18
Warbling vireo	summer	56,808,200	43	29	47	4	19
Wilson's warbler	summer	55,407,800	43	30	48	4	18
Mammals							
Elk		26,353,100	48	22	53	4	21
Western red-backed vole		27,305,200	45	19	56	4	20
Southern red-backed vole		20,903,800	42	48	35	5	12
Townsend's chipmunk		36,320,000	38	32	47	4	17
Northern flying squirrel		53,855,100	44	29	47	4	19
American marten		21,361,600	65	39	39	6	17
Fisher		20,957,700	66	35	45	4	16
Dusky-footed woodrat		17,918,200	34	16	55	4	26
Shrew-mole		52,585,300	44	30	47	4	18
Deer mouse		49,286,100	37	21	52	4	22
Forest deer mouse		15,405,600	52	52	33	5	10
Red tree vole		13,071,500	35	10	64	2	24
Red tree vole (CA)		5,752,100	22	28	52	3	17
Pacific shrew		4,786,400	62	27	48	6	19
Fog shrew		16,810,900	46	15	61	3	20

Appendix Table IV-C-2. Species ranges, percentage of range on federal land, and percentage of range by allocation on federal land for Option 2.

Species	season	Total range (acres)	% of range on federal land	Percent of range in: Congress-ionally reserved	Late-Sucessional Reserves	Adminstrative Withdrawn Areas	Matrix
Amphibians							
Northwestern salamander		37,175,600	38	32	40	5	23
Clouded salamander		20,723,400	45	16	48	5	31
Black salamander		8,179,700	27	8	40	12	40
Tailed frog		33,462,800	56	33	37	7	23
Oregon slender salamander		3,392,200	62	18	48	4	29
Cope's giant salamander		5,618,400	43	32	44	5	19
Pacific giant salamander		36,745,300	47	26	40	6	28
Shasta salamander		248,500	66	0	67	8	25
Dunn's salamander		12,763,000	38	11	54	3	32
Del Norte salamander		4,064,300	69	29	41	9	22
Larch Mountain salamander		1,209,500	64	22	53	7	18
Siskiyou Mountains salamander		353,000	78	2	55	11	32
Van Dyke's salamander		2,776,700	48	40	41	3	16
Cascade torrent salamander		4,863,900	49	15	52	4	28
Columbia torrent salamander		2,641,500	3	0	49	2	49
Olympic torrent salamander		3,611,400	42	64	27	0	9
Southern torrent salamander		10,448,000	37	17	51	5	27
Rough-skinned newt		49,530,400	37	23	40	5	31
Birds							
Northern goshawk		35,636,600	61	31	36	7	26
Wood duck	summer	50,733,600	39	28	38	6	28
Wood duck	winter	32,889,400	31	22	41	5	32
Bufflehead	summer	1,055,700	98	40	25	16	19
Bufflehead	winter	57,104,800	42	29	37	6	28
Barrow's goldeneye	summer	9,108,200	79	44	29	9	19
Barrow's goldeneye	winter	6,538,800	10	12	40	6	42
Hermit thrush		33,937,300	27	14	46	5	35
Brown creeper		56,443,500	43	29	37	6	28
Vaux's swift	summer	56,431,900	43	29	37	6	28
Northern flicker		57,104,800	42	29	37	6	28
Hermit warbler	summer	34,483,300	48	22	41	6	31
Pileated woodpecker		56,120,900	43	29	37	6	28
Western flycatcher	summer	54,810,800	42	30	37	6	27
Hammond's flycatcher	summer	38,867,200	55	30	36	6	27
Northern pgymy-owl		56,854,800	42	29	37	6	28
Bald eagle	summer	41,765,400	42	21	41	6	32
Bald eagle	winter	57,106,100	42	29	37	6	28
Harlequin duck	summer	10,805,400	78	51	27	7	15
Varied thrush		55,825,300	42	29	37	6	27
Hooded merganser	summer	37,300,400	40	34	38	5	24
Red crossbill		54,743,000	44	29	37	6	27
Common merganser		56,581,200	42	29	37	6	28
Flammulated owl	summer	15,405,800	57	20	36	9	34
Chestnut-backed chickadee		51,370,500	42	31	37	6	26
White-headed woodpecker		13,298,500	61	20	34	8	37
Black-backed woodpecker		11,927,900	65	24	39	8	29
Three-toed woodpecker		7,827,600	87	53	24	8	14
Hairy woodpecker		56,662,800	43	29	37	6	28
Golden-crowned kinglet		57,104,800	42	29	37	6	28
Red-breasted nuthatch		57,058,300	43	29	37	6	28

Appendix Table IV-C-2. Option 2 continued

Species	season	Total range (acres)	% of range on federal land	Percent of range in: Congress-ionally reserved	Late-Sucessional Reserves	Adminstrative Withdrawn Areas	Matrix
Birds (continued)							
White-breasted nuthatch		28,432,300	47	17	39	7	37
Pygmy nuthatch		9,674,900	43	13	33	7	46
Red-breasted sapsucker		50,882,900	42	29	37	6	27
Williamson's sapsucker		6,259,100	58	32	29	7	33
Great gray owl		1,589,300	88	37	32	9	22
Barred owl		45,896,500	43	31	38	6	25
Winter wren		54,152,700	43	30	37	6	27
Warbling vireo	summer	56,808,200	43	29	37	6	28
Wilson's warbler	summer	55,407,800	43	30	37	6	27
Mammals							
Elk		26,353,100	48	22	42	5	31
Western red-backed vole		27,305,200	45	19	42	7	32
Southern red-backed vole		20,903,800	42	48	29	6	16
Townsend's chipmunk		36,320,000	38	32	39	5	24
Northern flying squirrel		53,855,100	44	29	37	6	28
American marten		21,361,600	65	39	30	8	23
Fisher		20,957,700	66	35	33	7	25
Dusky-footed woodrat		17,918,200	34	16	40	5	39
Shrew-mole		52,585,300	44	30	37	6	26
Deer mouse		49,286,100	37	21	40	6	33
Forest deer mouse		15,405,600	52	52	29	6	13
Red tree vole		13,071,500	35	10	54	3	33
Red tree vole (CA)		5,752,100	22	28	42	5	25
Pacific shrew		4,786,400	62	27	40	8	25
Fog shrew		16,810,900	46	15	47	6	32

Appendix Table IV-C-3. Species ranges, percentage of range on federal land, and percentage of range by allocation on federal land for Option 3.

Species	season	Total range (acres)	% of range on federal land	Percent of federal land in: Congress-ionally reserved	Late-Sucession Reserves	Managed Late-sucession Reserves	Adminstrative Withdrawn Areas	Matrix
Amphibians								
Northwestern salamander		37,175,600	38	32	36	4	5	23
Clouded salamander		20,723,400	45	16	41	7	5	31
Black salamander		8,179,700	27	8	36	5	12	40
Tailed frog		33,462,800	56	33	34	3	7	23
Oregon slender salamander		3,392,200	62	18	39	9	4	29
Cope's giant salamander		5,618,400	43	32	41	3	5	19
Pacific giant salamander		36,745,300	47	26	36	4	6	27
Shasta salamander		248,500	66	0	67	0	8	25
Dunn's salamander		12,763,000	38	11	49	6	3	31
Del Norte salamander		4,064,300	69	29	38	3	9	22
Larch Mountain salamander		1,209,500	64	22	48	5	7	18
Siskiyou Mountains salamand		353,000	78	2	36	19	11	32
Van Dyke's salamander		2,776,700	48	40	40	1	3	16
Cascade torrent salamander		4,863,900	49	15	45	8	4	28
Columbia torrent salamander		2,641,500	3	0	53	0	2	45
Olympic torrent salamander		3,611,400	42	64	27	0	0	9
Southern torrent salamander		10,448,000	37	17	49	2	5	26
Rough-skinned newt		49,530,400	37	23	36	5	5	30
Birds								
Northern goshawk		35,636,600	61	31	32	4	7	26
Wood duck	summer	50,733,600	39	28	36	3	6	27
Wood duck	winter	32,889,400	31	22	39	3	5	31
Bufflehead	summer	1,055,700	98	40	25	1	16	18
Bufflehead	winter	57,104,800	42	29	34	3	6	28
Barrow's goldeneye	summer	9,108,200	79	44	27	3	8	17
Barrow's goldeneye	winter	6,538,800	10	12	41	0	6	41
Hermit thrush		33,937,300	27	14	41	5	5	35
Brown creeper		56,443,500	43	29	34	3	6	28
Vaux's swift	summer	56,431,900	43	29	34	4	6	27
Northern flicker		57,104,800	42	29	34	3	6	28
Hermit warbler	summer	34,483,300	48	22	37	5	6	30
Pileated woodpecker		56,120,900	43	29	34	4	6	27
Western flycatcher	summer	54,810,800	42	30	34	4	6	26
Hammond's flycatcher	summer	38,867,200	55	30	33	4	6	26
Northern pgymy-owl		56,854,800	42	29	34	4	6	27
Bald eagle	summer	41,765,400	42	21	37	5	6	31
Bald eagle	winter	57,106,100	42	29	34	3	6	28
Harlequin duck	summer	10,805,400	78	51	25	2	7	14
Varied thrush		55,825,300	42	29	34	4	6	27
Hooded merganser	summer	37,300,400	40	34	36	4	5	23
Red crossbill		54,743,000	44	29	34	4	6	27
Common merganser		56,581,200	42	29	34	4	6	28
Flammulated owl	summer	15,405,800	57	20	33	3	9	34
Chestnut-backed chickadee		51,370,500	42	31	34	4	6	25
White-headed woodpecker		13,298,500	61	20	32	3	8	37
Black-backed woodpecker		11,927,900	65	24	36	4	8	28
Three-toed woodpecker		7,827,600	87	53	24	2	8	14
Hairy woodpecker		56,662,800	43	29	34	3	6	28
Golden-crowned kinglet		57,104,800	42	29	34	3	6	28
Red-breasted nuthatch		57,058,300	43	29	34	3	6	28

Appendix Table IV-C-3. Option 3 continued

Species	season	Total range (acres)	% of range on federal land	Percent of federal land in: Congress-ionally reserved	Late-Sucession Reserves	Managed Late-sucession Reserves	Adminstrative Withdrawn Areas	Matrix
Birds (continued)								
White-breasted nuthatch		28,432,300	47	17	33	5	7	37
Pygmy nuthatch		9,674,900	43	13	34	1	7	45
Red-breasted sapsucker		50,882,900	42	29	34	4	6	27
Williamson's sapsucker		6,259,100	58	32	31	0	6	31
Great gray owl		1,589,300	88	37	30	3	9	22
Barred owl		45,896,500	43	31	35	4	6	24
Winter wren		54,152,700	43	30	34	4	6	26
Warbling vireo	summer	56,808,200	43	29	34	3	6	28
Wilson's warbler	summer	55,407,800	43	30	34	4	6	27
Mammals								
Elk		26,353,100	48	22	39	5	5	30
Western red-backed vole		27,305,200	45	19	37	6	7	32
Southern red-backed vole		20,903,800	42	48	30	1	6	15
Townsend's chipmunk		36,320,000	38	32	36	3	5	23
Northern flying squirrel		53,855,100	44	29	34	4	6	27
American marten		21,361,600	65	39	29	1	7	23
Fisher		20,957,700	66	35	29	4	7	25
Dusky-footed woodrat		17,918,200	34	16	36	4	5	-39
Shrew-mole		52,585,300	44	30	34	4	6	26
Deer mouse		49,286,100	37	21	36	4	6	33
Forest deer mouse		15,405,600	52	52	28	1	6	12
Red tree vole		13,071,500	35	10	50	5	3	32
Red tree vole (CA)		5,752,100	22	28	39	3	5	25
Pacific shrew		4,786,400	62	27	37	4	8	24
Fog shrew		16,810,900	46	15	40	8	5	32

Appendix Table IV-C-4. Species ranges, percentage of range on federal land, and percentage of range by allocation on federal land for Option 4.

Species	season	Total range (acres)	% of range on federal land	Percent of range in: Congressionally reserved	Late-Sucessional Reserves*	Adminstrative Withdrawn Areas	Matrix
Amphibians							
Northwestern salamander		37,175,600	38	32	39	5	24
Clouded salamander		20,723,400	45	16	43	6	35
Black salamander		8,179,700	27	8	32	14	46
Tailed frog		33,462,800	56	33	35	7	25
Oregon slender salamander		3,392,200	62	18	41	4	36
Cope's giant salamander		5,618,400	43	32	41	6	21
Pacific giant salamander		36,745,300	47	26	37	7	30
Shasta salamander		248,500	66	0	6	24	70
Dunn's salamander		12,763,000	38	11	52	3	34
Del Norte salamander		4,064,300	69	29	39	9	24
Larch Mountain salamander		1,209,500	64	22	48	8	22
Siskiyou Mountains salamander		353,000	78	2	38	15	44
Van Dyke's salamander		2,776,700	48	40	41	3	17
Cascade torrent salamander		4,863,900	49	15	48	4	32
Columbia torrent salamander		2,641,500	3	0	56	2	43
Olympic torrent salamander		3,611,400	42	64	28	0	8
Southern torrent salamander		10,448,000	37	17	51	6	26
Rough-skinned newt		49,530,400	37	23	38	6	33
Birds							
Northern goshawk		35,636,600	61	31	32	7	29
Wood duck	summer	50,733,600	39	28	37	6	29
Wood duck	winter	32,889,400	31	22	40	6	32
Bufflehead	summer	1,055,700	98	40	16	21	23
Bufflehead	winter	57,104,800	42	29	35	7	30
Barrow's goldeneye	summer	9,108,200	79	44	27	9	20
Barrow's goldeneye	winter	6,538,800	10	12	43	10	35
Hermit thrush		33,937,300	27	14	44	5	37
Brown creeper		56,443,500	43	29	35	7	30
Vaux's swift	summer	56,431,900	43	29	35	7	30
Northern flicker		57,104,800	42	29	35	7	30
Hermit warbler	summer	34,483,300	48	22	38	7	33
Pileated woodpecker		56,120,900	43	29	35	7	29
Western flycatcher	summer	54,810,800	42	30	35	7	28
Hammond's flycatcher	summer	38,867,200	55	30	34	7	28
Northern pgymy-owl		56,854,800	42	29	35	7	29
Bald eagle	summer	41,765,400	42	21	38	7	34
Bald eagle	winter	57,106,100	42	29	35	7	30
Harlequin duck	summer	10,805,400	78	51	26	8	16
Varied thrush		55,825,300	42	29	35	7	29
Hooded merganser	summer	37,300,400	40	34	38	5	24
Red crossbill		54,743,000	44	29	35	7	29
Common merganser		56,581,200	42	29	35	7	29
Flammulated owl	summer	15,405,800	57	20	31	11	38
Chestnut-backed chickadee		51,370,500	42	31	35	7	27
White-headed woodpecker		13,298,500	61	20	30	9	40
Black-backed woodpecker		11,927,900	65	24	34	10	32
Three-toed woodpecker		7,827,600	87	53	22	9	16
Hairy woodpecker		56,662,800	43	29	35	7	30
Golden-crowned kinglet		57,104,800	42	29	35	7	30
Red-breasted nuthatch		57,058,300	43	29	35	7	30

Appendix Table IV-C-4. Option 4 continued

Species	season	Total range (acres)	% of range on federal land	Percent of range in: Congress-ionally reserved	Late-Sucessional Reserves*	Adminstrative Withdrawn Areas	Matrix
Birds (continued)							
White-breasted nuthatch		28,432,300	47	17	33	8	41
Pygmy nuthatch		9,674,900	43	13	30	8	48
Red-breasted sapsucker		50,882,900	42	29	35	7	29
Williamson's sapsucker		6,259,100	58	32	29	7	33
Great gray owl		1,589,300	88	37	23	13	27
Barred owl		45,896,500	43	31	36	6	26
Winter wren		54,152,700	43	30	35	7	28
Warbling vireo	summer	56,808,200	43	29	35	7	30
Wilson's warbler	summer	55,407,800	43	30	35	7	29
Mammals							
Elk		26,353,100	48	22	40	5	32
Western red-backed vole		27,305,200	45	19	38	7	35
Southern red-backed vole		20,903,800	42	48	31	6	15
Townsend's chipmunk		36,320,000	38	32	39	5	24
Northern flying squirrel		53,855,100	44	29	35	7	29
American marten		21,361,600	65	39	29	8	24
Fisher		20,957,700	66	35	30	7	28
Dusky-footed woodrat		17,918,200	34	16	37	6	42
Shrew-mole		52,585,300	44	30	35	7	28
Deer mouse		49,286,100	37	21	37	7	35
Forest deer mouse		15,405,600	52	52	29	6	12
Red tree vole		13,071,500	35	10	54	3	34
Red tree vole (CA)		5,752,100	22	28	40	6	26
Pacific shrew		4,786,400	62	27	36	10	27
Fog shrew		16,810,900	46	15	42	7	36

* Includes 147,000 acres of Managed Late-Successional Areas

Appendix Table IV-C-5. Species ranges, percentage of range on federal land, and percentage of range by allocation on federal land for Option 5.

Species	season	Total range (acres)	% of range on federal land	Percent of range in: Congress-ionally reserved	Late-Sucessional Reserves*	Adminstrative Withdrawn Areas	Matrix
Amphibians							
Northwestern salamander		37,175,600	38	32	32	6	30
Clouded salamander		20,723,400	45	16	36	7	41
Black salamander		8,179,700	27	8	27	16	49
Tailed frog		33,462,800	56	33	29	9	29
Oregon slender salamander		3,392,200	62	18	27	6	48
Cope's giant salamander		5,618,400	43	32	35	7	26
Pacific giant salamander		36,745,300	47	26	31	8	35
Shasta salamander		248,500	66	0	6	24	70
Dunn's salamander		12,763,000	38	11	44	4	41
Del Norte salamander		4,064,300	69	29	37	9	25
Larch Mountain salamander		1,209,500	64	22	41	9	28
Siskiyou Mountains salamander		353,000	78	2	23	21	53
Van Dyke's salamander		2,776,700	48	40	35	4	21
Cascade torrent salamander		4,863,900	49	15	34	6	44
Columbia torrent salamander		2,641,500	3	0	56	2	43
Olympic torrent salamander		3,611,400	42	64	28	0	8
Southern torrent salamander		10,448,000	37	17	49	6	28
Rough-skinned newt		49,530,400	37	23	32	7	38
Birds							
Northern goshawk		35,636,600	61	31	25	9	34
Wood duck	summer	50,733,600	39	28	31	8	33
Wood duck	winter	32,889,400	31	22	36	7	35
Bufflehead	summer	1,055,700	98	40	8	24	28
Bufflehead	winter	57,104,800	42	29	28	9	34
Barrow's goldeneye	summer	9,108,200	79	44	20	12	24
Barrow's goldeneye	winter	6,538,800	10	12	42	10	35
Hermit thrush		33,937,300	27	14	38	6	42
Brown creeper		56,443,500	43	29	28	9	34
Vaux's swift	summer	56,431,900	43	29	28	9	34
Northern flicker		57,104,800	42	29	28	9	34
Hermit warbler	summer	34,483,300	48	22	30	9	39
Pileated woodpecker		56,120,900	43	29	28	9	34
Western flycatcher	summer	54,810,800	42	30	29	8	33
Hammond's flycatcher	summer	38,867,200	55	30	27	9	33
Northern pgymy-owl		56,854,800	42	29	28	9	34
Bald eagle	summer	41,765,400	42	21	31	8	40
Bald eagle	winter	57,106,100	42	29	28	9	34
Harlequin duck	summer	10,805,400	78	51	20	10	19
Varied thrush		55,825,300	42	29	28	9	34
Hooded merganser	summer	37,300,400	40	34	32	6	29
Red crossbill		54,743,000	44	29	29	9	34
Common merganser		56,581,200	42	29	28	9	34
Flammulated owl	summer	15,405,800	57	20	23	14	44
Chestnut-backed chickadee		51,370,500	42	31	29	8	31
White-headed woodpecker		13,298,500	61	20	23	12	45
Black-backed woodpecker		11,927,900	65	24	25	13	38
Three-toed woodpecker		7,827,600	87	53	15	12	19
Hairy woodpecker		56,662,800	43	29	28	9	34
Golden-crowned kinglet		57,104,800	42	29	28	9	34
Red-breasted nuthatch		57,058,300	43	29	28	9	34

Appendix Table IV-C-5. Option 5 continued

Species	season	Total range (acres)	% of range on federal land	Percent of range in: Congress-ionally reserved	Late-Sucessional Reserves*	Adminstrative Withdrawn Areas	Matrix
Birds (continued)							
White-breasted nuthatch		28,432,300	47	17	24	10	48
Pygmy nuthatch		9,674,900	43	13	23	11	53
Red-breasted sapsucker		50,882,900	42	29	29	8	33
Williamson's sapsucker		6,259,100	58	32	20	11	37
Great gray owl		1,589,300	88	37	10	18	34
Barred owl		45,896,500	43	31	29	8	31
Winter wren		54,152,700	43	30	29	9	33
Warbling vireo	summer	56,808,200	43	29	28	9	34
Wilson's warbler	summer	55,407,800	43	30	29	8	33
Mammals							
Elk		26,353,100	48	22	32	7	38
Western red-backed vole		27,305,200	45	19	32	9	41
Southern red-backed vole		20,903,800	42	48	27	8	17
Townsend's chipmunk		36,320,000	38	32	32	7	29
Northern flying squirrel		53,855,100	44	29	29	8	34
American marten		21,361,600	65	39	24	10	27
Fisher		20,957,700	66	35	24	9	33
Dusky-footed woodrat		17,918,200	34	16	31	7	47
Shrew-mole		52,585,300	44	30	29	9	33
Deer mouse		49,286,100	37	21	30	8	40
Forest deer mouse		15,405,600	52	52	25	8	15
Red tree vole		13,071,500	35	10	47	3	39
Red tree vole (CA)		5,752,100	22	28	36	6	29
Pacific shrew		4,786,400	62	27	29	12	32
Fog shrew		16,810,900	46	15	35	8	42

* Includes 147,000 acres of Managed Late-Successional Areas

Appendix Table IV-C-6. Species ranges, percentage of range on federal land, and percentage of range by allocation on federal land for Option 6 and Option 10**.

Species	season	Total range (acres)	% of range on federal land	Percent of range in: Congress-ionally reserved	Late-Sucessional Reserves	Adminstrative Withdrawn Areas	Matrix
Amphibians							
Northwestern salamander		37,175,600	38	32	35	6	28
Clouded salamander		20,723,400	45	16	40	6	38
Black salamander		8,179,700	27	8	29	15	48
Tailed frog		33,462,800	56	33	32	8	27
Oregon slender salamander		3,392,200	62	18	37	5	39
Cope's giant salamander		5,618,400	43	32	39	6	23
Pacific giant salamander		36,745,300	47	26	34	8	32
Shasta salamander		248,500	66	0	6	24	70
Dunn's salamander		12,763,000	38	11	48	3	37
Del Norte salamander		4,064,300	69	29	37	10	25
Larch Mountain salamander		1,209,500	64	22	47	8	23
Siskiyou Mountains salamander		353,000	78	2	30	17	51
Van Dyke's salamander		2,776,700	48	40	40	3	18
Cascade torrent salamander		4,863,900	49	15	44	5	36
Columbia torrent salamander		2,641,500	3	0	53	2	45
Olympic torrent salamander		3,611,400	42	64	27	0	9
Southern torrent salamander		10,448,000	37	17	49	6	28
Rough-skinned newt		49,530,400	37	23	34	6	36
Birds							
Northern goshawk		35,636,600	61	31	29	8	32
Wood duck	summer	50,733,600	39	28	33	7	32
Wood duck	winter	32,889,400	31	22	37	6	35
Bufflehead	summer	1,055,700	98	40	15	21	23
Bufflehead	winter	57,104,800	42	29	31	8	33
Barrow's goldeneye	summer	9,108,200	79	44	22	10	23
Barrow's goldeneye	winter	6,538,800	10	12	32	10	46
Hermit thrush		33,937,300	27	14	39	6	41
Brown creeper		56,443,500	43	29	31	8	33
Vaux's swift	summer	56,431,900	43	29	31	8	32
Northern flicker		57,104,800	42	29	31	8	33
Hermit warbler	summer	34,483,300	48	22	34	8	36
Pileated woodpecker		56,120,900	43	29	31	8	32
Western flycatcher	summer	54,810,800	42	30	31	7	31
Hammond's flycatcher	summer	38,867,200	55	30	30	8	32
Northern pgymy-owl		56,854,800	42	29	31	8	32
Bald eagle	summer	41,765,400	42	21	34	8	37
Bald eagle	winter	57,106,100	42	29	31	8	33
Harlequin duck	summer	10,805,400	78	51	22	9	18
Varied thrush		55,825,300	42	29	31	8	32
Hooded merganser	summer	37,300,400	40	34	34	5	28
Red crossbill		54,743,000	44	29	31	8	32
Common merganser		56,581,200	42	29	31	8	32
Flammulated owl	summer	15,405,800	57	20	28	12	40
Chestnut-backed chickadee		51,370,500	42	31	31	7	30
White-headed woodpecker		13,298,500	61	20	27	10	43
Black-backed woodpecker		11,927,900	65	24	30	11	36
Three-toed woodpecker		7,827,600	87	53	19	10	18
Hairy woodpecker		56,662,800	43	29	31	8	33
Golden-crowned kinglet		57,104,800	42	29	31	8	33
Red-breasted nuthatch		57,058,300	43	29	31	8	33

Appendix Table IV-C-6. Option 6 and 10 continued **

Species	season	Total range (acres)	% of range on federal land	Percent of range in: Congress-ionally reserved	Late-Sucessional Reserves	Adminstrative Withdrawn Areas	Matrix
Birds (continued)							
White-breasted nuthatch		28,432,300	47	17	29	9	44
Pygmy nuthatch		9,674,900	43	13	27	9	51
Red-breasted sapsucker		50,882,900	42	29	32	8	32
Williamson's sapsucker		6,259,100	58	32	24	8	36
Great gray owl		1,589,300	88	37	22	13	28
Barred owl		45,896,500	43	31	32	7	29
Winter wren		54,152,700	43	30	31	8	31
Warbling vireo	summer	56,808,200	43	29	31	8	33
Wilson's warbler	summer	55,407,800	43	30	31	7	32
Mammals							
Elk		26,353,100	48	22	36	6	36
Western red-backed vole		27,305,200	45	19	35	8	38
Southern red-backed vole		20,903,800	42	48	27	7	18
Townsend's chipmunk		36,320,000	38	32	34	5	28
Northern flying squirrel		53,855,100	44	29	31	7	32
American marten		21,361,600	65	39	26	9	26
Fisher		20,957,700	66	35	27	8	31
Dusky-footed woodrat		17,918,200	34	16	34	6	45
Shrew-mole		52,585,300	44	30	32	7	31
Deer mouse		49,286,100	37	21	33	7	38
Forest deer mouse		15,405,600	52	52	26	7	15
Red tree vole		13,071,500	35	10	49	3	37
Red tree vole (CA)		5,752,100	22	28	38	6	28
Pacific shrew		4,786,400	62	27	33	11	29
Fog shrew		16,810,900	46	15	39	7	39

** Table information is the same for Option 6 and Option 10.

Appendix Table IV-C-7. Species ranges, percentage of range on federal land, and percentage of range by allocation on federal land for Option 7.

Species	season	Total range (acres)	% of range on federal land	Percent of range in: Congress-ionally reserved	Late-Sucessional Reserves*	Adminstrative Withdrawn Areas	Matrix
Amphibians							
Northwestern salamander		37,175,600	38	32	27	7	34
Clouded salamander		20,723,400	45	16	27	9	48
Black salamander		8,179,700	27	8	26	16	50
Tailed frog		33,462,800	56	33	25	10	33
Oregon slender salamander		3,392,200	62	18	27	6	48
Cope's giant salamander		5,618,400	43	32	32	7	29
Pacific giant salamander		36,745,300	47	26	26	9	39
Shasta salamander		248,500	66	0	6	24	70
Dunn's salamander		12,763,000	38	11	33	6	50
Del Norte salamander		4,064,300	69	29	18	15	38
Larch Mountain salamander		1,209,500	64	22	41	9	28
Siskiyou Mountains salamander		353,000	78	2	23	21	53
Van Dyke's salamander		2,776,700	48	40	31	5	24
Cascade torrent salamander		4,863,900	49	15	34	6	44
Columbia torrent salamander		2,641,500	3	0	42	2	55
Olympic torrent salamander		3,611,400	42	64	24	0	12
Southern torrent salamander		10,448,000	37	17	32	9	41
Rough-skinned newt		49,530,400	37	23	27	8	42
Birds							
Northern goshawk		35,636,600	61	31	22	10	36
Wood duck	summer	50,733,600	39	28	27	9	37
Wood duck	winter	32,889,400	31	22	28	8	42
Bufflehead	summer	1,055,700	98	40	8	24	28
Bufflehead	winter	57,104,800	42	29	24	9	37
Barrow's goldeneye	summer	9,108,200	79	44	19	12	24
Barrow's goldeneye	winter	6,538,800	10	12	36	11	41
Hermit thrush		33,937,300	27	14	29	8	49
Brown creeper		56,443,500	43	29	24	9	37
Vaux's swift	summer	56,431,900	43	29	24	9	37
Northern flicker		57,104,800	42	29	24	9	37
Hermit warbler	summer	34,483,300	48	22	25	10	43
Pileated woodpecker		56,120,900	43	29	24	9	37
Western flycatcher	summer	54,810,800	42	30	25	9	36
Hammond's flycatcher	summer	38,867,200	55	30	25	9	36
Northern pgymy-owl		56,854,800	42	29	24	9	37
Bald eagle	summer	41,765,400	42	21	27	9	43
Bald eagle	winter	57,106,100	42	29	24	9	37
Harlequin duck	summer	10,805,400	78	51	19	10	19
Varied thrush		55,825,300	42	29	24	9	37
Hooded merganser	summer	37,300,400	40	34	27	7	32
Red crossbill		54,743,000	44	29	25	9	37
Common merganser		56,581,200	42	29	24	9	37
Flammulated owl	summer	15,405,800	57	20	21	14	44
Chestnut-backed chickadee		51,370,500	42	31	25	9	35
White-headed woodpecker		13,298,500	61	20	22	12	46
Black-backed woodpecker		11,927,900	65	24	24	13	39
Three-toed woodpecker		7,827,600	87	53	15	13	19
Hairy woodpecker		56,662,800	43	29	24	9	37
Golden-crowned kinglet		57,104,800	42	29	24	9	37
Red-breasted nuthatch		57,058,300	43	29	24	9	37

Appendix Table IV-C-7. Option 7 continued

Species	season	Total range (acres)	% of range on federal land	Percent of range in: Congress-ionally reserved	Late-Sucessional Reserves*	Adminstrative Withdrawn Areas	Matrix
Birds (continued)							
White-breasted nuthatch		28,432,300	47	17	23	10	49
Pygmy nuthatch		9,674,900	43	13	23	11	53
Red-breasted sapsucker		50,882,900	42	29	25	9	37
Williamson's sapsucker		6,259,100	58	32	20	11	37
Great gray owl		1,589,300	88	37	10	18	34
Barred owl		45,896,500	43	31	25	9	35
Winter wren		54,152,700	43	30	25	9	36
Warbling vireo	summer	56,808,200	43	29	24	9	37
Wilson's warbler	summer	55,407,800	43	30	25	9	36
Mammals							
Elk		26,353,100	48	22	28	8	43
Western red-backed vole		27,305,200	45	19	25	10	46
Southern red-backed vole		20,903,800	42	48	25	9	18
Townsend's chipmunk		36,320,000	38	32	28	7	32
Northern flying squirrel		53,855,100	44	29	25	9	37
American marten		21,361,600	65	39	21	11	30
Fisher		20,957,700	66	35	21	10	34
Dusky-footed woodrat		17,918,200	34	16	24	8	52
Shrew-mole		52,585,300	44	30	25	9	36
Deer mouse		49,286,100	37	21	25	9	44
Forest deer mouse		15,405,600	52	52	23	9	16
Red tree vole		13,071,500	35	10	34	5	50
Red tree vole (CA)		5,752,100	22	28	28	9	35
Pacific shrew		4,786,400	62	27	25	12	37
Fog shrew		16,810,900	46	15	26	10	49

* Includes 147,000 acres of Managed Late-Successional Areas

Appendix Table IV-C-8. Species ranges, percentage of range on federal land, and percentage of range by allocation on federal land for Option 8.

Species	season	Total range (acres)	% of range on federal land	Percent of range in: Congress-ionally reserved	Late-Sucessional Reserves	Adminstrative Withdrawn Areas	Matrix
Amphibians							
Northwestern salamander		37,175,600	38	32	35	6	28
Clouded salamander		20,723,400	45	16	40	6	38
Black salamander		8,179,700	27	8	29	15	48
Tailed frog		33,462,800	56	33	32	8	27
Oregon slender salamander		3,392,200	62	18	37	5	39
Cope's giant salamander		5,618,400	43	32	39	6	23
Pacific giant salamander		36,745,300	47	26	34	8	32
Shasta salamander		248,500	66	0	6	24	70
Dunn's salamander		12,763,000	38	11	48	3	37
Del Norte salamander		4,064,300	69	29	37	10	25
Larch Mountain salamander		1,209,500	64	22	47	8	23
Siskiyou Mountains salamander		353,000	78	2	30	17	51
Van Dyke's salamander		2,776,700	48	40	40	3	18
Cascade torrent salamander		4,863,900	49	15	44	5	36
Columbia torrent salamander		2,641,500	3	0	53	2	45
Olympic torrent salamander		3,611,400	42	64	27	0	9
Southern torrent salamander		10,448,000	37	17	49	6	28
Rough-skinned newt		49,530,400	37	23	34	6	36
Birds							
Northern goshawk		35,636,600	61	31	29	8	32
Wood duck	summer	50,733,600	39	28	33	7	32
Wood duck	winter	32,889,400	31	22	37	6	35
Bufflehead	summer	1,055,700	98	40	15	21	23
Bufflehead	winter	57,104,800	42	29	31	8	33
Barrow's goldeneye	summer	9,108,200	79	44	22	10	23
Barrow's goldeneye	winter	6,538,800	10	12	32	10	46
Hermit thrush		33,937,300	27	14	39	6	41
Brown creeper		56,443,500	43	29	31	8	33
Vaux's swift	summer	56,431,900	43	29	31	8	32
Northern flicker		57,104,800	42	29	31	8	33
Hermit warbler	summer	34,483,300	48	22	34	8	36
Pileated woodpecker		56,120,900	43	29	31	8	32
Western flycatcher	summer	54,810,800	42	30	31	7	31
Hammond's flycatcher	summer	38,867,200	55	30	30	8	32
Northern pgymy-owl		56,854,800	42	29	31	8	32
Bald eagle	summer	41,765,400	42	21	34	8	37
Bald eagle	winter	57,106,100	42	29	31	8	33
Harlequin duck	summer	10,805,400	78	51	22	9	18
Varied thrush		55,825,300	42	29	31	8	32
Hooded merganser	summer	37,300,400	40	34	34	5	28
Red crossbill		54,743,000	44	29	31	8	32
Common merganser		56,581,200	42	29	31	8	32
Flammulated owl	summer	15,405,800	57	20	28	12	40
Chestnut-backed chickadee		51,370,500	42	31	31	7	30
White-headed woodpecker		13,298,500	61	20	27	10	43
Black-backed woodpecker		11,927,900	65	24	30	11	36
Three-toed woodpecker		7,827,600	87	53	19	10	18
Hairy woodpecker		56,662,800	43	29	31	8	33
Golden-crowned kinglet		57,104,800	42	29	31	8	33
Red-breasted nuthatch		57,058,300	43	29	31	8	33

Appendix Table IV-C-8. Option 8 continued

Species	season	Total range (acres)	% of range on federal land	Percent of range in: Congress-ionally reserved	Late-Sucessional Reserves	Adminstrative Withdrawn Areas	Matrix
Birds (continued)							
White-breasted nuthatch		28,432,300	47	17	29	9	44
Pygmy nuthatch		9,674,900	43	13	27	9	51
Red-breasted sapsucker		50,882,900	42	29	32	8	32
Williamson's sapsucker		6,259,100	58	32	24	8	36
Great gray owl		1,589,300	88	37	22	13	28
Barred owl		45,896,500	43	31	32	7	29
Winter wren		54,152,700	43	30	31	8	31
Warbling vireo	summer	56,808,200	43	29	31	8	33
Wilson's warbler	summer	55,407,800	43	30	31	7	32
Mammals							
Elk		26,353,100	48	22	36	6	36
Western red-backed vole		27,305,200	45	19	35	8	38
Southern red-backed vole		20,903,800	42	48	27	7	18
Townsend's chipmunk		36,320,000	38	32	34	5	28
Northern flying squirrel		53,855,100	44	29	31	7	32
American marten		21,361,600	65	39	26	9	26
Fisher		20,957,700	66	35	27	8	31
Dusky-footed woodrat		17,918,200	34	16	34	6	45
Shrew-mole		52,585,300	44	30	32	7	31
Deer mouse		49,286,100	37	21	33	7	38
Forest deer mouse		15,405,600	52	52	26	7	15
Red tree vole		13,071,500	35	10	49	3	37
Red tree vole (CA)		5,752,100	22	28	38	6	28
Pacific shrew		4,786,400	62	27	33	11	29
Fog shrew		16,810,900	46	15	39	7	39

Appendix Table IV-C-9. Species ranges, percentage of range on federal land, and percentage of range by allocation on federal land for Option 9.

Species	season	Total range (acres)	% of range on federal land	Percent of federal land in: Congress-ionally reserved	Late-Sucessional Reserves	Adaptive Management Areas	Adminstrative Withdrawn Areas	Matrix
Amphibians								
Northwestern salamander		37,175,600	38	32	31	7	5	25
Clouded salamander		20,723,400	45	16	35	7	6	36
Black salamander		8,179,700	27	8	29	10	14	39
Tailed frog		33,462,800	56	33	29	7	7	24
Oregon slender salamander		3,392,200	62	18	28	7	6	41
Cope's giant salamander		5,618,400	43	32	34	11	5	18
Pacific giant salamander		36,745,300	47	26	30	7	7	30
Shasta salamander		248,500	66	0	7	0	24	69
Dunn's salamander		12,763,000	38	11	41	9	3	36
Del Norte salamander		4,064,300	69	29	35	2	10	25
Larch Mountain salamander		1,209,500	64	22	34	15	6	23
Siskiyou Mountains salamand		353,000	78	2	22	66	4	6
Van Dyke's salamander		2,776,700	48	40	36	9	3	13
Cascade torrent salamander		4,863,900	49	15	34	6	6	39
Columbia torrent salamander		2,641,500	3	0	7	87	0	6
Olympic torrent salamander		3,611,400	42	64	27	9	0	0
Southern torrent salamander		10,448,000	37	17	45	6	6	25
Rough-skinned newt		49,530,400	37	23	31	8	6	32
Birds								
Northern goshawk		35,636,600	61	31	27	5	7	29
Wood duck	summer	50,733,600	39	28	31	7	6	28
Wood duck	winter	32,889,400	31	22	34	10	6	29
Bufflehead	summer	1,055,700	98	40	15	0	21	24
Bufflehead	winter	57,104,800	42	29	29	6	7	29
Barrow's goldeneye	summer	9,108,200	79	44	22	4	9	21
Barrow's goldeneye	winter	6,538,800	10	12	38	10	10	31
Hermit thrush		33,937,300	27	14	37	10	5	34
Brown creeper		56,443,500	43	29	29	6	7	29
Vaux's swift	summer	56,431,900	43	29	29	6	7	29
Northern flicker		57,104,800	42	29	29	6	7	29
Hermit warbler	summer	34,483,300	48	22	31	7	7	33
Pileated woodpecker		56,120,900	43	29	29	6	7	29
Western flycatcher	summer	54,810,800	42	30	29	6	7	28
Hammond's flycatcher	summer	38,867,200	55	30	29	6	7	28
Northern pgymy-owl		56,854,800	42	29	29	6	7	29
Bald eagle	summer	41,765,400	42	21	32	7	7	33
Bald eagle	winter	57,106,100	42	29	29	6	7	29
Harlequin duck	summer	10,805,400	78	51	21	4	8	17
Varied thrush		55,825,300	42	29	29	6	7	29
Hooded merganser	summer	37,300,400	40	34	31	6	5	25
Red crossbill		54,743,000	44	29	29	6	7	28
Common merganser		56,581,200	42	29	29	6	7	29
Flammulated owl	summer	15,405,800	57	20	28	5	11	36
Chestnut-backed chickadee		51,370,500	42	31	29	7	7	26
White-headed woodpecker		13,298,500	61	20	27	7	9	38
Black-backed woodpecker		11,927,900	65	24	28	4	10	34
Three-toed woodpecker		7,827,600	87	53	20	4	8	15
Hairy woodpecker		56,662,800	43	29	29	6	7	29
Golden-crowned kinglet		57,104,800	42	29	29	6	7	29
Red-breasted nuthatch		57,058,300	43	29	29	6	7	29

Appendix Table IV-C-9. Option 9 continued

Species	season	Total range (acres)	% of range on federal land	Percent of federal land in: Congress-ionally reserved	Late-Sucessional Reserves	Adaptive Management Areas	Adminstrative Withdrawn Areas	Matrix
Birds (continued)								
White-breasted nuthatch		28,432,300	47	17	28	6	8	40
Pygmy nuthatch		9,674,900	43	13	29	3	8	47
Red-breasted sapsucker		50,882,900	42	29	29	7	7	28
Williamson's sapsucker		6,259,100	58	32	27	2	6	33
Great gray owl		1,589,300	88	37	20	3	13	27
Barred owl		45,896,500	43	31	30	6	6	26
Winter wren		54,152,700	43	30	29	6	7	28
Warbling vireo	summer	56,808,200	43	29	29	6	7	29
Wilson's warbler	summer	55,407,800	43	30	29	6	7	28
Mammals								
Elk		26,353,100	48	22	33	5	6	35
Western red-backed vole		27,305,200	45	19	32	8	8	33
Southern red-backed vole		20,903,800	42	48	27	5	5	14
Townsend's chipmunk		36,320,000	38	32	32	7	4	25
Northern flying squirrel		53,855,100	44	29	29	6	7	29
American marten		21,361,600	65	39	27	3	8	23
Fisher		20,957,700	66	35	26	6	7	26
Dusky-footed woodrat		17,918,200	34	16	30	8	6	41
Shrew-mole		52,585,300	44	30	30	6	7	27
Deer mouse		49,286,100	37	21	31	7	7	34
Forest deer mouse		15,405,600	52	52	25	6	5	11
Red tree vole		13,071,500	35	10	40	9	3	37
Red tree vole (CA)		5,752,100	22	28	37	7	7	21
Pacific shrew		4,786,400	62	27	31	0	11	31
Fog shrew		16,810,900	46	15	35	7	7	36

V

Aquatic Ecosystem Assessment

Chapter V

Aquatic Ecosystem Assessment

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Chapter V Contributors

The Aquatic/Watershed Group comprised ecologists, fish biologists, hydrologists, and geomorphologists. Jim Sedell and Gordon Reeves provided the leadership for this team. Members of this team who formed the core group that produced this chapter include Kelly Burnett, Lisa Brown, Mike Furniss, Elizabeth Gaar, Gordon Grant, Bruce McCammon, Tom Robertson, and Fred Swanson. Cara Berman, John Cannell, Dennis Harr, Bob House, Dave Montgomery, Chester Novak, Leslie Reid, Cindy Ricks, Peter Teensma, Fred Weinmann, Jack Williams and Robert Ziemer contributed major ideas and wrote sections. Sandy Arbogast, John Cessell, Sharon Clarke, and George Lienkaemper provided spatial analysis and illustration support on the spur of the moment. Katie Farrell typed the early drafts as well as the final draft. Kirsten Schumaker assisted with development of appendices C and H. Our expert panel of Peter Bisson, Dan Bottom, Stan Gregory, Harvey Kelsey, and Peter Moyle provided useful ideas and opinions on the fish utilization of streams in the northern spotted owl forests.

K. Norman Johnson, Sarah Crim, and Margaret Shannon provided the essential data, comments, and help regarding the interface of the aquatic and riparian conservation strategies to policy questions and needs.

Chapter V

AQUATIC ECOSYSTEM ASSESSMENT

Introduction

Cumulative effects of past and present human activities have degraded aquatic systems substantially. As a result, few high quality aquatic ecosystems remain in the United States. The Nationwide Rivers Inventory, completed in 1982 by the U.S. National Park Service, found that, of 3.25 million stream miles examined in the lower 48 states, less than 2 percent were considered of "high natural quality"(Benke, 1990). The phenomenon of diminishing aquatic system quality is not limited to riverine environments. Between the 1780's and the 1980's, the lower 48 states lost approximately 53 percent of all wetlands (Dahl 1990; Tiner 1991). Some states lost a much higher percentage than this; for example by the 1980's, only 9 percent of California's pre-European settlement wetlands remained. These studies only examined wetland loss and did not assess the health of those remaining. Thus, the actual area of high quality wetlands may likely be much lower than the total reported acres.

Common sources of aquatic system degradation include changes in water quality and quantity and habitat modification or destruction. These physical alterations often bring about changes in ecosystem organization. Key ecosystem components may be eliminated and processes leading to ecological recovery may be arrested (Steedman and Regier 1987). There may be reduced efficiency of nutrient cycling, changes in productivity, reduced species diversity, changes in the size distribution and life-history traits of the fauna, increased incidence of disease, and increased population fluctuations with increasing levels of stress (Woodwell 1970; Paloheimo and Regier 1982; Odum 1985; Rapport et al. 1985; Moyle and Leidy 1992).

The present condition of North America's native fish fauna is attributable, in part, to the degradation of aquatic ecosystems and habitat. Williams et al. (1989) listed 364 species and subspecies in need of special management consideration because of low or declining populations. This was an increase of 139 taxa since 1978. Many of these species were found in the western North America. Moyle and Williams (1990) found that 57 percent of the freshwater native fishes of California were extinct or in need of immediate attention. This decline in fish has also been accompanied by declines in other aquatic organism such as amphibians (Blaustein and Wake 1990).

Aquatic ecosystems in the range of the northern spotted owl exhibit signs of degradation and ecological stress. Recent studies reported the loss (Sedell and Froggatt 1984; Sedell and Everest 1991) or simplification of habitat (Bisson and Sedell 1984; Hicks et al. 1991a; Bisson et al. 1992) in streams. Approximately 55 percent of the 27,000 stream miles examined in Oregon are either severely or moderately impacted by nonpoint source pollution (Edwards et al. 1992). Over one third of Washington state's wetlands have been lost (Dahl 1990), and 90 percent of those remaining are considered degraded (Washington Department of Wildlife 1992). Concern about aquatic ecosystems is elevated with the identification of large numbers of native freshwater and anadromous fish species and stocks that require special management considerations due to low or declining numbers (Williams et al. 1989; Nehlsen et al. 1991).

Although several factors are responsible for declines of anadromous fish populations, habitat loss and modification are major determinants of their current status. Of the 314 at-risk anadromous salmonid stocks identified within the range of the northern spotted owl, only 55 occur solely on nonfederal land. Thus, federal agencies share in the responsibility for managing habitat for the other 259 at-risk stocks.

Over the last century, federal land within the range of the northern spotted owl has become increasingly important for ensuring the existence of high quality aquatic resources. Privately held forest lands have been developed into farms, urban areas, transportation corridors, and industrial forests. Conversion of native forest to tree farms and agriculture decreases the capacity of these lands to supply high quality aquatic resources. Thus, society's reliance on federal forest lands to sustain aquatic resources continues to grow. Congress recognized the role federal lands play through the Organic Act of 1897, establishing the National Forest Reserves for the "purpose of securing favorable conditions of water flows....for the use and necessities of the citizens of the United States."

An ecosystem approach is necessary to halt habitat degradation, maintain habitat and ecosystems that are currently in good condition, and to aid the recovery of habitat of at-risk fish species and stocks. It should be noted that the forest ecosystem management options developed in this exercise can not resolve all issues contributing to the decline of anadromous salmonids, such as artificial propagation practices, and excess harvest in sport and commercial fisheries. They are centered on actions and programs that federal land-management agencies can implement to maintain and restore aquatic and riparian habitats on lands under their jurisdiction. This approach is both prudent and necessary given the current perilous state of many native salmon and trout stocks (Nehlsen et al. 1991; Higgins et al. 1992; U.S. Fish and Wildlife Service 1992), resident fish (Williams et al. 1989; U.S. Fish and Wildlife Service 1992), and other riparian-dependent organisms found on federal lands within the range of the northern spotted owl. In the following sections the scientific rationale for these conservation strategy scenarios is set forth and the specific elements are described.

This chapter describes and evaluates options for managing fish habitat and aquatic ecosystems on federal lands within the range of the northern spotted owl. We first describe the Regional setting encompassed by the range of the northern spotted owl. Second, the state of the aquatic biological resources within the northern spotted owl's range are outlined, including the status of aquatic organisms and the characteristics and present conditions of aquatic ecosystems. Third, the Aquatic Conservation Strategy that is aimed at maintaining and restoring the ecological health of aquatic ecosystems is proposed. This strategy includes three related scenarios that comprise the aquatic component of the 10 forest ecosystem management options developed by the Forest Ecosystem Management Assessment Team. We conclude by rating the sufficiency, quality, and distribution and abundance of habitat to allow fish species populations to stabilize over federal lands. Ratings for other late-successional and old growth associated species that may also be riparian dependents, such as vascular and nonvascular plants, amphibians, bats, and arthropods were provided in chapter IV.

Regional Context

Physiographic Setting

Stream and riparian habitat conditions vary greatly across the range of the northern spotted owl due to both natural and management-related factors. Precipitation ranges from several hundred inches per year in some areas near the coast to less than 20 inches east of the crest of the Cascade Range. Geologic and climatic history of uplift, volcanism, glaciation, and tectonism influence topographic relief, landforms and channel patterns, dominant types of erosion processes, and overall sediment production rates (appendix V-A). (Note: these provinces differ from those in chapter IV which are delineated primarily by vegetative type.) The type and structure of streamside vegetation reflects both climate and the disturbance regime of the area, determined by hydrology, geologic agents, and other processes such as forest fires. Many of these critical components of landscape form and function occur in distinctive combinations characteristic to each physiographic province in the region. Consequently, evaluation of stream and riparian conditions and programs for managing these ecosystems will be tailored ultimately to specific physiographic provinces and watersheds.

A critical aspect of the Pacific Northwest riverine and riparian environment is the widespread occurrence of steep, unstable hillslopes. Recent geologic uplift, weathered rocks and soil, and heavy rainfall all contribute to high landslide frequency and to high sediment loads in many of the region's rivers. Hillslope steepness is one of the simplest indicators of areas prone to debris slides and flows (rapid mass movements of soil and organic material down hillslopes and stream channels). The regional pattern of slope steepness, based on 90-meter resolution digital elevation model, displays extensive areas of slopes steeper than 50 percent (fig. V-1), throughout the Forest Service and Bureau of Land Management lands of this region. This image (fig. V-1) under-represents the extent of steep slopes in areas of short hillslope lengths, such as the southern part of the Oregon Coast Range. The steep slopes of the Siuslaw National Forest are better displayed with 30-meter digital elevation data (fig. V-2).

Geographic patterns of slope instability can be revealed by combining rock stability characteristics with these slope steepness data. For example, such a map for the Siuslaw National Forest located in the Oregon coast range (fig. V-3), displays extensive areas of

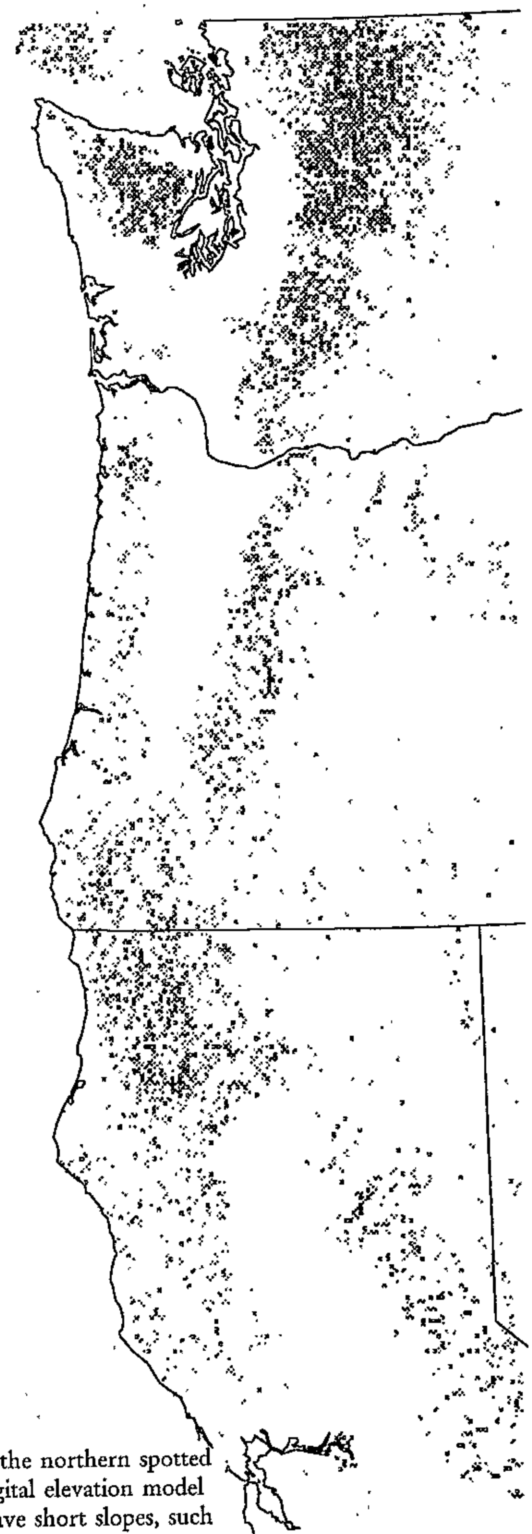

Figure V-1. Slope class map for the northern spotted owl region, based on 90-meter digital elevation model data. Steepness in areas which have short slopes, such as in the Oregon Coast Range, is underrepresented due to the 90-meter resolution.

0 – 40 percent slope | 41 – 50 percent slope | > 50 percent slope

Figure V-2. Slope class map for the Siuslaw National Forest, based on 30-meter digital elevation model data.

Figure V-3. Debris flow hazard on the Siuslaw National Forest derived from slope class and rock type.

high debris flow hazard which are greatest in the southern areas and generally decreasing towards the north. The Willamette National Forest, located in the Oregon western cascades, exhibits less extensive areas of high debris flow hazard, particularly in the high cascades (eastern half of the forest) underlain by young stable rocks (fig. V-4). The western half of the Forest, where most general forestry operations have occurred, has some areas of high debris flow hazard in addition to high earthflow hazard.

Ocean Conditions and Near-shore Environments Affecting Anadromous Salmonids

Ocean conditions for anadromous salmonids in the range of the northern spotted owl are highly variable. The oceanic boundary between cool, nutrient-rich northern currents and warm, nutrient-poor southern currents occurs off the coast of northern California, Oregon, and Washington (fig. V-5) (Fulton and LaBrasseur 1985). Favorable conditions exist when the boundary is more southerly. This situation occurred on an average of 1 in 4 years in the last 40 years (Bottom et al. 1986). During favorable ocean conditions, survival of at least some stocks is greater than during less favorable conditions (Nickelson 1986).

The coast in this region has a low shoreline/coastline ratio (fig. V-6) (Bottom et al. 1986). As a consequence, there are few well-developed estuaries and other nearshore rearing areas. Many estuarine environments in the range of the northern spotted owl have been degraded or lost by dredging, diking, and agriculture and urban runoff. Estuaries are relatively protected sites of early growth in the marine environment and are important for future ocean survival of anadromous salmonids (Hager and Noble 1976; Bilton et al. 1982; Ward et al. 1989; Henderson and Cass 1991; Pearcy 1992). These areas are particularly important during periods of unfavorable ocean conditions. In much of the region of the northern spotted owl, salmonids moving to the ocean have limited near-shore areas in which to rear. In contrast, British Columbia and southeast Alaska have higher shoreline/coastline ratios and thus more and better near-shore and estuarine habitats.

The paucity of high quality near-shore habitats and variable ocean conditions makes freshwater habitat more crucial for the survival and persistence of anadromous salmonid stocks in the range of the northern spotted owl than it is for stocks in more northerly areas. Compared to areas with more stable ocean conditions and better developed near-shore habitats, anadromous salmonids in the region of the northern spotted owl are more dependent on freshwater environments to achieve larger sizes, which increase probability of marine survival.

Status of Aquatic and Riparian Dependent Organisms

Anadromous Salmonids

Populations of anadromous salmonids become reproductively isolated from each other as they ascend their spawning streams. These locally adapted populations are referred to as stocks (Ricker 1972). More than 100 stocks are already extinct (Konkel and McIntyre

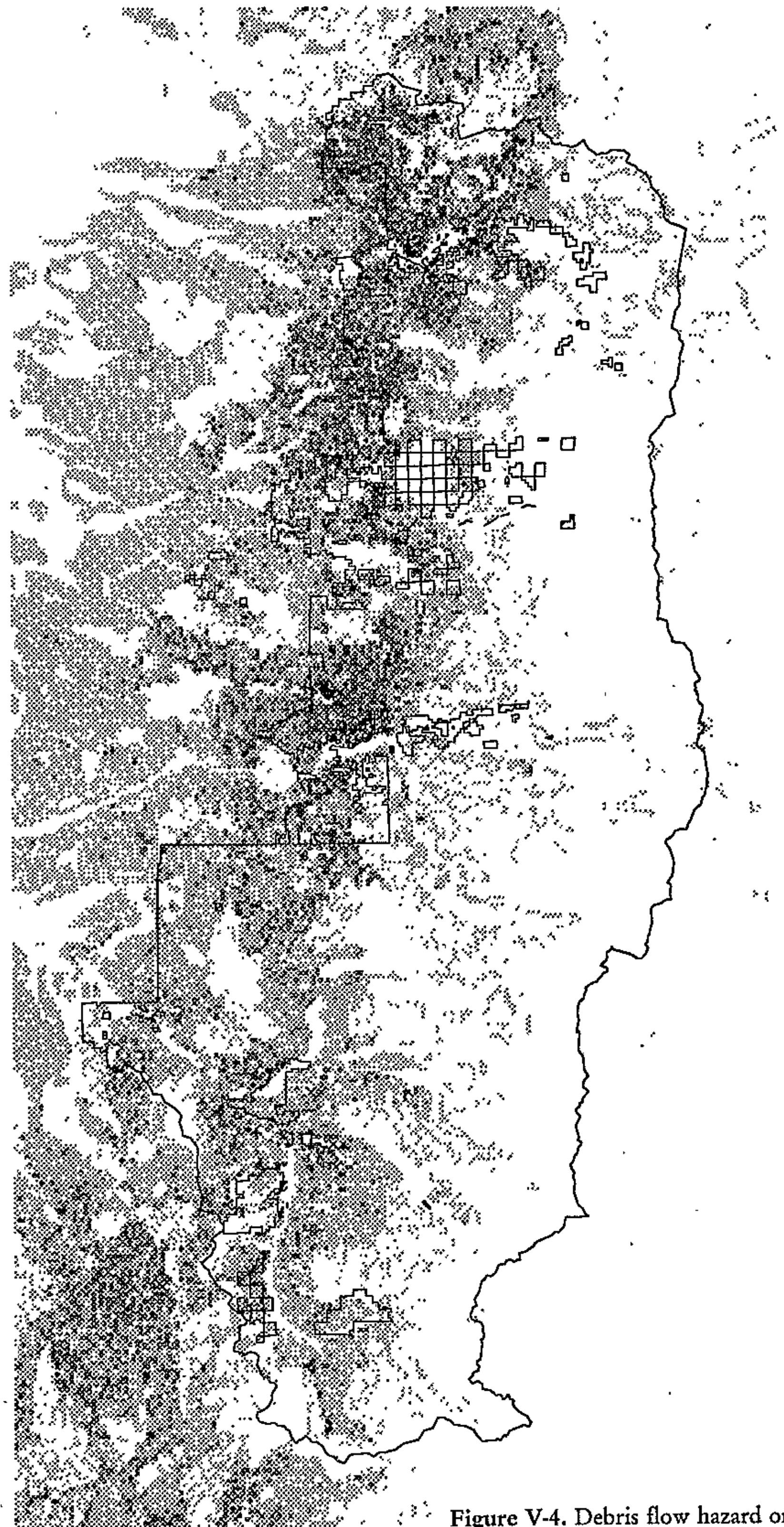

Figure V-4. Debris flow hazard on the Willamette National Forest derived from slope class and rock type.

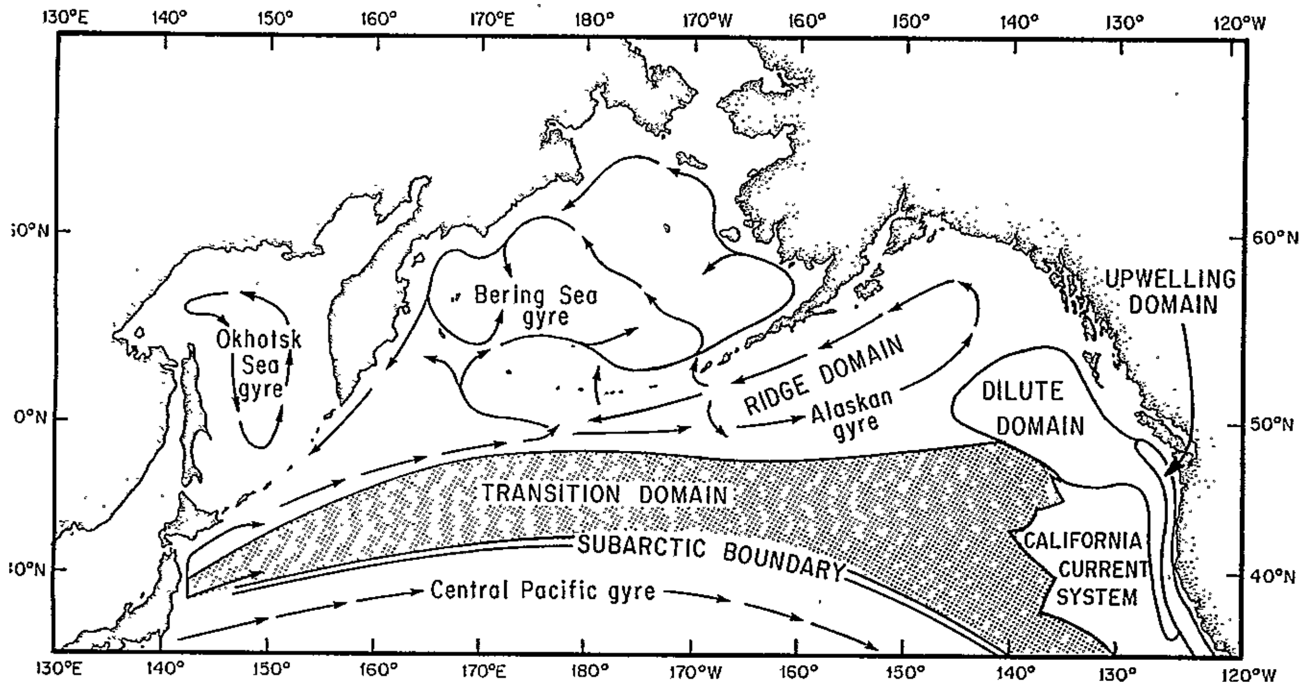

Figure V-5. Location of the boundary between northerly and southerly ocean currents (shaded area) (Fulton and LaBrasseur 1985).

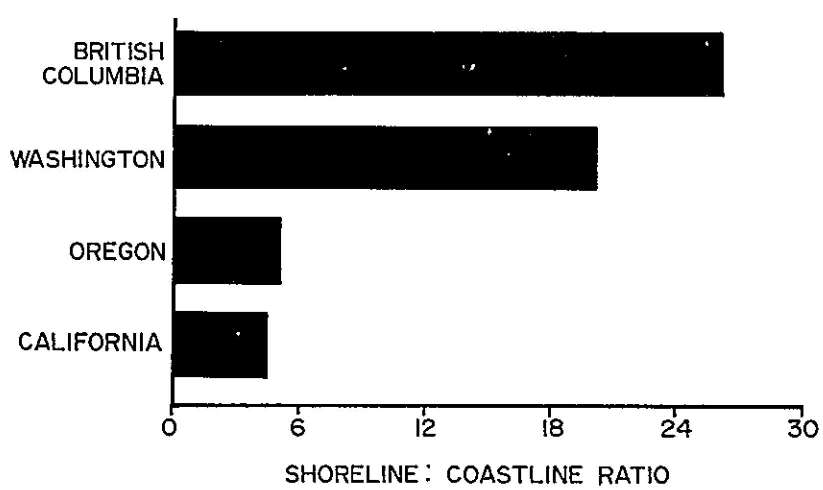

Figure V-6. Shoreline:coastline ratio along the west coast of North America. Shoreline is a measure of the coastal perimeter, while coastline represents the straight latitudinal distance for each region. The number of bays and relative proportion of protected littoral habitat increase with an increasing shoreline:coastline ratio (Bottom et al. 1986).

1987; Nehlsen et al. 1991) and hundreds of others are at risk of extinction throughout the Pacific Northwest. Because the Endangered Species Act includes provisions for listing "distinct population segments" of vertebrate species, some stocks of salmonids have been listed as endangered or threatened and other listings are probable (Williams et al. 1992). (See appendix V-B for common and scientific names of fish cited in this chapter.)

The Endangered Species Committee of the American Fisheries Society recently identified 214 stocks of anadromous salmon and trout in California, Idaho, Oregon, and Washington in need of special management considerations because of low or declining numbers (Nehlsen et al. 1991). Of the 214, 101 were believed to be at a high risk of extinction, 58 at a moderate risk, and 54 were of special concern. Additional reports have been released on the status of West Coast anadromous salmonid stocks: Higgins et al. (1992) for northern California, Nickelson et al. (1992) for coastal Oregon streams, and Washington Department of Fisheries et al. (1993) for Washington. These recent reports provide more detailed stock assessments and in some cases, subdivide many of the stocks listed by Nehlsen et al. (1991).

Within the range of the northern spotted owl there are an estimated 314 anadromous salmonid stocks at risk (appendix V-C), including all the stocks listed by Nehlsen et al. (1991) or Higgins et al. (1992) as having either a moderate or high risk of extinction or a similar rating by Nickelson et al. (1992) or Washington Department of Fisheries et al. (1993) (see table V-C-1). This includes 81 chinook, 98 coho, 6 sockeye, 28 chum, 6 pink, 89 steelhead trout, and 5 sea-run cutthroat trout stocks (appendix V-C). There are 259 of these stocks on federal lands within the range of the northern spotted owl.

However, not all of these anadromous salmonids stocks are likely to qualify as "species" pursuant to the Endangered Species Act. While the Act defines "species" to include "any distinct population segment of any species of vertebrate fish or wildlife which interbreeds when mature," the National Marine Fisheries Service has further refined and interpreted the term "distinct population segment" as it applies to Pacific salmon. The National Marine Fisheries Service considers a stock to be "distinct" if it represents an evolutionarily significant unit of the biological species (Waples 1991). A stock, or group of stocks, must meet two criteria to be considered by the National Marine Fisheries Service to constitute an evolutionarily significant unit: (1) it must be substantially reproductively isolated from conspecific units, and (2) it must represent an important component in the evolutionarily legacy of the species. The second criterion could be confirmed, for example, if the stock contains unique genetic characters, a unique life history trait, or displays an unusual or distinctive adaptation to its environment.

To date, four populations of anadromous salmonids have been listed as threatened or endangered pursuant to the Endangered Species Act. One, the Sacramento winter chinook salmon is found within the range of the northern spotted owl. However, the amount of habitat for this stock on federal land is minimal. The other three are found outside the range of the spotted owl. Two stocks within the range of the northern spotted owl are presently being reviewed by the National Marine Fisheries Service to determine if they warrant listing pursuant to the Endangered Species Act. These are coastal steelhead trout, and the North and South Umpqua River sea-run cutthroat trout.

Primary factors contributing to the decline of anadromous salmonid stocks include: (1) degradation and loss of freshwater and estuarine habitats; (2) timing and overexploitation in commercial and recreational fisheries; (3) migratory impediments such as dams; and

(4) loss of genetic integrity due to the effects of hatchery practices and introduction of nonlocal stocks (Nehlsen et al. 1991). Often two or more of these factors operating in concert are responsible for a decline in population numbers.

Loss and degradation of freshwater habitats are the most frequent factors responsible for the decline of anadromous salmonid stocks (Nehlsen et al. 1991). This includes decreases in the quantity and quality of habitat and the fragmentation of habitat into isolated patches. These changes result from a suite of human activities that include agriculture, timber harvest and associated activities, road construction, livestock grazing, water withdrawal and diversion, and dams (Nehlsen et al. 1991). In the northern spotted owl region, the first four activities are primarily responsible for the loss or decrease in the quality of fish habitat. On federal lands, the most significant management activities affecting fish habitat are timber harvest and associated activities.

Resident Fish Species and Subspecies

Some resident fish populations have exhibited declines similar to those in anadromous salmonid stocks. We identified eight resident fish species within the range of the northern spotted owl that are at risk. Two, the Klamath shortnose sucker and the Lost River sucker, are listed under the Endangered Species Act. These species are found on the edge of the range of the northern spotted owl and their habitat is indirectly affected by timber harvest activities on federal lands. Five fishes are currently candidates for listing under the Endangered Species Act: the Oregon chub, the Olympic mudminnow, the Jenny Creek sucker, the McCloud River redband trout, and the bull trout. A status review by the U.S. Fish and Wildlife Service is currently underway for the bull trout. One other, the Salish sucker is identified as at risk by the American Fisheries Society (Williams et al. 1989) because of low or declining numbers.

Habitat loss and degradation are principal causal factors in declines of these fishes (Williams et al. 1989). In addition, introductions of nonnative fish and artificial propagation practices have impacted resident trout population. Like anadromous salmonid stocks, many of these fishes have been adversely affected by hatchery practices or overharvest.

Other Aquatic, Riparian and Wetland Organisms

The Forest Ecosystem Management Assessment Team evaluated 199 plant and animal species that use streams, wetlands, and riparian areas in late-successional forests (table V-1). Five species of riparian and aquatic vascular plants are of special concern under various state, federal, and agency listings (chapter IV). These species are dependent on a predictable hydrologic regime, shade, and cool water for survival. Several species of lichens and bryophytes are also dependent on conditions in streams and riparian areas.

Amphibians require cool, moist conditions to maintain their respiratory functions. They are also sensitive to increased temperatures and sedimentation that may reduce reproductive and foraging success. Extirpation of populations in specific areas of the Pacific Northwest has occurred for several species and the ranges of several others has been drastically reduced (Corn and Bury 1989; Blaustein and Wake 1990). Forest dwelling species have declined the most. As a result, several species of amphibians are currently candidates for listing under the Endangered Species Act (U.S. Fish and Wildlife Service 1992).

Table V-1. Species associated with late-successional and old-growth forests utilizing streams, wetlands, and riparian areas. Vascular plants, lichens, mosses, and mollusks are exclusively associated with aquatic, wetland, or riparian habitats. Vertebrate species significantly utilize riparian areas for foraging, roosting, and travel if old forest conditions are present. (Derived from Chapter IV.)

Vascular Plants	29
Lichens	
Aquatic	3
Riparian	9
Bryophytes (mosses)	
Aquatic	3
Splash zone	5
Floodplain	13
Mollusks	
Freshwater snails	54
Freshwater clams	3
Amphibians	
Salamanders	12
Frogs	1
Birds	38
Mammals	18
Bats	11
Total	**199**

Many freshwater mollusk species have restricted distributions, often being found in single stream systems, springs and seeps (chapter IV). They are sensitive to changes in flow conditions and increased levels of sedimentation.

Many species of aquatic invertebrates are proposed for listing under state or federal endangered species laws. However, in general not enough information is known about them to adequately address their current status or whether additional species should be examined (chapter IV).

Characteristics of Aquatic Ecosystems and Present Habitat Conditions

Understanding current conditions and future options for aquatic ecosystems in the Pacific Northwest requires an appreciation of those physical and biological processes and elements that create and maintain habitat. These factors derive from upland terrestrial and aquatic environments as well as the riparian area, a zone of transition between these areas in which vegetation and microclimate are strongly influenced by the aquatic system (Gregory and Ashkenas 1990; Gregory et al. 1991). Here we consider the critical components of aquatic ecosystems and their current conditions in the range of the northern spotted owl.

Key physical components of a fully functioning aquatic ecosystem include complex habitats consisting of floodplains, banks, channel structure (i.e. pools and riffles), water column and sub-surface waters. These are created and maintained by rocks, sediment, large wood, and favorable conditions of water quantity and quality. Upslope and riparian areas influence aquatic systems by supplying sediment, large wood and water. Disturbance processes such as landslides and floods are important delivery mechanisms. Over time scales of 1-100 years, streams are clearly disturbance dependent systems (Pringle et al. 1988). To maintain community viability throughout a large drainage basin, it is necessary to maintain features of the natural disturbance regime (i.e., frequency duration, and magnitude) in different portions of a basin. Aquatic ecosystems consist of a diversity of species, populations and communities that may be uniquely adapted to these specific structures and processes.

Spatial and temporal connectivity within and between watersheds is necessary for maintaining aquatic and riparian ecosystem functions (Naiman et al. 1992). A large river basin can be visualized as a mosaic of a terrestrial "patches" (Pickett and White 1985) or smaller watersheds linked by stream, riparian, and sub-surface networks (Stanford and Ward, 1992). Lateral, vertical, and drainage network linkages are critical to aquatic system function. Important connections within basins include linkages among headwater tributaries and downstream channels as paths for water, sediment, and disturbances; and linkages among floodplains, surface water, and ground water systems (hyporheic zones) as exchange areas for water, sediment and nutrients. Unobstructed physical and chemical paths to areas critical for fulfilling life history requirements of aquatic and riparian-dependent species must also be maintained. Connections among basins must allow for movement between refugia.

The following discussion of aquatic ecosystems focuses on third to fifth order streams (Strahler 1957); these streams are generally 10-60 feet wide and are representative of most aquatic systems on federal lands within the range of the northern spotted owl. Streams of this size support mixed species assemblages of juvenile anadromous salmonids and resident fish. Not all of the desired features are expected to occur in a specific reach of stream, but they generally occur throughout a productive watershed.

Instream Components

Large Wood

Large quantities of downed trees are a functionally important component of many streams (Swanson et al. 1976; Sedell and Luchessa, 1982; Sedell and Froggat, 1984; Harmon et al. 1986; Bisson et al. 1987; Maser et al. 1988; Naiman et al. 1992). Large woody debris influences channel morphology by affecting longitudinal profile, pool formation, channel pattern and position, and channel geometry (Bisson et al. 1987). Downstream transport rates of sediment and organic matter are controlled in part by storage of this material behind large wood (Betscha 1979). Large wood affects the formation and distribution of habitat units, provides cover and complexity, and acts as a substrate for biological activity (Swanson et al. 1982; Bisson et al. 1987). Wood enters streams inhabited by fish either directly from the adjacent riparian zone from tributaries that may not be inhabited by fish, or hillslopes (Naiman et al. 1992).

Large wood in streams has been reduced due to a variety of past and present timber harvesting practices and associated activities. Many riparian management areas on federal lands are inadequate as long term sources of wood. Widths of intact riparian areas have been reduced by timber harvest activities. Furthermore, in some areas where riparian buffers have been established, partial harvest and salvage logging within them have reduced their ability to contribute large wood to streams (Bryant 1980; Bisson et al. 1987). Also, absence of protection for riparian areas for nonfish-bearing streams has reduced the amount of wood which these streams could deliver to fish-bearing streams (Naiman et al. 1992). Debris flows and dam-break floods resulting from natural processes or timber harvest activities may remove large wood from channels and riparian vegetation from streambanks on one portion of a drainage system and deposit this material downstream (Benda and Zhang, 1990; Swanston 1991).

Other human activities have also resulted in the loss of wood in streams. Mandated cleanup activities removed wood from streams throughout the region of the northern spotted owl from the 1950's through 1970's (Narver 1971; Bisson and Sedell 1984). Earlier activities such as splash-damming, which stored water to flood streams and transport logs, also removed large amounts of wood from streams (Sedell and Luchessa 1982; Sedell et al. 1991).

Water Quality

High water quality is essential for survival, growth, reproduction, and migration of individuals composing aquatic and riparian communities. Elements of water quality that are important for aquatic organisms include water temperatures within a range that corresponds with migration and emergence needs of fish and other aquatic organisms (Sweeney and Vannote 1978; Quinn and Tallman 1987). Desired conditions include an abundance of cool (generally less than 68^{O}F), well-oxygenated water that is present at all times of the year, free of excessive amounts of suspended sediments (Sullivan et al. 1987) and other pollutants that could limit primary production and benthic invertebrate abundance (Cordone and Kelley 1961; Lloyd et al. 1987).

The U.S. Environmental Protection Agency reporting the results of state 305(b) and 319 assessments found many streams on lands managed by the U.S. Forest Service and Bureau of Land Management in the range of the northern spotted owl to be either moderately or severely impacted by increases in water temperature and sedimentation (Edwards et al. 1992). On federal lands in Oregon, 55 percent (20,400 miles) of the streams are moderately or severely impaired (fig. V-7). On Bureau of Land Management lands, 7,300 miles of streams, and 4,900 miles of streams on Forest Service lands have water temperature problems. An additional, 8,000-11,000 miles have problems with turbidity, erosion, and bank instability. See appendix V-D for a more detailed discussion.

The Regional Ecosystem Assessment Project of Region 6 of the Forest Service attempted, as a first approximation, to compare current aquatic ecosystem conditions with the range of natural conditions to discover "where forests are in or out of balance." Comparable data were provided by National Forests in northern California and Bureau of Land Management. Although the range of natural conditions was estimated by compiling data from existing sources and professional judgement, results indicate a simplification of habitat and a reduction in aquatic system quality in the majority of river basins.

The Regional Ecosystem Assessment Project used maximum daily stream temperature as an indicator of aquatic ecosystem conditions. The range of natural conditions was estimated for a river basin using knowledge of temperatures in wilderness or other unmanaged areas. In the absence of existing stream temperature data, current conditions

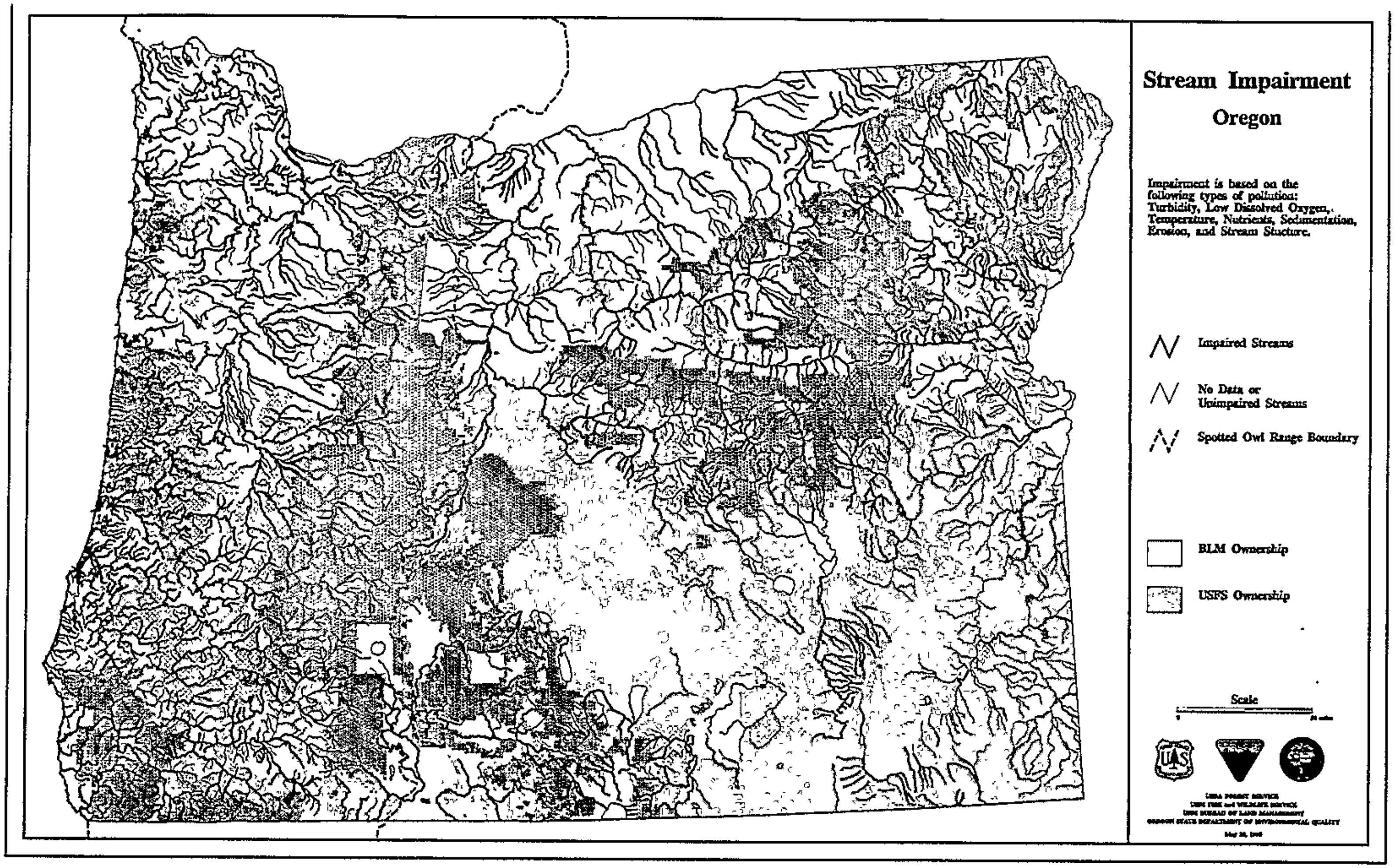

Figure V-7. Stream Impairment for the state of Oregon.

were estimated based on ground water or air temperature data. For a majority of rivers, current maximum stream temperatures exceeded the warmest estimated naturally occurring temperatures or were in the upper portion of the range of natural conditions (fig. V-8).

Increased water temperature can often be traced to removal of shade-producing riparian vegetation along fish-bearing streams and along smaller tributary streams that supply cold water to fish-bearing streams (Beschta et al. 1987; Bisson et al. 1987). Removal of streambank vegetation has resulted largely from timber harvest in riparian areas.

Changes in the water temperature regime can affect the survival and production of anadromous salmonids, even when temperatures are below levels considered to be lethal. For example, Reeves et al. (1987) found that interspecific competition between redside shiners and juvenile steelhead trout was influenced by water temperature; trout dominated at lower temperatures (less than 68°F) and shiners at higher temperatures (greater than 68°F). In Carnation Creek, British Columbia, water temperatures during both summer and winter changed because of timber harvest activities. The consequence of this was accelerated growth and earlier migration of juvenile coho salmon (Holtby 1988). However, Holtby speculated that survival of coho salmon to adults would decrease because of the earlier time of ocean entry. Berman and Quinn (1991) found that fecundity and viability of eggs of adult spring chinook salmon were affected by elevated water temperatures.

Accelerated rates of erosion and sediment yield are a consequence of most forest management activities. Road networks in many upland areas of the Pacific Northwest are the most important source of management-accelerated delivery of sediment to anadromous fish habitats (Ice 1985; Swanson et al. 1985). The sediment contribution to streams from roads is often much greater than that from all other land management activities combined, including log skidding and yarding (Gibbons and Salo 1973). Road-related landsliding, surface erosion and stream channel diversions frequently deliver large quantities of sediment to steams, both chronically and catastrophically during large storms (Swanson and Dyrness 1975; Swanston and Swanson 1976; Beschta 1978; Gardner 1979; Reid and Dunne 1984). Roads may have unavoidable effects on streams, no matter how well they are located, designed or maintained. Many older roads with poor locations and inadequate drainage control and maintenance pose high risks of erosion and sedimentation of stream habitats.

Federal lands within the range of the northern spotted owl contain approximately 110,000 miles of roads (table V-2). A substantial proportion of this network constitutes current and potential sources of damage to riparian and aquatic habitats, mostly through sedimentation. Roads in uplands cross streams frequently. There are an estimated 250,000 stream crossings (culverts) in the road network. The majority of these stream crossings cannot tolerate more than a 25-year flow event without failure. The chance of a 25-year flow event is about 34 percent in 10 years, and 70 percent in 30 years (fig. V-9). When stream crossings fail, a local dam-break flood usually occurs, resulting in severe impacts to water quality and habitat.

Roads modify natural hillslope drainage networks and accelerate erosion processes. These changes can alter physical processes in streams, leading to changes in streamflow regimes, sediment transport and storage, channel bank and bed configurations, substrate composition, and stability of slopes adjacent to streams. These changes can have

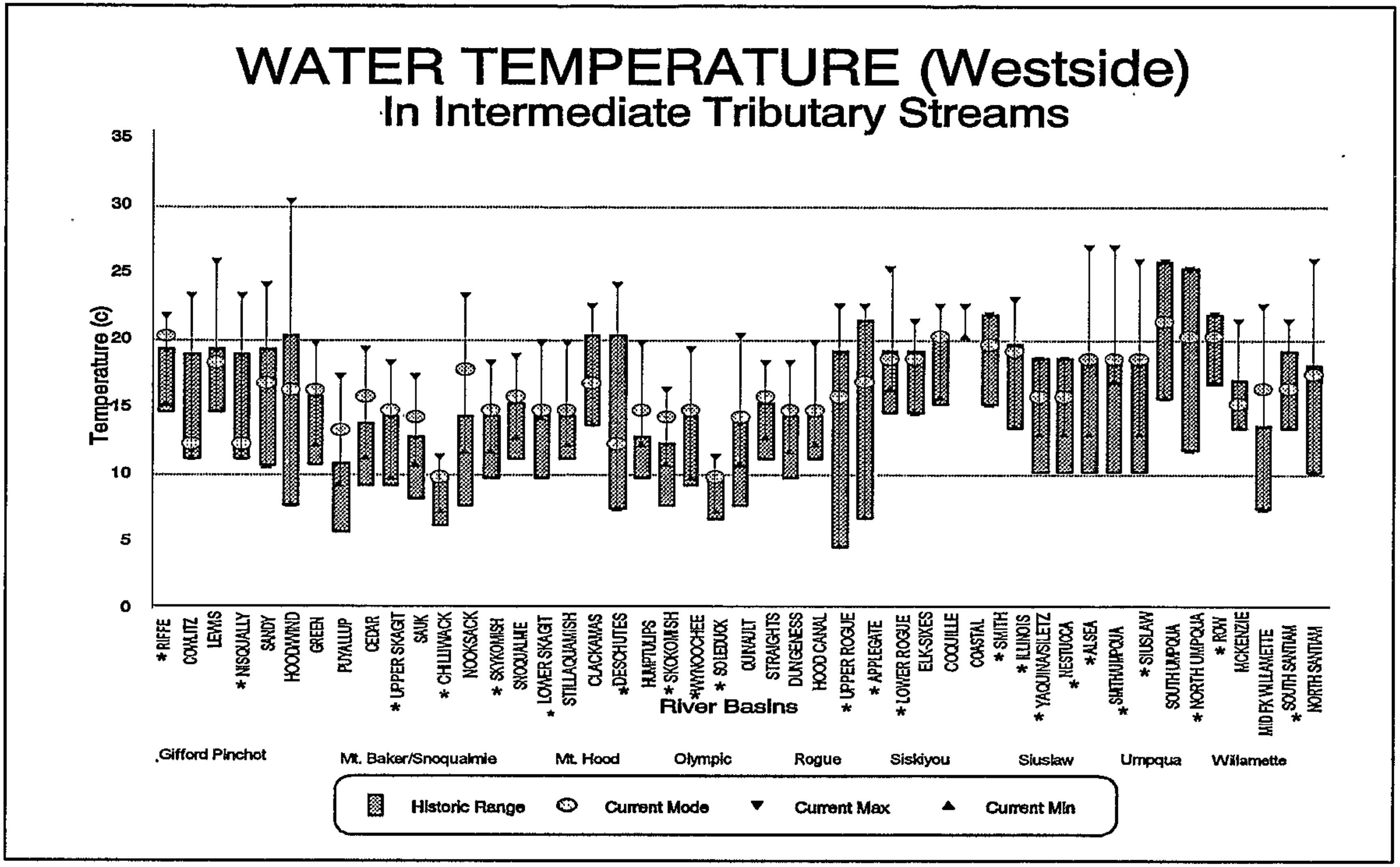

Figure V-8. Historic range, current range, and current mode of water temperature for streams west of the Cascade Mountains in Washington and Oregon. Basins that had limited data are shown by (*). (USDA Forest Service 1993).

Table V-2. Summary of road development on public lands in the range of the northern spotted owl

National Forest or BLM District	Total Road Miles	ML 1 [1] Miles	Ml 1 %	ML 2 [2] Miles	ML 2 %	"Public" [3] Road Miles	Public Road %	Native Surface Miles	Native Surface %	Gross area minus wilderness (sq. mi.)	Net roaded area [4] (sq. mi.)	% of non-wilderness in roadless	Road Density (mi/sq. mi.)
Deschutes NF	8,722	469	5	7,535	86	718	8	7,009	80	2,179	2,009	8	4.34
Mt. Hood NF	3,818	443	12	2,236	59	1,139	30	845	22	1,428	1,211	15	3.15
Rogue River NF	2,782	90	3	1,830	66	862	31	1,055	38	837	711	15	3.92
Siskiyou NF	2,949	300	10	2,092	71	557	19	689	23	1,343	899	33	3.28
Siuslaw NF	2,540	220	9	1,625	64	695	27	115	5	910	868	5	2.92
Umpqua NF	4,880	1,276	26	2,447	50	1,157	24	1,132	23	1,498	1,325	12	3.68
Willamette NF	6,424	700	11	3,757	58	1,967		380	6	2,023	1,768	13	3.63
Winema NF	6,221	1,848	30	3,111	50	1,262	20	5,374	86	1,488	1,451	2	4.29
Coos Bay BLM	1,924										511		3.76
Medford BLM	5,628										1,436		3.92
Eugene BLM	1,935										492		3.94
Roseburg BLM	2,924	Road maintenance level and surfacing data not available for BLM lands									655		4.46
Salem BLM	2,636										622		4.23
Arcata BLM	135										277		0.49
Redding BLM	350										387		0.90
Gifford-Pinchot NF	4,341	569	13	2,777	64	995	23	719	17	1,861	1,525	18	2.85
Mt. Baker-Snoqualmie	2,988	615	21	968	32	1,405	47	94	3	1,565	934	40	3.20
Okanogan NF	2,665	477	18	1,158	43	1,030	39	1,615	61	1,688	1,226	27	2.17
Olympic NF	2,463	556	23	1,207	49	701	28	1,446	59	872	738	15	3.34
Wenatchee NF	5,069	840	17	3,214	63	1,015	20	3,362	66	2,067	1,198	42	4.23
Klamath NF	4,656	895	19	2,478	53	1,284	28	3,295	71	1,477	1,100	26	4.23
Shasta-Trinity NF	6,528	981	15	3,914	60	1,633	25	4,939	76	2,690	2,255	16	2.89
Mendocino NF	2,486	619	25	1,402	56	465	19	2,422	97	1477	1,255	16	1.10
Six Rivers NF	2,489	648	26	1,192	48	649	26		0	1,304	1,085	17	2.29
TOTALS	87,554	11,547	13	42,941	49	17,534	20	34,491	39	26,707	25,940		3.38
adjusted by 1.25 [5]	109,443												4.22

[1] ML 1 - Maintenance Level 1 are roads that are closed but still considered part of the transportation system.
[2] ML 2 - Maintenance Level 2 are roads suitable for high-clearance vehicles only.
[3] "Public" refers to roads that are designed and maintained for normal-clearance vehicles (FS Maintenance Levels 3, 4 & 5).
[4] Derived by subtracting Inventoried Roadless Area acreage from gross NF acreage without Wilderness.
[5] Estimated adjustment for non-system roads.

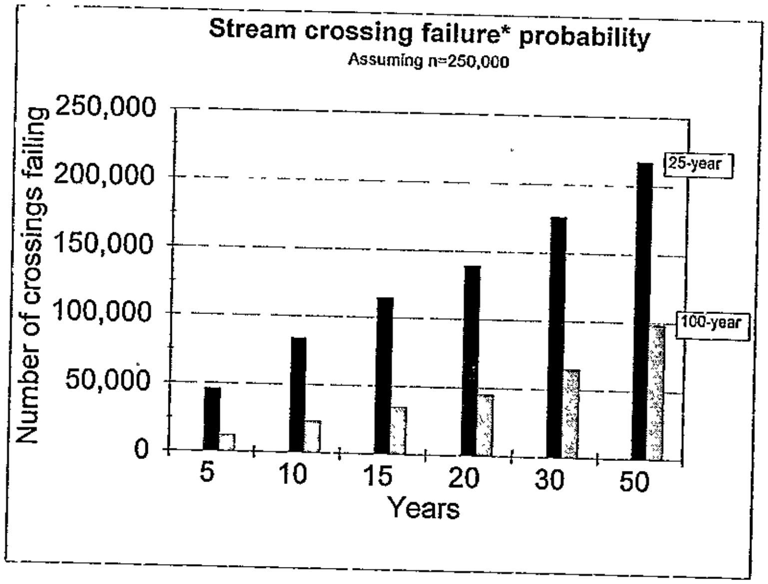

Figure V-9. Theoretical probability of stream crossing failure. Values are based on: $J = 1 - (1 - 1/T)^N$, where N = number of years considered, T = flood recurrence interval, J = chance of failure (Schmidt 1981). Probabilities for an individual crossing sized for 25- and 100-year flows were multiplied by the total estimated number of crossings on public lands within the range of the northern spotted owl (~250,000). *Analysis assumes random spatial distribution of storms, and that exceedance of design flows constitutes crossing failure. The actual consequences of design flow exceedance would vary widely.

significant biological consequences that affect virtually all components of stream ecosystems (Furniss et al. 1991).

Increased levels of sedimentation often have adverse effects on fish habitats and riparian ecosystems. Fine sediment deposited in spawning gravels can reduce survival of eggs and developing alevins (Everest et al. 1987; Hicks et al. 1991a). Primary production, benthic invertebrate abundance, and thus, food availability for fish may be reduced as sediment levels increase (Cordone and Kelley 1961; Lloyd et al. 1987). Social (Berg and Northcote 1985) and feeding behavior (Noggle 1978; Sigler et al. 1984) can be disrupted by increased levels of suspended sediment. Pools, an important habitat type, may be lost due to increased levels of sediment (Kelsey et al. 1981; Megahan 1982).

Water Quantity

Aquatic organisms require adequate flows be maintained at critical times to satisfy requirements of various life stages. For example, fish are adapted to natural variations in flow regimes but may be adversely affected by disturbances that alter natural flow cycles (Statzner et al. 1988). Timing, magnitude, duration, and spatial distribution of peak and low flows must be sufficient to create and sustain riparian and aquatic system habitat and to retain patterns of sediment, nutrient, and wood routing. The timing, variability, and duration of floodplain inundation and water table elevation in meadows, floodplains and wetlands affect maintenance of main channel connectivity within these areas.

Timber harvest and associated activities can alter the amount and timing of streamflow by changing onsite hydrologic processes (Keppeler and Ziemer 1990; Wright et al. 1990).

These activities, which include harvest, thinning, yarding, road building, and slash disposal can produce changes that are either short-lived or long-lived depending on which hydrologic processes they alter and the intensity of the alteration (Harr 1983). Thus, changes in the hydrologic system caused by road building are most pronounced where road densities are the greatest (Harr et al. 1979; Wright et al. 1990; Ziemer 1981). Similarly, the effects of clearcut logging on hydrologic processes are greater than those resulting from thinning (Harr 1983; Harr et al. 1979).

Changes in hydrologic processes can be grouped into two classes according to causal mechanisms. One class consists of changes resulting from removing forest vegetation through harvest. These changes, which can be very large close to the harvest areas immediately following harvest, gradually diminish over time as vegetation regrowth occurs (Harr 1983; Harr et al. 1979; Harris 1977; Hicks et al. 1991b). Processes that depend on the amount and size of forest vegetation include rain or snow interception, fog drip (Azevedo and Morgan 1974; Byers 1953; Harr 1982; Ingwerson 1985; Isaac 1946), transpiration (Harr 1983; Harr et al. 1979, 1982), and snow accumulation and melt (Berris and Harr 1987; Coffin and Harr 1992; Harr 1981; Troendle 1983; Swanson and Golding 1982). These processes, most of which are at least partially energy-dependent, all increase the amount or timing of water arriving at the soil surface and the resultant amount of water flowing from a logged watershed. The longevity of changes in these processes brought about by timber harvest generally is on the order of three to four decades and is related to vegetation characteristics such as tree height, leaf area, canopy density, and canopy closure (Coffin and Harr 1992; Harr and Coffin 1992; Troendle 1983; Hicks et al. 1991b).

A second class of changes in hydrologic processes consists of those that control infiltration and the flow of surface and subsurface water. This class is dominated by the effects of forest roads. The relatively impermeable surfaces of roads cause surface runoff that bypasses longer, slower subsurface flow routes (Harr et al. 1975, 1979; Ziemer 1981). Where roads are insloped to a ditch, the ditch extends the drainage network, collects surface water from the road surface and subsurface water intercepted by roadcuts, and transports this water quickly to streams (fig. V-10) (Wemple draft; Megahan et al. 1992). The longevity of changes in hydrologic processes resulting from forest roads is as permanent as the road. Until a road is removed and natural drainage patterns are restored, the road will likely continue to affect the routing of water through watersheds.

In watersheds on the order of 20-200 square miles, increased peak flows have been detected after roading and clearcutting occurred (Christner and Harr 1982; Jones and Grant in review). Higher flows result from a combination of wetter, more efficient water-transporting soils following reduced evapotranspiration (Harr et al. 1982; Harris 1977), increased snow accumulation and subsequent melt during rainfall (Berris and Harr 1987; Harr 1986; Harr and Coffin 1992) surface runoff from roads (Harr et al. 1975, 1979) extension of drainage networks by roadside ditches (Wemple draft) and possibly reduced roughness of stream channels following debris removal and salvage logging in riparian zones (Jones and Grant in review).

The alteration in stream flow regime resulting from timber harvest and associated activities can have both positive and negative effects on the aquatic system (Hicks, B.J 1991a). For example, decreased evapotranspiration following logging and prior to vegetation regrowth can increase summer stream flows which may bring about short-term increases in juvenile salmonid survival. Conversely, increased peak flows may

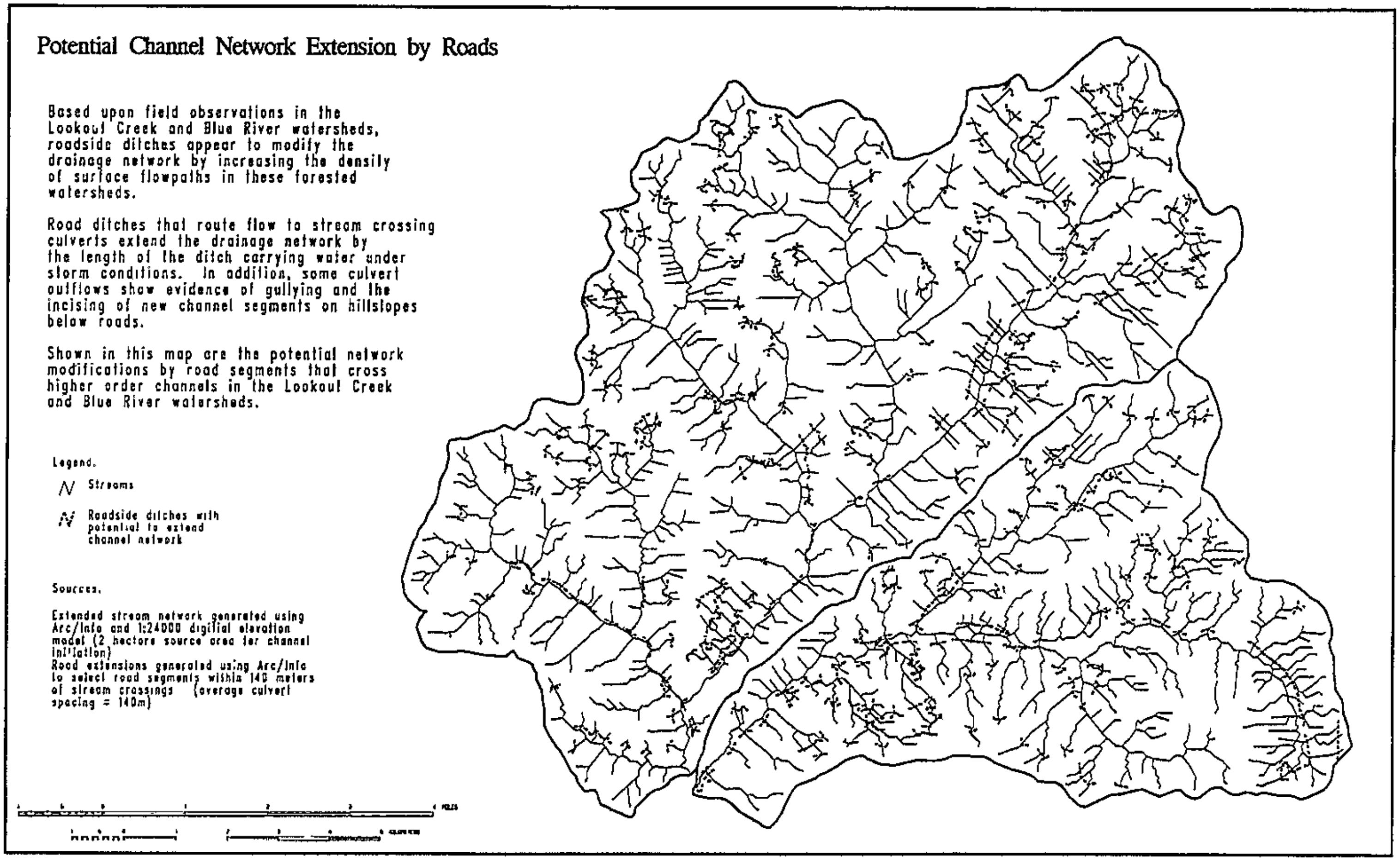

Figure V-10. Map of potential channel network extension by roads. (B. Wemple, Oregon State University).

increase bed-load movement and reduce survival of salmonid eggs and alevins. Effects of streamflow changes on aquatic organisms have not been documented independently from other logging effects. The extent to which the positive effects of short-term increase in summer flows is offset by the detrimental effect of increased peak flows and resultant scour is unknown.

Inchannel habitat. A primary factor influencing the diversity of stream fish communities is habitat complexity. Attributes of habitat diversity include the variety and range of hydraulic conditions (i.e., depths and water velocities) (Kaufmann 1987), number of pieces and size of wood (Bisson et al. 1987), types and frequency of habitat units, and variety of bed substrate (Sullivan et al. 1987). More diverse habitats support more diverse assemblages and communities (Gorman and Karr 1978; Schlosser 1982; Angermeier and Karr 1984). Habitat diversity can also mediate biotic interactions such as competition (Kalleberg 1958; Hartman 1965) and predation (Crowder and Cooper 1982; Schlosser 1988).

Large pools, a primary characteristic of high quality aquatic ecosystems, have been lost in basins that have had varying levels of land management. The number of large, deep pools (i.e., more than 6 feet deep and greater than 50 yards square surface areas) in many tributaries of the Columbia River, have decreased in the past 50 years (Sedell and Everest 1991) (table V-3). Over all, there has been a 58 percent reduction in the number of large, deep pools in resurveyed streams on National Forests within the range of the northern spotted owl in western and eastern Washington. A similar trend was found in streams on private lands in coastal Oregon, where large, deep pools decreased by 80 percent. Ralph et al. (unpubl. ms.) reported the loss of pools in streams in basins with moderate (less than 50 percent of the basin harvested in the last 40 years) to intensive (more than 50 percent of the basin harvested within the last 40 years and a road density of more than 5.3 miles per square mile) levels of timber harvest in western Washington. Bisson and Sedell (1984) reported similar results for other streams in western Washington. Primary reasons for the loss of pools are filling by sediments (Megahan 1982), loss of pool-forming structures such as boulders and large wood (Bryant 1980; Sullivan et al. 1987), and loss of sinuosity by channelization (Furniss et al. 1991; Benner 1992).

The Regional Ecosystem Assessment Project of Region 6 of the U.S. Forest Service included pool frequency as a primary indicator of aquatic ecosystem condition. The Region 6 stream inventory or comparable data provided current conditions. Current pool frequency was below the range of natural conditions for most rivers examined (fig. V-11). For the few rivers in which pool frequency was within the estimated range of natural conditions, the overlap was limited to the lower portion of the range.

Habitat simplification may result from timber harvest activities (Bisson and Sedell 1984; Hicks et al. 1991a; Bisson et al. 1992; Frissel 1992; Ralph et al. unpub. ms.). Timber harvest activities can result in a decrease in the number and quality of pools (Sullivan et al. 1987). Wood is a major habitat-forming element in streams. Reduction of wood in the channel, either from present or past activities, generally reduces pool quantity and quality (House and Boehne 1987; Bisson et al. 1987). Constricting naturally unconfined channels with bridge approaches or streamside roads reduces stream meandering and decreases pools formed by stream meanders that undercut banks (Furniss et al. 1991). Increased mass failures from roads and timber harvest on unstable slopes can result in the loss of pools due to sediment influxes (Morrison 1975; Swanson and Dyrness 1975;

Table V-3. Changes in the frequency of large, deep pools (>50 yds^2 and >6 feet deep) between 1935 and 1992 in streams on national forest within the range of the northern spotted owl.

		1935-1945		1987-1992		
	Miles Surveyed	Number	Number /Miles	Number	Number /Pool	Percent Change
Western Washington						
Cascades						
Cowlitz River Basin	52.1	421	8.1	176	3.4	-58%
Lewis River Basin	4.8	22	4.6	13	2.7	-41%
Wind River Basin	35.4	75	2.1	80	2.3	10%
Coastal						
Grays River Basin	20.7	107	5.2	34	1.6	-69%
Elochoman River Basin	21.5	79	3.7	13	0.3	-84%
Abernathy Basin	8.3	3	0.4	3	0.4	-NC
Germany Basin	8.0	7	0.9	4	0.5	-44%
Coweeman River Basin	26.4	87	3.3	4	0.2	-94%
Eastern Washington						
Yakima River Basin	28.5	98	3.4	14	0.5	-85%
Wenatchee River Basin	60.7	143	2.4	125	2.1	-13%
Methow River Basin	119.0	106	0.9	52	0.4	-56%
Coastal Oregon						
Lewis and Clark River	10.4	47	4.5	10	1.0	-78%
Clatskanie River	15.5	135	8.7	20	1.3	-85%

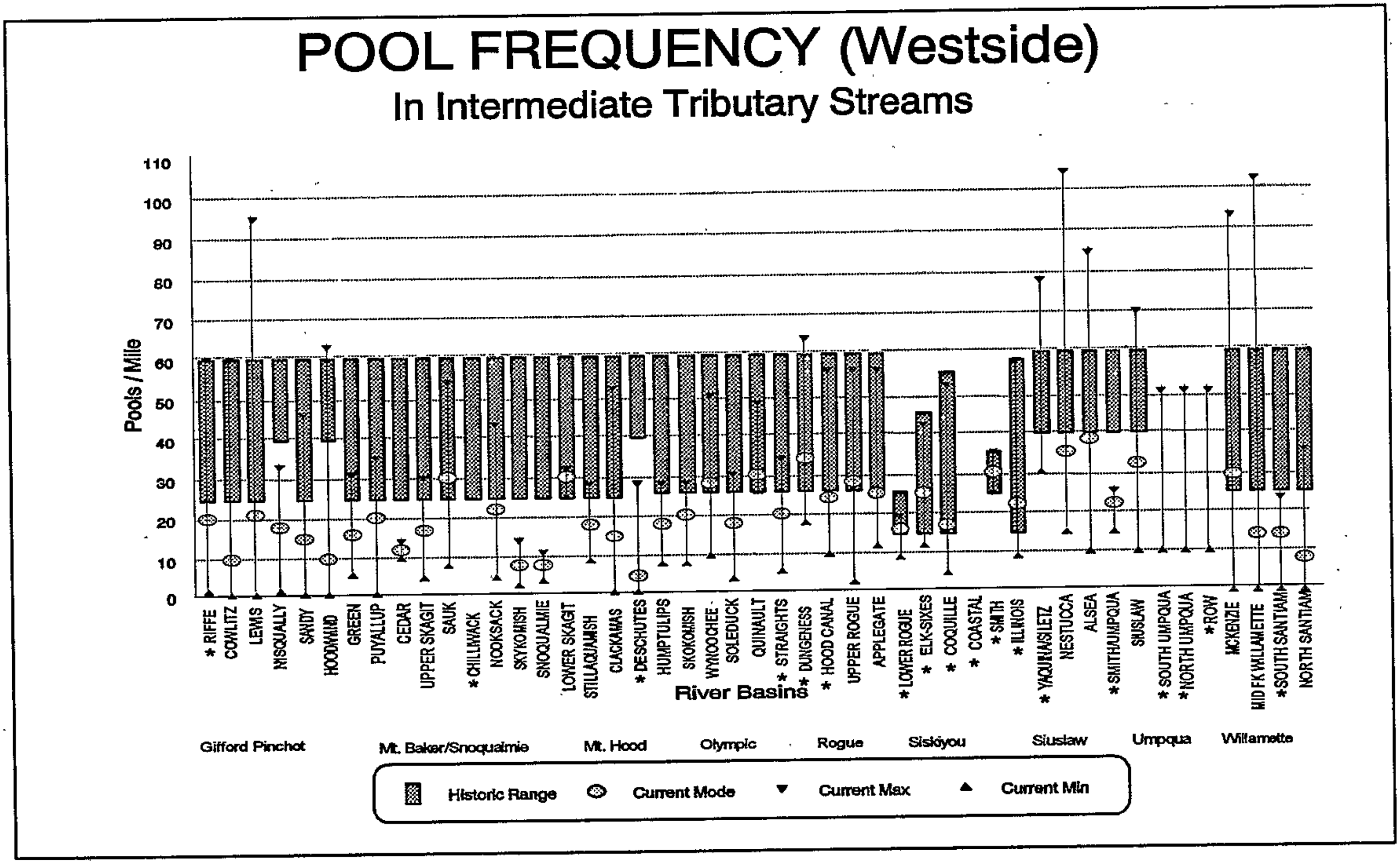

Figure V-11. Historic range, current range, and current mode of river basin pool frequency in intermediate tributary streams west of the Cascade Mountains in Washington and Oregon. Basins that had limited data are shown by (*). (USDA Forest Service 1993).

Beschta 1978; Swanson et al. 1981; Ziemer and Swanston 1977; Ketcheson and Froehlich 1978; Marion 1981; Grant and Wolff 1991; Coats 1987; Janda et al. 1975; Kelsey et al. 1981; Madej 1984; Nolan and Marron 1985).

In Pacific Northwest streams, habitat simplification resulting from timber harvest and associated activities leads to a decrease in the diversity of the anadromous salmonid complex (Bisson and Sedell 1984; Li et al. 1987; Hicks 1990; Reeves et al. 1993). One species may increase in abundance and dominance while others decrease. Holtby (1988), Holtby and Scrivener (1989), and Scrivener and Brownlee (1989) in British Columbia and Rutherford et al. (1987) in Oklahoma reported similar responses by fish communities in streams affected by timber harvest activities. Similar patterns have also been observed in streams altered by other anthropogenic activities such as agriculture (Schlosser 1982; Berkman and Rabini 1987) and urbanization (Leidy 1984; Scott et al. 1986).

Riparian Ecosystem Components

Riparian areas are particularly dynamic portions of the landscape. These areas are shaped by disturbances characteristic of upland ecosystems, such as fire and windthrow, as well as disturbance processes unique to stream systems, such as lateral channel erosion, peakflow, deposition by floods and debris flows. Near-stream, floodplain riparian areas may have plant communities of relatively high diversity (Gregory et al. 1991) and extensive hydrologic and nutrient cycling interactions between groundwater and riparian vegetation.

Riparian vegetation regulates the exchange of nutrients and material from upland forests to streams (Swanson et al. 1982; Gregory et al. 1991). Fully functional riparian ecosystems have a suite of characteristics which are summarized below. Large conifers or a mixture of large conifers and hardwoods are found in riparian zones along all streams in the watershed, including those not inhabited by fish (Naiman et al. 1992). Riparian zone-stream interactions are a major determinant of large woody debris loading (House and Boehne 1987; Bisson et al. 1987; Sullivan et al. 1987). Stream temperatures and light levels that influence ecological processes are moderated by riparian vegetation (Agee 1988; Gregory et al. 1991). Streambanks are vegetated with shrubs and other low-growing woody vegetation. Root systems in streambanks of the active channel stabilize banks, allow development and maintenance of undercut banks, and protect banks during large storm flows (Sedell and Beschta 1991). Riparian vegetation contributes leaves, twigs, and other forms of fine litter that are an important component of the aquatic ecosystem food base (Vannote et al. 1980).

Riparian areas are widely considered to be important wildlife habitat. A distinct microclimate is maintained along stream channels, created by cold air drainage and the presence of turbulent surface waters. Large wood on the ground is an important habitat component in riparian areas. Maintaining the integrity of the vegetation is particularly important for riparian-dependent organisms including amphibians, arthropods, mammals, birds, and bats (see appendix V-E for greater detail).

Riparian habitat conditions on federal lands within the range of the northern spotted owl have been degraded by road construction and land management activities. For example, coast range riparian areas outside of wilderness areas are nearly all red alder or bigleaf maple because of timber harvest and associated activities. Riparian areas have very few large trees greater than 10 inches diameter growing within 100-200 feet of the stream, suggesting that streamside recruitment of large wood may be deficient for decades.

Riparian Processes as a Function of Distance from Stream Channels

Many effects of riparian vegetation on streams decrease with increasing distance from the streambank (VanSickle and Gregory 1990; McDade et al. 1990; Beschta et al. 1987) (figs. V-12 and V-13) and are influenced by the degree of channel constraint and floodplain development (Sparks et al. 1990; Sedell et al. 1989).

Root strength. The upstream head of steep channels and other steep hillslope areas are common initiation sites of debris slides and debris flows (Dietrich and Dunne 1978). Root strength provided by trees and shrubs contribute to slope stability; and loss of root strength following tree death by timber harvest or other causes may lead to increased incidence of debris slides and flows (Sidle et al. 1985). The soil stabilizing zone of influence for vegetation in these sites is the slide scar width plus half a tree crown diameter (fig. V-12). Half a tree crown diameter is an estimate of the extent to which root systems of trees adjacent to the slide scar margin affect soil stability. The contribution of root strength to maintaining streambank integrity also declines at distances greater than one-half a crown diameter (Burroughs and Thomas 1977; Wu 1986; and personal communication, F.J. Swanson and T. Spies, Pacific Northwest Research Station, Corvallis, Oregon).

Large wood delivery to streams. The probability that a falling tree will enter the stream is a function of slope distance from the channel in relation to tree height (VanSickle and Gregory 1990; McDade et al. 1990; Andrus and Lorenzen, 1992; Beschta et al. 1993). The effectiveness of floodplain riparian forests and riparian forests along constrained channels to deliver large wood is low at distances greater than approximately one tree height away from the channel (fig. V-12).

Large wood delivery to riparian areas. Large downed logs are recruited into riparian areas from the riparian forests and from upslope forests. Similar to large wood delivery from riparian areas into streams, the effectiveness of upland forests to deliver large wood to the riparian area is naturally expected to decline at distances greater than approximately one tree height from the stand edge (Thomas et al. 1993). Timber harvest adjacent to the riparian area creates an edge that eliminates one source of large wood. Thus, long-term levels of large wood may diminish in the riparian zone.

Leaf and other particulate organic matter input. The distance away from the stream from which leaf litter input originates depends on site-specific conditions. Thus, the effectiveness of floodplain riparian forests to deliver leaf and other particulate organic matter declines at distances greater than approximately one-half a tree height away from the channel (fig. V-12). We are unaware of studies examining litter fall from riparian zones as a function of distance of litter source from the channel. However, Erman et al. (1977) reported that the composition of benthic invertebrate communities in streams with riparian buffers greater than 100 feet were indistinguishable from those in streams flowing through unlogged watersheds. While other factors could have been influencing community structure, in fact, riparian forests of widths equal to or greater than 100 feet

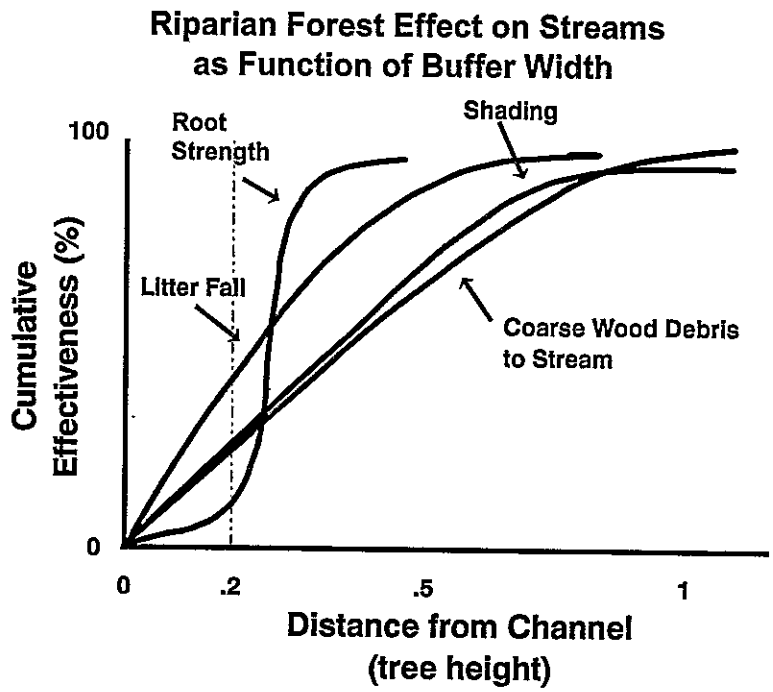

Figure V-12. Generalized curves indicating percent of riparian ecological functions and processes occurring within varying distances from the edge of a forest stand.

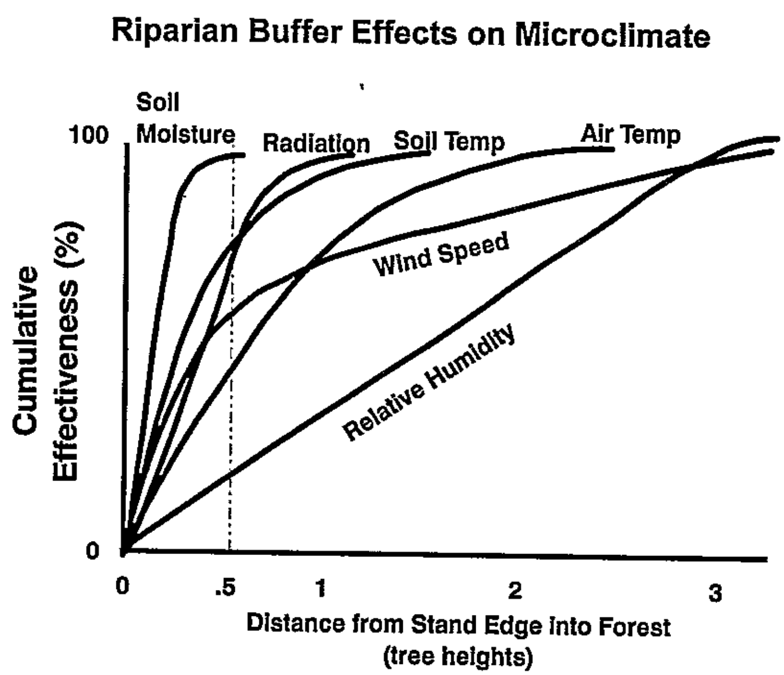

Figure V-13. Generalized curves indicating percent of microclimatic attributes occurring within varying distances of the edge of a riparian forest stand (after Chen, J 1991).

retained sufficient litter inputs to maintain biotic community structures in the stream. The curve in figure V-12 is consistent with Erman et al. (1977) and our professional judgement.

Shade. Effectiveness of streamside forest to provide shade varies with topography, channel orientation, extent of canopy opening above the channel, and forest structure, particularly the extent of both under- and overstory. Although, any curve depicting this function is by necessity quite generalized (fig. V-12), buffer width correlates well with degree of shade (Beschta et al. 1987). In the Oregon Coast Range and western Cascade Mountains riparian buffers of 100 feet or more have been reported to provide as much shade as undisturbed late successional/old-growth forests (Steinblums 1977).

Riparian microclimate. Streamside and upslope forest affect microclimate and thereby habitat in the riparian environment. Microclimate is likely influenced by widths of both the riparian area and the stream channel. Riparian zones along larger streams, third-order and greater, consist of two distinct parallel bands of vegetation separated by the stream channel. By contrast, channels of lower order streams are so narrow that a functionally continuous canopy usually exists.

We are aware of no reported field observations of microclimate in riparian zones, but Chen (1991) documented change in soil and air temperature, soil moisture, relative humidity, wind speed, and radiation as a function of distance from a clearcut edge into upslope forest in two Cascades study sites. Patterns vary substantially with season, time of day, edge aspect, and extent of tree removal in the harvested stand. Figure V-13 shows the maximum effects observed by Chen (1991).

When timber is harvested to the outer limit of the riparian zone, an edge is created that may affect the interior microclimatic conditions of the riparian forest. If the forest is harvested from only one side of a small stream, leaving both riparian areas intact, then the edge effect on the microclimatic conditions within the riparian forest may be comparable to that demonstrated in upland forests (fig. V-13).

Removing upland forest from both sides of the riparian zone of a small stream, creates two edges, and the effect on microclimatic conditions may be additive, if not synergistic. The degree to which the two edge effects are additive depends on the total width of the riparian corridor and is probably influenced by season, time of day, aspect, channel orientation, and extent of tree removal from the harvested stand. This situation is somewhat analogous to harvesting the forest adjacent to the riparian area along a larger river. When this forest is removed, the riparian area of a larger river becomes a corridor with two edges, one created by the river channel itself and one resulting from timber harvest. Thus, buffers may need to be wider to maintain interior microclimatic conditions than other riparian functions.

Water quality. Castelle et al. (1992) provide a thorough literature review of widths of riparian areas required to protect water quality functions. In general, the authors found that widths of riparian areas required to protect water quality ranged from 12-860 feet. Widths varied as a function of geomorphic characteristics such as slope and soil type and by vegetative structure and cover. Effectiveness of buffers at improving water quality adjacent to logging operations was studied by Broderson (1973), Darling et al. (1982), Lynch et al. (1985), and Corbett and Lynch (1985). Broderson studied three watersheds in western Washington and found that 200 foot buffers, or about one site-potential tree height, would be effective to remove sediment in most situations if the buffer were measured from the edge of the floodplain.

Wildlife habitat. The Washington Department of Wildlife (1992) recommended wetland buffer widths for protection of wildlife species in that state. Roderick and Milner (1991) also prescribe wildlife protection buffer requirements for wetlands and riparian habitats in Washington. These widths vary from 100 to 600 feet depending on species and habitat usage. See appendix V-E for greater detail.

Aquatic Conservation Strategy

This conservation strategy is aimed at restoring and maintaining the ecological health of watersheds (Karr et al. 1986, Karr 1991, Naiman et al. 1992). The strategy was designed to provide a scientific basis for protecting aquatic ecosystem and enables planning for sustainable resource management. It is a region-wide strategy seeking to retain, restore, and protect those processes and landforms that contribute habitat elements to streams and promote good habitat conditions for fish and other aquatic and riparian-dependent organisms. The foundation of the conservation strategy is a refinement of the approach outlined in Thomas et al. (1993). All options under consideration, with the exception of Option 7, utilize one of three scenarios derived from this conservation strategy. These are referred to as Riparian Reserve 1, Riparian Reserve 2, and Riparian Reserve 3 and will be discussed in detail below.

An effective conservation strategy must protect aquatic ecosystem functions and processes, organized at a watershed scale, while recognizing that land ownership patterns rarely coincide with the distinct topographic boundaries of watersheds. Any conservation strategy that attempts to protect all components of the aquatic ecosystem ranging from landslides areas in the uplands to mainstem riparian forests must be extensive and comprehensive. Decision criteria for protection, monitoring and restoration must be included.

At the heart of this approach is the recognition that fish and other aquatic organisms evolved within a dynamic environment that has been constantly influenced and changed by geomorphic and ecologic disturbances. Stewardship of aquatic resources has the highest likelihood of protecting biological diversity and productivity when land use activities do not substantially alter the natural disturbance regime to which these organisms are adapted (Swanson et al. in press).

This conservation strategy employs several tactics with which to approach the goal of maintaining the "natural" disturbance regime. Land-use activities need to be limited or excluded in parts of the watershed prone to instability. The distribution of land-use activities, such as timber harvest or roads, must minimize increases in peak streamflows. Headwater riparian zones need to be protected, so that when debris slides and flows occur they contain large wood and boulders necessary for creating habitat farther downstream. Riparian zones along larger channels need protection to limit bank erosion, ensure an adequate and continuous supply of large wood to channels, and provide shade and microclimate protection. Watersheds currently containing the best habitat or with the greatest potential for recovery shall receive increased protection and be priorities for restoration programs.

Current scientific understanding of fish habitat relationships is inadequate to allow definition of specific habitat requirements for fish throughout their life cycle at the watershed level. Some general habitat needs of fish are well known, such as deep resting pools, cover, certain temperature ranges, food supply, and clean gravels for spawning (Bjornn and Reiser 1991). However, we cannot specify how these habitats and conditions should be distributed through time and space to provide for fish needs. In natural watersheds, different species and age-classes interact with multiple habitat elements in complex ways. This interaction occurs within a landscape where the quality and distribution of habitat elements change with time in relation to disturbance processes and land-use imposed changes on streams and riparian zones.

We believe that any species-specific strategy aimed at defining explicit standards for habitat elements would be insufficient for protecting even the targeted species. To succeed, any Aquatic Conservation Strategy must strive to maintain and restore ecosystem health at watershed and landscape scales. Thus, this is the approach the conservation strategy proposed here employs. This approach seeks to prevent further degradation and restore habitat over broad landscapes as opposed to individual projects or small watersheds. We emphasize, however, that **it will require time for this strategy to work.** Because it is based on natural disturbance processes, it may take decades to over a century to accomplish all of its objectives. Some improvements in aquatic ecosystems, however, can be expected in 10 to 20 years. We believe that if this approach is conscientiously implemented, it will protect habitat for fish and other riparian-dependent species resources and restore currently degraded habitats.

Aquatic Conservation Strategy Objectives

Federal lands within the range of the northern spotted owl shall be managed to:

1. Maintain and restore the distribution, diversity, and complexity of watershed and landscape-scale features to ensure protection of the aquatic systems to which species, populations and communities are uniquely adapted.

2. Maintain and restore spatial and temporal connectivity within and between watersheds. Lateral, longitudinal, and drainage network connections include floodplains, wetlands, upslope areas, headwater tributaries, and intact refugia. These linages must provide chemically and physically unobstructed routes to areas critical for fulfilling life history requirements of aquatic and riparian-dependent species.

3. Maintain and restore the physical integrity of the aquatic system, including shorelines, banks, and bottom configurations.

4. Maintain and restore water quality necessary to support healthy riparian, aquatic, and wetland ecosystems. Water quality must remain in the range that maintains the biological, physical, and chemical integrity of the ecosystem, benefitting survival, growth, reproduction, and migration of individuals composing its aquatic and riparian communities.

5. Maintain and restore the sediment regime which the aquatic system evolved. Elements of the sediment regime include the timing, volume, rate, and character of sediment input, storage, and transport.

6. Maintain and restore in-stream flows sufficient to create and sustain riparian, aquatic, and wetland habitats and to retain patterns of sediment, nutrient, and wood routing. The timing, magnitude, duration, and spatial distribution of peak, high, and low flows must be protected.

7. Maintain and restore the timing, variability, and duration of floodplain inundation and water table elevation in meadows and wetlands.

8. Maintain and restore the species composition and structural diversity of plant communities in riparian zones and wetlands to provide adequate summer and winter thermal regulation, nutrient filtering, appropriate rates of surface erosion, bank erosion, and channel migration and to supply amounts and distributions of large wood sufficient to sustain physical complexity and stability.

9. Maintain and restore habitat to support well-distributed populations of native plant, invertebrate, and vertebrate riparian-dependent species.

Quantifiable Objectives for Desired Conditions

Relationships between long-term trends in aquatic system degradation and the effects of forest management practices are well known, but quantitative relationships have been difficult to establish (Hicks et al. 1991a, Bisson et al. 1992). Due to inherent differences in stream size, storm magnitude, and geology, similar management practices may result in a different response (Hicks 1990). In addition, extended time periods and triggering climatic event may be required before the effects of land management are expressed in streams.

The wide range of natural variation of individual stream habitat variables and the complex, and little understood interplay between these (e.g., numbers of pools and pieces of large wood, percent fine sediment, and water temperature) makes it difficult to establish relevant quantitative management directives for habitat features. It is also difficult to quantify direct linkages among processes and functions outside the stream channel to in-channel conditions and biological variables.

Structural components of stream habitat must not be used as management goals in and of themselves. No target management or threshold level for these habitat variables can be uniformly applied to all streams. While this approach is appealing in its simplicity, it does not allow for natural variation among streams (Gregory et al. 1991; Rosgen 1988; Ralph et al. unpub. ms.). Furthermore, attaining the predetermined value does nothing to insure aquatic ecosystem processes are protected. These habitat parameters must be viewed collectively as part of the larger issue of watershed health and maintenance of natural physical and biological integrity (Karr 1991; Naiman et al. 1992).

An interagency effort, between the U.S. Forest Service and the Bureau of Land Management, is developing a strategy for maintaining and restoring anadromous fish habitat and watersheds. This project is establishing quantifiable objectives for desired conditions. The group is using empirical data and theoretical models to arrive at quantifiable channel, water, and riparian conditions. At the regional level, such quantifiable objectives may be appropriate to set direction for planning. However, we believe that watershed-specific objectives are necessary to accommodate natural variability along the stream network.

Components of the Strategy

The basic components of the Aquatic Conservation Strategy are:

1. **Riparian Reserves:** Lands along streams and unstable areas where special Standards and Guidelines govern land-use.

2. **Key Watersheds:** A system of large refugia comprising watersheds that are crucial to at-risk fish species and stocks and for high quality water.

3. **Watershed analysis:** Procedures for conducting analysis that evaluate geomorphic and ecologic processes operating in specific watersheds. This should enable watershed planning that achieves Aquatic Conservation Strategy Objectives. Watershed analysis provides the basis for monitoring and restoration programs and the foundation from which Riparian Reserves can be delineated.

4. **Watershed Restoration:** A comprehensive, long-term program of watershed restoration to restore watershed health, riparian ecosystems, and fish habitats.

These components are designed to operate together to maintain and restore the productivity and resilience of riparian and aquatic ecosystems. They will not achieve the desired results if implemented alone or in some limited combination.

Each of the options developed for managing federal lands within the range of the northern spotted owl (described in chapter III), include a set of Late-Successional Reserves. Total area in Late-Successional Reserves varied from 5-9 million acres depending on the option (table V-4). While these reserves were not derived for the Aquatic Conservation Strategy, they are an important component. They confer two major benefits to fish habitat and aquatic ecosystems. First, the Standards and Guidelines under which Reserves are managed limit activity in these areas; providing increased protection for all stream types. Second, since these Reserves possess late-successional characteristics, they tend to be relatively undisturbed areas although some management may have taken place in them in the past. Some Reserves offer core areas of good stream habitat in predominantly degraded landscapes that will act as refugia and centers from which degraded areas can be recolonized as they recover. Streams in these Reserves may be particularly important for endemic or locally distributed fish species and stocks.

Riparian Reserves

Riparian Reserves are portions of watersheds where riparian-dependent resources receive primary emphasis and where special Standards and Guidelines (appendix V-F) apply. Riparian Reserves include those portions of a watershed that are directly coupled to streams and rivers, that is, the portions of a watershed required for maintaining hydrologic, geomorphic, and ecologic processes that directly affect streams, stream processes, and fish habitats. Riparian Reserves include the more common land resource management riparian management zones or streamside management zones and primary

Table V-4 Land allocations by option in millions of acres.

Option	1	2	3	4	5	6	7	8	9	10
Congressionally Withdrawn	6.98	6.98	6.98	6.98	6.98	6.98	6.98	6.98	6.98	6.98
Late-Successional Reserve	11.50	8.92	8.04	8.41	6.86	7.52	5.91	7.52	7.05	7.52
Riparian Reserve	1.87	1.99	2.12	2.88	2.65	2.29	0.62	1.50	2.23	2.29
Administratively Withdrawn	1.08	1.52	1.68	1.66	2.08	1.83	2.29	1.83	1.65	1.83
Matrix	2.83	4.85	4.59	4.33	5.69	5.64	8.46	6.43	4.86	5.64
Managed Late-Successional	-	-	.85	-	-	-	-	-	-	-
Adaptive Management Areas	-	-	-	-	-	-	-	-	1.49	-
Total	24.26	24.26	24.26	24.26	24.26	24.26	24.26	24.26	24.26	24.26

source areas for wood and sediment such as landslides and landslide-prone slopes in headwater areas and along streams. Riparian Reserves generally parallel the stream network but also include other areas necessary for maintaining hydrologic, geomorphic, and ecologic processes. Riparian habitat conditions on federal lands within the range of the northern spotted owl have been degraded by road construction and land management activities.

Every watershed in National Forests and Bureau of Land Management Districts within the range of the northern spotted owl will have Riparian Reserves. Land allocated to Riparian Reserve status varies between options from 0.62 to 2.88 million acres (table V-4). It is important to note that the Riparian Reserve acreage is calculated only for land outside the Late-Successional Reserves and Congressionally Withdrawn Areas, thus if two options have identical interim widths for Riparian Reserves, the option with the larger Late-Successional Reserve system will have less Riparian Reserve acreage. For example, Options 1 and 4 both have interim Riparian Reserves of identical widths, but Option 1 has a much larger Late-Successional Reserve system and thus appears to have fewer acres in Riparian Reserves.

Maintaining the connectivity of all parts of the aquatic ecosystem is necessary for healthy watersheds and good fish habitat (Naiman et al. 1992). First- and second-order streams (Strahler 1957), which generally include permanently flowing nonfish-bearing streams and seasonally flowing or intermittent streams, often comprise over 70 percent of the cumulative channel length in mountain watersheds in the Pacific Northwest (Benda et al. 1992). These streams are sources of water, nutrients, wood, and other vegetative material for streams inhabited by fish and other aquatic organisms (Swanson et al. 1982; Benda and Zhang 1990; Vannote et al. 1980). Decoupling the stream network can result in the disruption and loss of functions and processes necessary for creating and maintaining fish habitat. Under this conservation strategy, Riparian Reserves are used, in part, to maintain and restore riparian structures and functions of intermittent streams.

Riparian Reserves will confer benefits to riparian-dependent and associated species other than fish. They will enhance habitat conservation for organisms that are dependent on the transition zone between upslope and riparian areas. Improved travel and dispersal corridors for many terrestrial animals and plants and a greater connectivity of the watershed should also result from establishment of Riparian Reserves.

Tree heights and slope distance provide ecologically appropriate metrics with which to establish Riparian Reserve widths. For example, tree height distance away from the stream is a better indicator of potential wood recruitment or degree of shade than is an arbitrary distance. Likewise, slope distance is a more meaningful ecological distance than horizontal distance.

Thomas et al. (1993) used specified widths, geomorphic features, or a distance equal to the height of a site-potential tree to delineate riparian areas. They defined a site-potential tree as a tree that has attained the maximum height possible given the site conditions where it occurs. We redefined the height of a site-potential tree as the average maximum height of the tallest dominant trees (200 years or more) for a given site class. Johnson et al. (1993 in prep.) used data collected in a 1978 Bureau of Land Management riparian forest inventory to estimate this height for various sites. National Forests and Bureau of Land Management Districts identified the site classes of riparian areas on lands under their jurisdiction. For all forests west of the Cascades, except the

Siuslaw National Forest, site-class IV was used. The height of a site-potential tree in these areas was 170 feet. The Siuslaw National Forest was classified as a site-class II for which a site-potential tree was 250 feet. The height of site-potential trees on forests east of the Cascades was estimated at 110 feet. These heights were used to delineate interim widths of Riparian Reserves for analysis purposes. Further analysis of plots from forest inventories for the Siuslaw, Willamette, and Olympic National Forests indicate the tallest tree heights were about 10 percent less than in the Bureau of Land Management riparian inventory. Forest-specific riparian inventories are needed to better determine the height of a site-potential tree for a given area. Tree heights used in this effort are probably an upper limit (See Johnson et al. 1993 for further details.)

Prescribed widths for Riparian Reserves of different waterbodies were determined based on several ecological and geomorphic factors. Watershed analysis will identify critical hillslope, riparian, and channel processes that must be evaluated in order to delineate Riparian reserves that assure protection of riparian and aquatic functions. Project level considerations of these processes and features will be the basis on which site-specific Riparian Reserves are delineated. We have established a set of interim widths of Riparian Reserves for all watersheds that apply until watershed analysis is completed, a site-specific analysis is conducted and described, and the rationale for final Riparian Reserve boundaries is presented. Interim widths are designed to provide a high level of fish habitat and riparian protection until watershed and project analysis can be completed.

Five types of streams or water bodies and interim widths of Riparian Reserves for each are:

- *Fish-bearing streams* - Riparian Reserves consist of the stream and the area on either side of the stream extending from the edges of the active stream channel to the top of the inner gorge, or to the outer edges of the 100-year floodplain, or to the outer edges of riparian vegetation, or to a distance equal to the height of two site-potential trees, or 300 feet slope distance (600 feet, including both sides of the stream channel), whichever is greatest. This is the same in all Riparian Reserve scenarios.

- *Permanently flowing nonfish-bearing streams* - Riparian Reserves consist of the stream and the area on either side of the stream extending from the edges of the active stream channel to the top of the inner gorge, or to the outer edges of the 100-year floodplain, or to the outer edges of riparian vegetation, or depending upon the Riparian Reserve scenario - a distance equal to the height of some fraction of a site-potential tree, or a specified slope distance (table V-5), whichever is greatest.

- *Constructed ponds and reservoirs, and wetlands greater than 1 acre* - Riparian Reserves consist of the body of water or wetland and the area from the outer edges of the riparian vegetation, or to the extent of seasonally saturated soil, or to the extent of moderately and highly unstable areas, or to a distance equal to the height of one site-potential tree, or 150 feet slope distance for wetlands greater than 1 acre, and from the edge of the maximum pool elevation of constructed ponds and reservoirs, whichever is greatest. This is the same in all Riparian Reserve scenarios.

- *Lakes and natural ponds* - Riparian Reserves consist of the body of water or wetland and the area from the outer edges of the riparian vegetation, or to the extent of seasonally saturated soil, or to the extent of moderately and highly unstable areas, or to a distance equal to the height of two site-potential trees, or 300 feet slope distance, whichever is greatest. This is the same in all Riparian Reserve scenarios.

- *Seasonally flowing or intermittent streams, wetlands less than 1 acre, and unstable and potentially unstable areas* - This category applies to features with high variability in size and site-specific characteristics. At a minimum, the Riparian Reserve must include:

    - The extent of unstable and potentially unstable areas.

    - The stream channel and extend to the top of the inner gorge.

    - The stream channel or wetland and the area from the edges of the stream channel or wetland to the outer edges of the riparian vegetation.

    - Depending upon the Riparian Reserve scenario, extension from the edges of the stream channel to a distance equal to the height of some fraction of a site-potential tree, or a specified slope distance, whichever is greatest (table V-5).

Three scenarios were developed that define Interim Widths of Riparian Reserves (table V-5). These scenarios differ with respect to Interim widths for streams in Key and non-Key Watersheds (see Key Watershed discussion that follows). These scenarios are components of the set of options defined in chapter III. Interim widths of Riparian Reserves on permanently flowing, fish-bearing streams are identical for all three scenarios. For permanently flowing, nonfish-bearing streams, interim widths for scenarios 1 and 2 are identical, while those for scenario 3 are defined as one half that of the other two.

The greatest difference among scenarios is in interim widths defined for intermittent streams. In both Riparian Reserve scenarios 1 and 3 the interim widths on intermittent streams do not vary between Key and non-Key Watersheds. However, the interim widths for these streams prescribed in scenario 1 are six times greater than in scenario 3 (table V-5). In Riparian Reserve scenario 2, interim widths within Tier 1 Key Watersheds are the same as in scenario 1. In all other watersheds, scenario 2 widths are one half those defined for scenario 1.

Intermittent streams. Intermittent streams are an important, and often over-looked, component of aquatic ecosystems (Naiman et al. 1992). Intermittent streams are defined as any non-permanently flowing drainage features having a definable channel and evidence of annual scour or deposition. This includes what are sometimes referred to as ephemeral streams if they meet these two criteria. Several important ecological processes occur in them, including storage and processing of organic materials, the products of which are later transported to downstream areas. Intermittent streams store sediment and wood and are sources of these materials for permanently flowing streams.

Table V-5. Minimum widths of Riparian Reserves expressed as whichever slope distance is greatest. In addition, Riparian Reserves must include the 100-year floodplain, inner gorge, unstable and potentially unstable areas. See text for other criteria used to determine Riparian Reserve widths. Options to which Riparian Reserve scenario apply are also listed.

Riparian Reserve Scenario	Stream class	Tier 1 Key watershed	Tier 2 Key watershed	All other watersheds
Riparian Reserve 1 Options 1,4	Fish Bearing Streams	Average Height of Two Site Potential Trees or 300 Feet	Average Height of Two Site Potential Trees or 300 Feet	Average Height of Two Site Potential Trees or 300 Feet
Riparian Reserve 1 Options 1,4	Permanently Flowing Non-Fish Bearing Streams	Average Height of One Site Potential Tree or 150 Feet	Average Height of One Site Potential Tree or 150 Feet	Average Height of One Site Potential Tree or 150 Feet
Riparian Reserve 1 Options 1,4	Intermittent Streams	Average Height of One Site Potential Tree or 100 Feet	Average Height of One Site Potential Tree or 100 Feet	Average Height of One Site Potential Tree or 100 Feet
Riparian Reserve 2 Options 2,3,5,6,9,10	Fish Bearing Streams	Average Height of Two Site Potential Trees or 300 Feet	Average Height of Two Site Potential Trees or 300 Feet	Average Height of Two Site Potential Trees or 300 Feet
Riparian Reserve 2 Options 2,3,5,6,9,10	Permanently Flowing Non-Fish Bearing Streams	Average Height of One Site Potential Tree or 150 Feet	Average Height of One Site Potential Tree or 150 Feet	Average Height of One Site Potential Tree or 150 Feet
Riparian Reserve 2 Options 2,3,5,6,9,10	Intermittent Streams	Average Height of One Site Potential Tree or 100 Feet	Average Height of One-half Site Potential Tree or 50 Feet	Average Height of One-half Site Potential Tree or 50 Feet
Riparian Reserve 3 Option 8	Fish Bearing Streams	Average Height of Two Site Potential Trees or 300 Feet	Average Height of Two Site Potential Trees or 300 Feet	Average Height of Two Site Potential Trees or 300 Feet
Riparian Reserve 3 Option 8	Permanently Flowing Non-Fish Bearing Streams	Average Height of One-half Site Potential Tree or 75 Feet	Average Height of One-half Site Potential Tree or 75 Feet	Average Height of One-half Site Potential Tree or 75 Feet
Riparian Reserve 3 Option 8	Intermittent Streams	Average Height of 1/6 Site Potential Tree or 25 Feet	Average Height of 1/6 Site Potential Tree or 25 Feet	Average Height of 1/6 Site Potential Tree or 25 Feet

Removing the connection between intermittent and permanently flowing streams may have detrimental consequences to the physical and biological components of stream ecosystems, particularly in the long-term.

Intermittent streams and adjacent areas are often the lands prone to slope stability problems in a watershed. Protection of intermittent streams is important for preventing increased rate and frequency of landslides in time and space, preventing accelerated surface and fluvial erosion, providing habitat for species unique to small stream riparian areas, and maintaining the landslide- and flood-delivered supplies of large woody material throughout the landscape.

The width of Riparian Reserves necessary to protect the ecological integrity of intermittent streams varies with slope and rock type. Figure V-14 shows the estimated size of Riparian Reserves necessary to protect the ecological values of intermittent streams with different slope and rock types. These estimates were made by geomorphologists, hydrologists, and fish biologists from the Bureau of Land Management, U.S. Forest Service, and the U.S. Environmental Protection Agency. These distances are consistent with the height of 1 site-potential tree discussed previously.

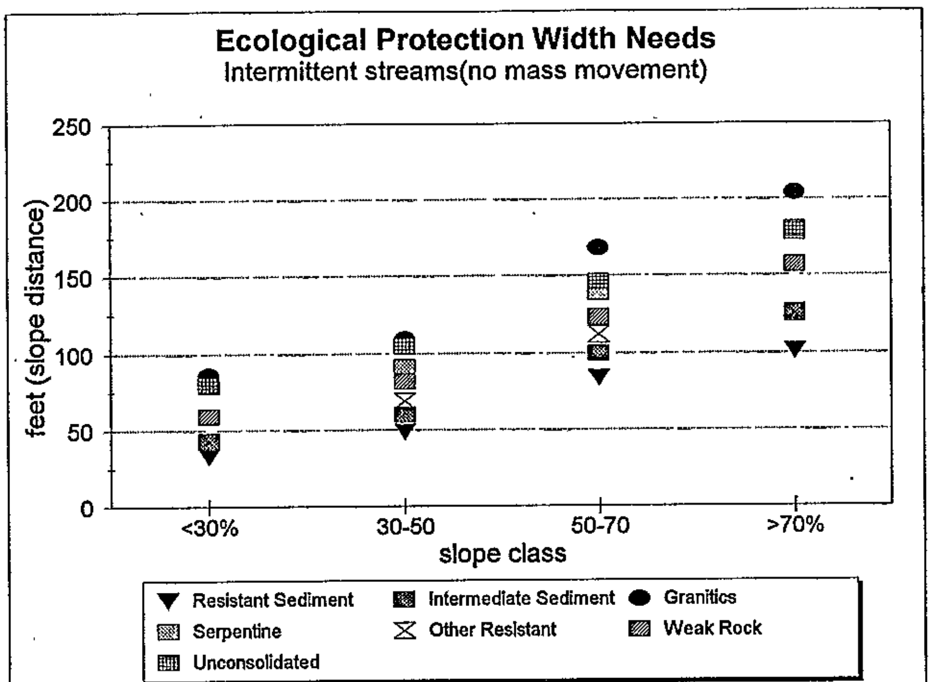

Figure V-14. Ecological protection needs for intermittent streams, by slope class and rock type. Values are the widths, and slope distance of streamside protection area needed for reasons other than slope stability as estimated by an interagency team of scientists based on professional judgement and experience. Protection needs included surface erosion of streamside slopes, fluvial erosion of the stream channel, soil productivity, habitat for riparian-dependent species, the ability of streams to transmit damage downstream, and the role of streams in the distribution of large wood to downstream fish-bearing waters.

The extent of intermittent streams on public lands is difficult to determine because: (1) no systematic inventory has been conducted using consistent criteria for defining or delineating channels on topographic maps; (2) topographic maps show many of the larger scale declivities in the landscape, but not all declivities are streams and not all streams that exist are shown on the maps; and (3) field inventory of the extent of intermittent streams is costly and the variability is so high that broad extrapolations to unsampled areas is questionable.

Both the Bureau of Land Management and U.S. Forest Service have estimates of the number of intermittent stream miles on lands under their jurisdiction but agency hydrologists believe these to be low. For this current effort, we sampled selected watersheds from National Forests and Bureau of Land Management Districts to estimate miles of intermittent channels. Using this procedure (described fully in appendix V-G) we estimate densities of intermittent streams on federal lands within the range of the northern spotted owl that are about 90 percent greater than previously estimated by the agencies.

Examples of extent of Riparian Reserves and Riparian Areas. Interim Riparian Reserves vary with Riparian Reserve scenario. The interim Riparian Reserve network under the scenarios 1 and 2 are demonstrated for Augusta Creek, Oregon in figures V-15 and V-16. Riparian Reserve scenario 2 is for non-Key Watersheds only. In addition, riparian areas similar to those used in Bureau of Land Management Land Management Plans and the Willamette National Forest Plan are displayed for Augusta Creek in figures V-17 to V-18, respectively.

Drainage basin area included within Interim Riparian Reserves and riparian areas varies among the management alternatives considered, ranging from 8.5 to 53 percent (table V-6). The major difference between management alternatives is due to the amount of intermittent streams included and the width of prescribed area along these streams.

Watershed analysis provides the ecological and geomorphic basis for changing the size and location of Interim Riparian Reserves. Figure V-19 illustrates how slope-stability and debris flow runout models may be used as part of watershed analysis in establishing Riparian Reserves. The result is that the basin is stratified into areas that may require wider or narrower Riparian Reserves than those prescribed for the interim. For example, on intermittent streams in unstable areas with high potential to generate slides and debris flows, Riparian Reserves wider than those prescribed for the interim may be necessary to ensure ecological integrity. Riparian Reserves in more stable areas may be less extensive, managed under upland standards and guides (e.g., levels of green tree retention as either single trees or in specified size patches), or a combination of these. The ultimate design of Riparian Reserves is likely to be a hybrid of decisions based on consideration of sites of special ecological value, slope stability, and natural disturbance processes.

Within a given physiographic province, similar geographic and topographic features control drainage network and hillslope stability patterns. These features may exert a strong influence on design of Riparian Reserves. For example, in the highly dissected southern Oregon Coast Range, debris flows originating in channel heads are the primary mass movement process. Large, slow-moving earthflows are dominant in the western Oregon Cascades. To adequately protect the aquatic system from management induced landsliding, riparian reserve design may vary as a result of these differences. In the

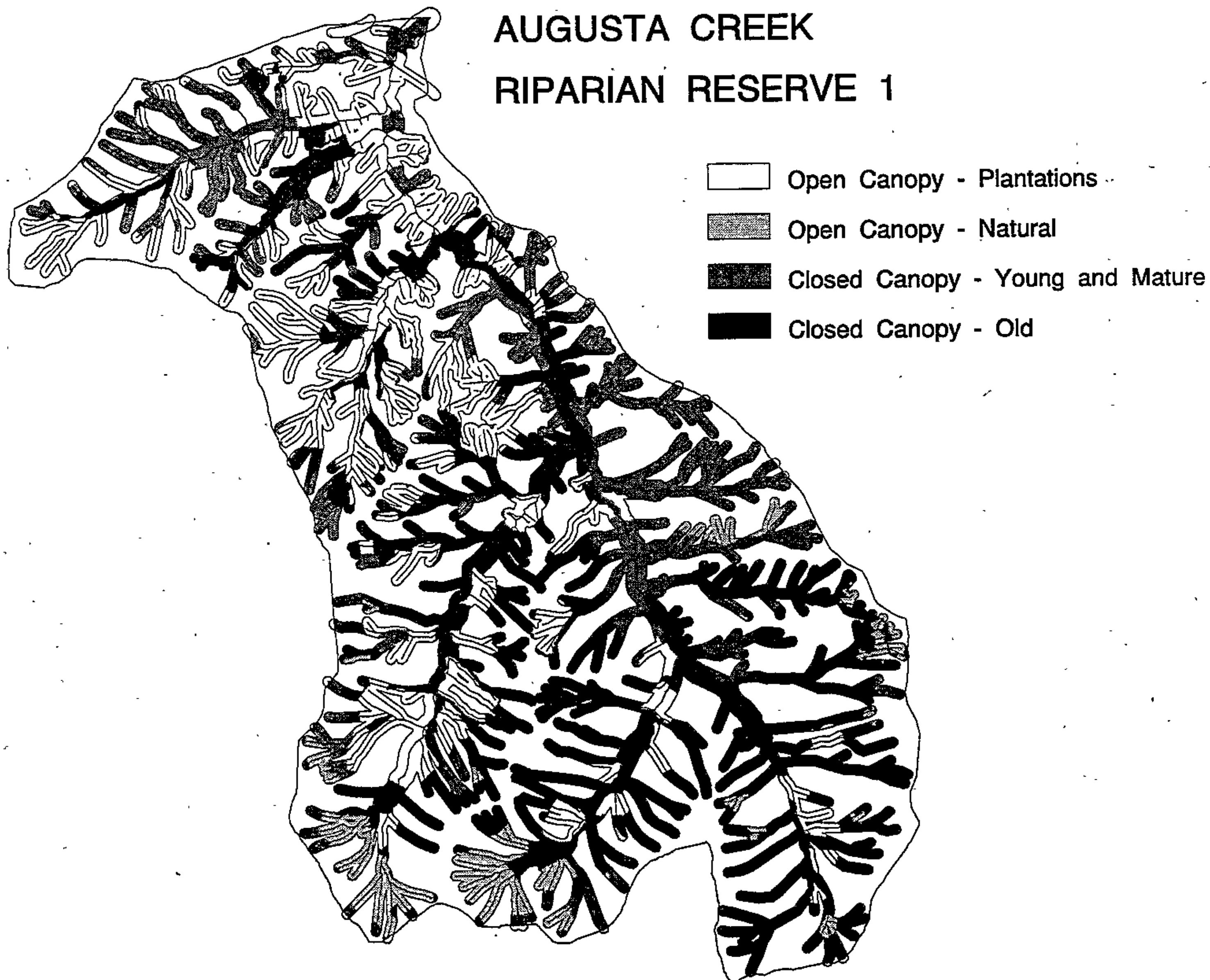

Figure V-15. Augusta Creek watershed with Riparian Reserves 1.

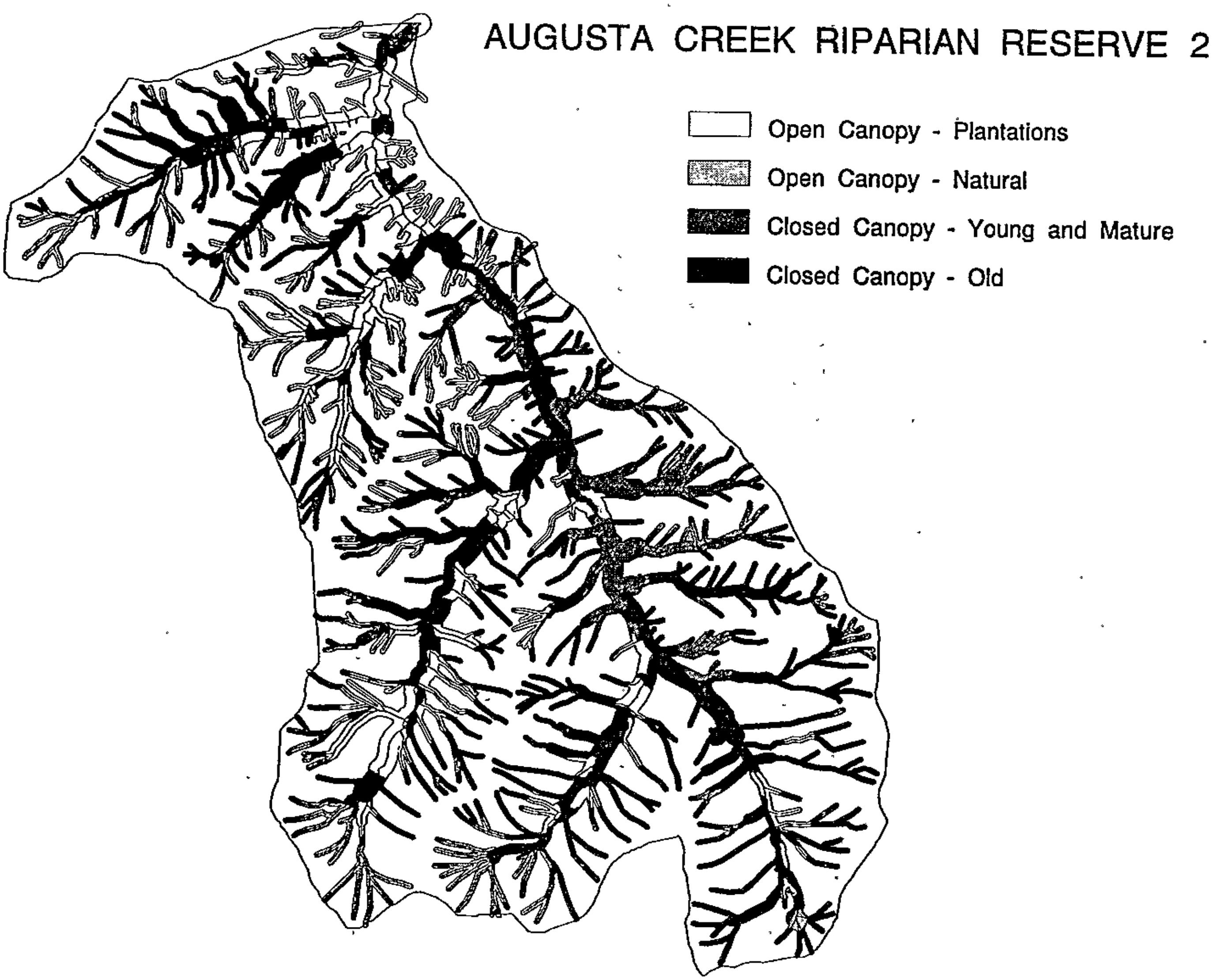

Figure V-16. Augusta Creek watershed with Riparian Reserves 2.

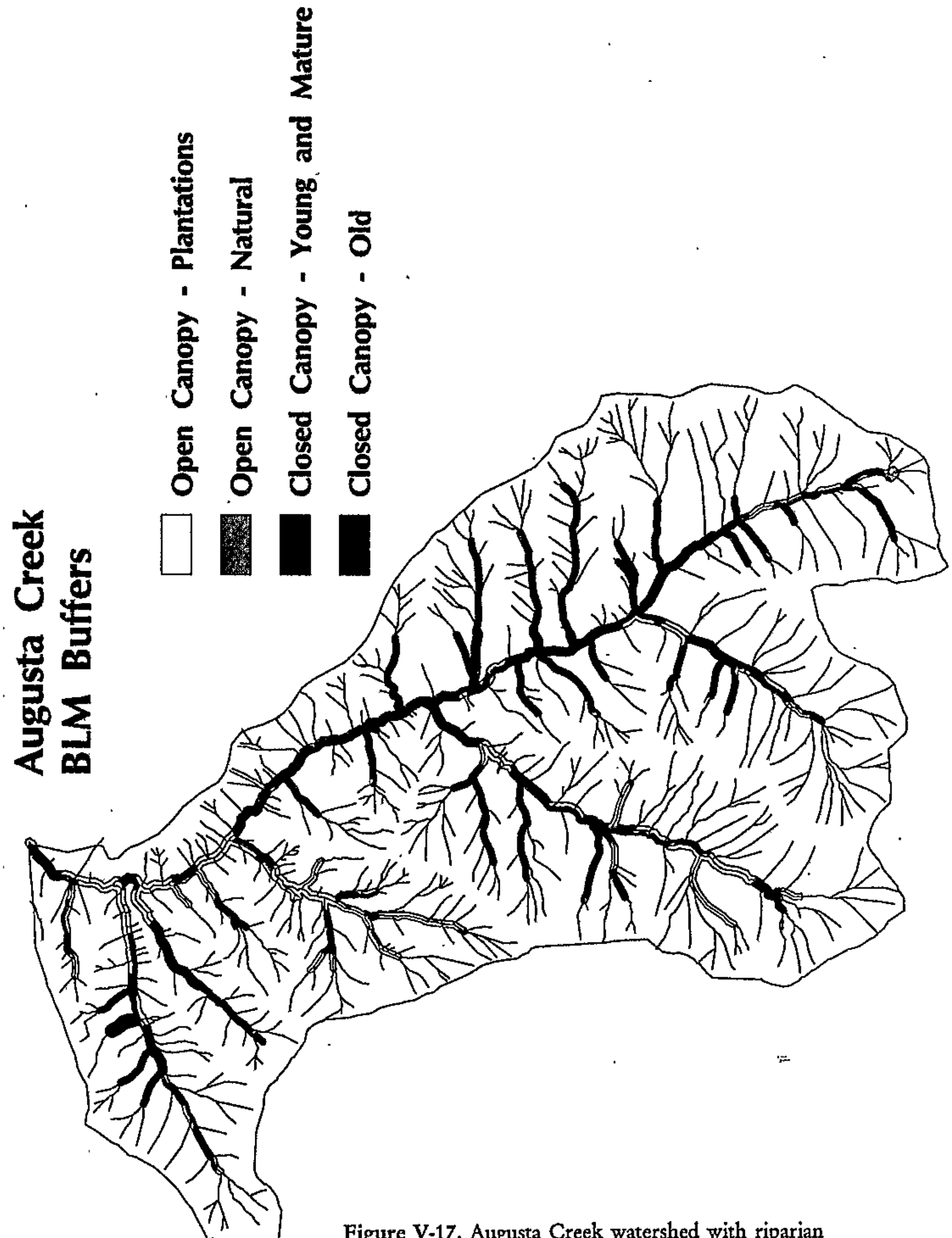

Figure V-17. Augusta Creek watershed with riparian buffers from proposed Bureau of Land Management plans.

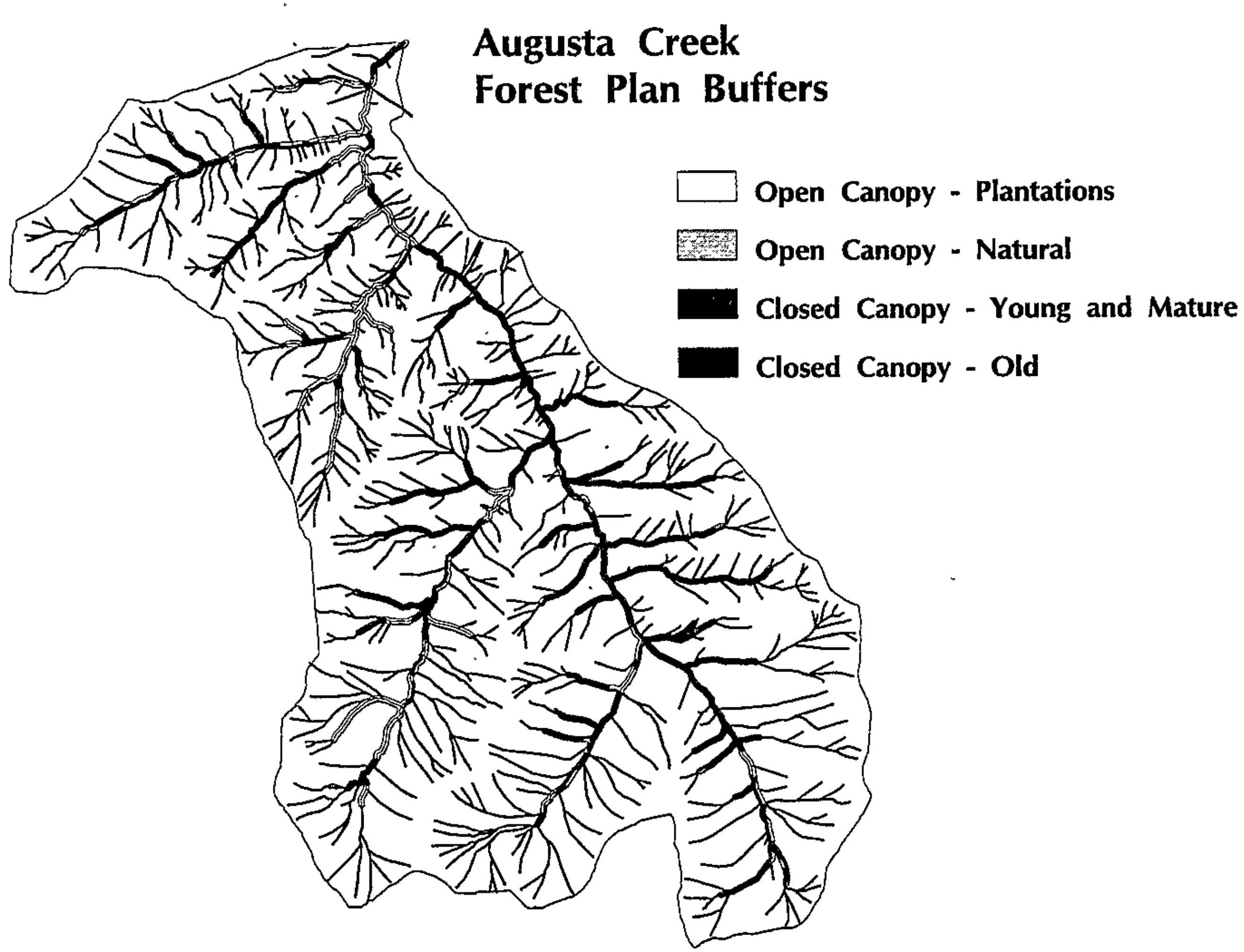

Figure V-18. Augusta Creek watershed with riparian buffers from the Willamette National Forest plan.

Table V-6. Riparian Reserve widths (one side of stream). Percent of basin area in Riparian Reserves or Areas are from Augusta Creek, Oregon.

Stream Category	Interior Widths (feet) of Riparian Reserve and Riparian Areas			
	Bureau of Land Management	Willamette National Forest Plan	Riparian Reserve 2 Non-Key Watershed	Riparian Reserve 1
High value, permanently flowing, fish bearing	225	200	340	340
Lower value, permanently flowing, fish bearing	150	100	340	340
Permanently flowing, non-fish bearing	100	100	170	170
Intermittent	0	25	85	170
Percent of area in Riparian Reserves or riparian areas	8.5	14	36	53

Coast Range, Riparian Reserves would tend to be in narrow bands associated with intermittent streams, relatively evenly distributed throughout the basin, while those in the Cascades may be locally extensive and centered around earthflows. Stable areas in other parts of the watershed may have reduced Riparian Reserves on intermittent streams.

We emphasize that the interim widths for Riparian Reserves are applied to all streams on National Forest and Bureau of Land Management lands within the range of the northern spotted owl until a watershed analysis can be completed. Watershed analysis is expected to yield the contextual information needed to define ecologically and geomorphically appropriate Riparian Reserves. Analysis of site specific characteristics may warrant Riparian Reserves that are narrower or wider than the interim widths. Although Riparian Reserve boundaries may be adjusted on permanently flowing streams, we consider the interim widths to approximate those necessary for attaining Aquatic Conservation Strategy Objectives. As we have demonstrated, intermittent streams may be highly variable in the degree to which a particular stream affects the hydrologic, geomorphic and ecologic processes in a watershed. Thus, it is possible to meet Aquatic Conservation Strategy Objectives with post-analysis reserve boundaries that are quite different from the interim. Regardless of stream type, changes to Riparian Reserves must be based on scientifically sound reasoning, fully justified and documented.

Once the Riparian Reserve width is established, either based on interim widths or watershed analysis, then land management activities allowed in the Riparian Reserve will be governed by Standards and Guidelines for managing Riparian Reserves

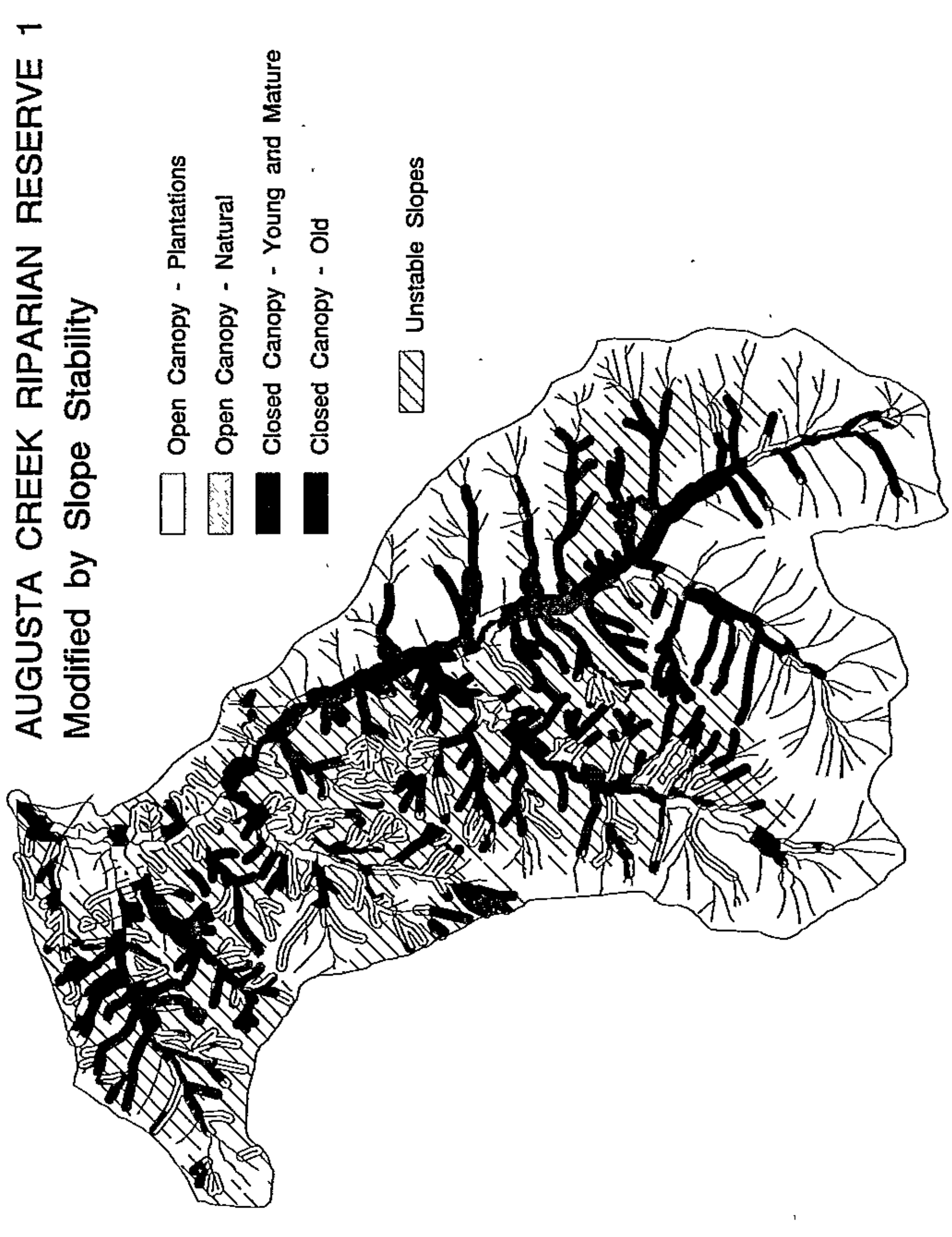

Figure V-19. Augusta Creek watershed with Riparian Reserve 1 modified by slope stability considerations.

(appendix V-F). These Standards and Guidelines prohibit activities in Riparian Reserves that retard or prevent attainment of the Aquatic Conservation Strategy Objectives.

Key Watersheds

Refugia, or designated areas providing high quality habitat, either currently or in the future, are a cornerstone of most species conservation strategies. Although fragmented areas of suitable habitat may be important, Moyle and Sato (1991) argue that to recover aquatic species, refugia should be focused at a watershed scale. Naiman et al. (1992), Sheldon (1988) and Williams et al. (1989) noted that past attempts to recover fish populations were unsuccessful because the problem was not approached from a watershed perspective.

A system of Key Watersheds that serves as refugia is crucial for maintaining and recovering habitat for at-risk stocks of anadromous salmonids and resident fish species, particularly in the short term. These refugia will include areas of good habitat as well as areas of degraded habitat. Areas presently in good condition serve as anchors for the potential recovery of depressed stocks. Those of lower quality habitat should have a high potential for restoration and will become future sources of good habitat with the implementation of a comprehensive restoration program (Component 4).

Johnson et al. (1991) identified a network of Key Watersheds located on U.S. National Forest lands throughout the range of the northern spotted owl. These watersheds contain at-risk fish species and stocks and either good habitat, or if habitat is in a degraded state, have a high restoration potential (Reeves and Sedell 1992). U.S. Forest Service fish biologists have since deleted some watersheds identified by Johnson et al. (1991) and added others as new information was incorporated and an overall design developed. Watersheds on Bureau of Land Management land have also been included as Key Watersheds. Current recommendations are reflected in figures V-20-22. (Appendix V-H lists all Key Watersheds.) A total of 162 Key Watersheds were designated that cover 8.7 million acres or approximately one third of the federal land within the range of the northern spotted owl (table V-7). Option 7 is the only option for which Key Watersheds were not designated.

The conservation strategy proposed here uses two designations for Key Watersheds: Tier 1 and Tier 2. Tier 1 Key Watersheds are specifically selected for directly contributing to conservation of habitat for at-risk anadromous salmonids, bull trout and resident fish species. The network of 139 Tier 1 Key Watersheds ensures that refugia are widely distributed across the landscape. Twenty-three Tier 2 Key Watersheds were identified. These may not contain at-risk fish stocks, but were selected as important sources of high quality water.

Because Key Watersheds maintain the best of what is left and have the highest potential for restoration, they are given special consideration. All Key Watersheds require watershed analysis prior to further resource management activity; except that in the short-term, until watershed analysis can be completed, minor activities such as those that would be Categorically Excluded under National Environmental Policy Act regulations may proceed if they are consistent with Aquatic Conservation Strategy Objectives and applying Interim Riparian Reserves and Standards and Guidelines. Key Watersheds that currently contain poor habitat are believed to have the best opportunity for successful restoration and will receive priority in any watershed restoration program.

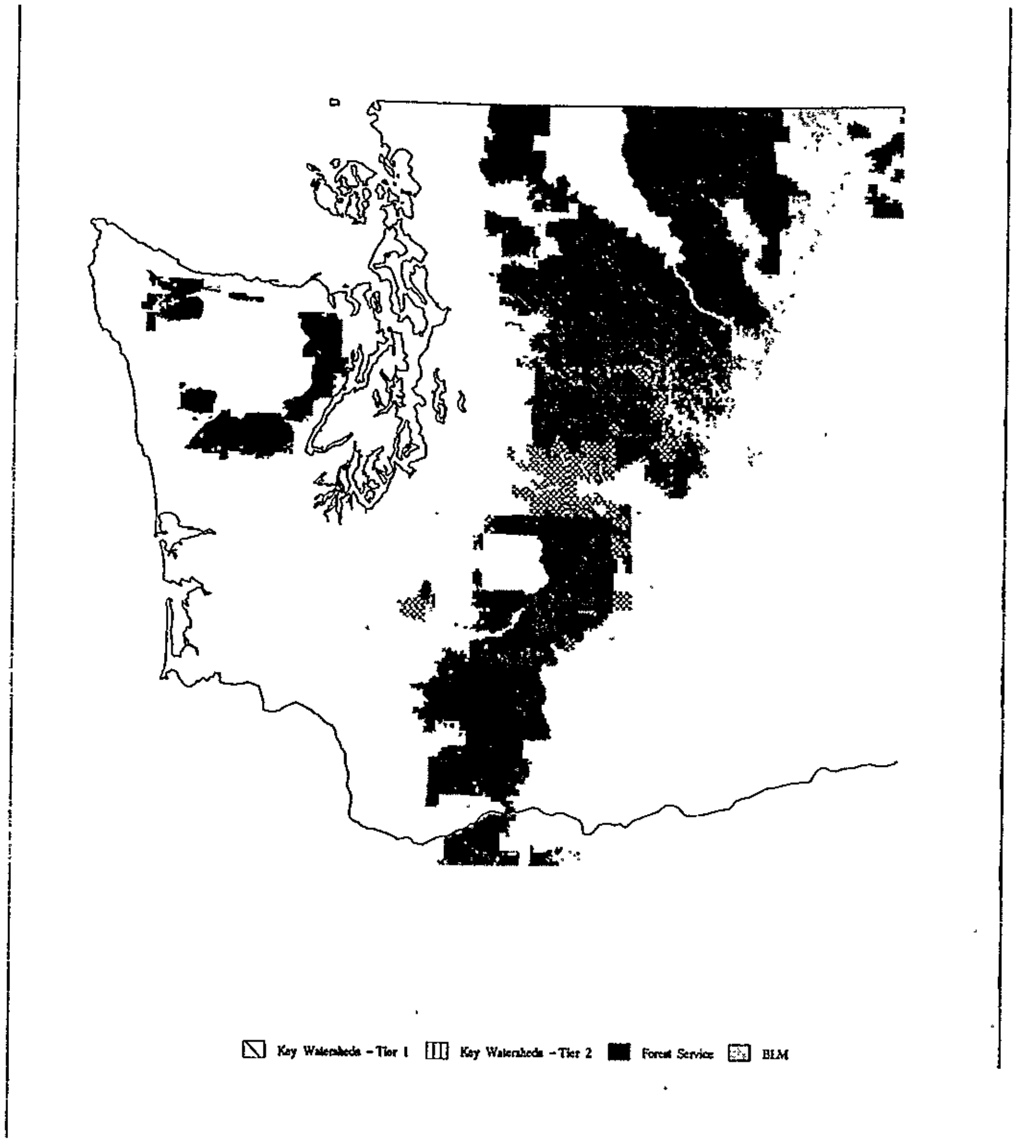

Figure V-20. Washington Key Watersheds.

Figure V-21. Oregon Key Watersheds.

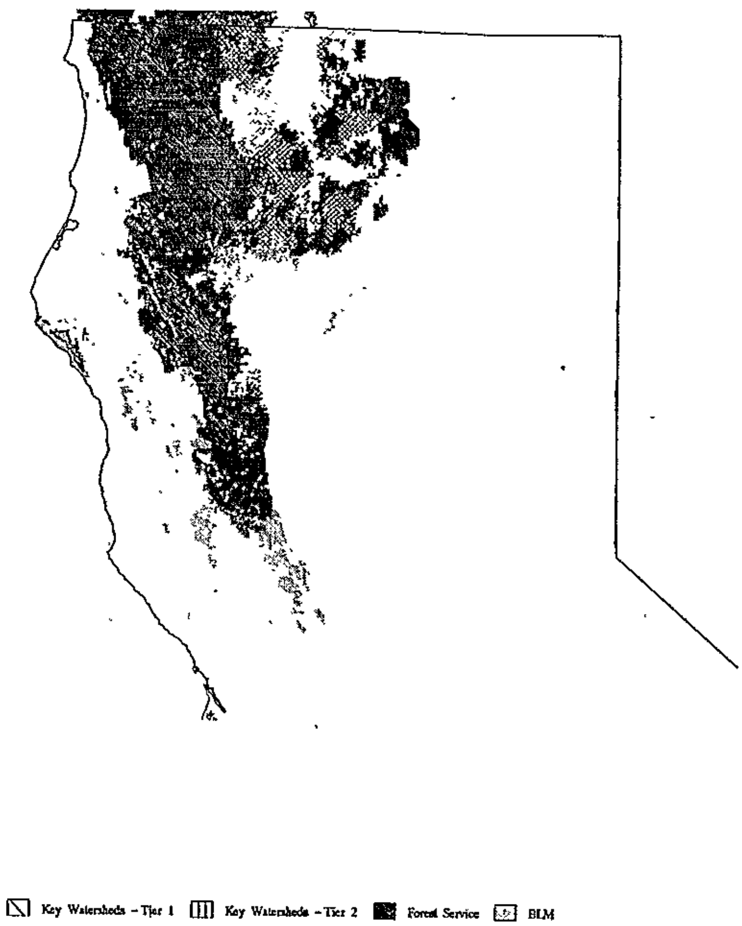

Figure V-22. California Key Watersheds.

Table V-7. Area of Key Watersheds in each state and physiographic province.

State/ Physiographic province	Total acres federal land	Tier 1 Watershed Total acres	Tier 1 Watershed Percent of total federal land	Tier 2 Watershed Total acres	Tier 2 Watershed Percent of total federal land
Washington					
Eastern Cascades	3,472,400	1,573,600	45	54,700	2
Western Cascades	3,721,700	1,468,300	39	219,000	6
Western Lowlands	126,300	0	0	0	0
Olympic Peninsula	1,518,800	218,900	14	48,400	3
Total:	**8,839,200**	**3,260,800**	**37**	**322,100**	**4**
Oregon					
Klamath	2,106,200	573,000	27	0	0
Eastern Cascades	1,557,400	246,800	16	214,200	14
Western Cascades	4,478,200	1,269,400	28	334,600	7
Coast Range	1,396,800	346,600	25	0	0
Willamette Valley	25,600	400	2	0	0
Total:	**9,564,200**	**2,436,200**	**25**	**548,800**	**6**
California					
Coast Range	388,200	56,500	15	0	0
Klamath	4,459,900	2,044,200	46	0	0
Cascades	1,009,200	0	0	0	0
Total:	**5,857,300**	**2,100,700**	**36**	**0**	**0**
Three-State Total:	**24,260,700**	**7,797,700**	**32**	**870,900**	**4**

Roadless areas and Key Watersheds. Over 3 million acres of inventoried roadless areas exist within National Forests in the range of the northern spotted owl (table V-8). Over 50 percent of this area is in Key Watersheds, with about 48 percent contained in Tier 1 Key Watersheds (table V-8).

The potential disturbance to Key Watersheds from activities in roadless areas can be estimated by calculating the timber-suitable roadless acres in the general Matrix of the northern spotted owl forests. The percentage of the total roadless area which is in the Matrix varies by option from 8 percent for Option 1, to 25 percent for Option 7 (table V-9). The percentage of the total roadless area that is in the Matrix and is suitable for timber harvest ranges from 4 percent in Option 1 to 17 percent in Option 7 (table V-9). If we assume that half of the timber-suitable Matrix of roadless areas are in Key Watersheds, there are an estimated 69,000 timber suitable acres in roadless areas in Option 1 to about 256,000 timber suitable acres in roadless areas in Option 7 in Key Watersheds.

Roadless areas are often characterized by significant amounts of unstable land. For example, roadless areas in the northern half of the Wenatchee National Forest are classified as 69 percent unstable land. The southern half of the same Forest has 30 percent of its roadless areas classified as unstable. Roadless areas of the Okanogan National Forest average 54 percent unstable, the Klamath National Forest 23-28 percent unstable, the Siskiyou National Forest 16 percent unstable, the Umpqua National Forest 18 percent unstable, the Willamette National Forest between 7-20 percent unstable, and the Trinity portion of the Shasta-Trinity National Forest over 20 percent unstable. Most of these unstable areas are considered inoperable because timber harvest and road construction could cause irretrievable loses of soil productivity and other watershed values. These lands consist of erosion and landslide-prone landforms such as inner gorges, unstable portions of slump-earthflow deposits, deeply weathered and dissected weak rocks, and headwalls.

Management activities in roadless areas will increase the risk to aquatic and riparian habitat, potentially impair the capacity of Key Watersheds to function as intended, and limit the potential to achieve Aquatic Conservation Strategy objectives. Of these management activities, roads represent the greatest risk to riparian and aquatic systems; much greater than timber harvest alone. Timber harvest can increase rates of mass movement several-fold (Ice 1985; Swanson et al. 1987). Road construction increases the rates of landsliding from 30-350 fold (Sidle et al. 1985).

To protect the remaining high quality habitats, no new roads will be constructed in roadless areas in Key Watersheds under all options except Option 7 and 8 (chapter III). We also recommend that there be a reduction in existing road mileage within Key Watersheds. If sufficient funding does not become available for this reduction, we recommend that there shall be at least be no net increase in road mileage in Key Watersheds. That is, if a mile of new road is constructed, at least 1 mile of road shall be removed, with priority for removing roads that pose the greatest risks to riparian and aquatic ecosystems. Watershed analysis must be conducted in all non-Key Watersheds that contain roadless area before any land management activities can occur within the roadless area.

Table V-8. Roadless acreage in Key Watersheds on National Forests within the range of northern spotted owl.[a]

		ROADLESS ACRES			
	Forest	Within Tier 1 Key Watersheds	Within Tier 2 Key Watersheds	Outside Key Watersheds	Total Roadless
Region 6	Gifford Pinchot	53,436	31,968	124,503	209,907
	Mt. Baker-Snoqualimie	214,879	0	169,654	384,533
	Okanogan	128,834	0	142,507	271,341
	Olympic	45,015	3,869	43,200	92,084
	Wenatchee	273,214	0	257,041	530,255
	Deschutes	10,351	13,987	75,232	99,570
	Mt. Hood	47,542	24,783	63,351	135,676
	Rogue River	15,567	0	58,530	74,097
	Siskiyou	143,307	0	136,345	279,652
	Siuslaw	22,056	0	3,435	25,491
	Umpqua	48,932	0	48,336	97,268
	Willamette	41,928	10,461	90,945	143,334
	Winema	1,615	1,934	17,342	20,891
Region 5	Klamath	154,804	0	99,096	253,900
	Mendocino	10,869	0	33,399	44,268
	Trinity	75,022	0	87,511	162,533
	Six Rivers	157,009	0	37,226	194,235
	Total	1,444,380	87,002	1,487,653	3,019,035
	Percent of Total	48%	3%	49%	

[a] Figures do not include the Shasta portion of the Shasta-Trinity National Forest

Table V-9. Roadless area in the Matrix in Washington, Oregon and California within the northern spotted owl range.

	Matrix[a]		Matrix: Timber suitable within long rotation areas[b]		Matrix: Timber suitable (includes long rotation areas)	
Option	Acres	As % of total roadless acres	Acres	As % of total roadless acres	Acres	As % of total roadless acres
1	247,880	8%	140,206	5%	140,206	5%
2	394,649	13%	115,775	4%	258,872	9%
3	497,532[c]	16%	-	-	354,834	12%
4	460,182	15%	-	-	308,939	10%
5	618,055	20%	-	-	415,156	14%
6	511,489	17%	147,422	5%	346,206	11%
7	753,696	25%	-	-	511,859	17%
8	511,489	17%	-	-	346,206	11%
9	685,323[d]	23%	-	-	454,955	15%

[a] Does not include the Shasta half of the Shasta-Trinity National Forest.
[b] Suitable is defined as physically suitable for timber harvest outside of Late-Successional Reserves, and Congressionally and Administratively Withdrawn Areas. We did not subtract Riparian Reserve acreage from these matrix numbers.
[c] Includes roadless area in Managed Reserves.
[d] Includes roadless area in Adaptive Management Areas.

Watershed Analysis

Watershed analysis and its role in protecting aquatic habitat. In planning for ecosystem management and establishing Riparian Reserves to protect and restore riparian and aquatic habitat, the overall watershed condition and the suite of processes operating there need to be considered. Watershed condition includes more than just the state of the channel and riparian zone. It also includes the condition of the uplands, distribution and type of seral classes of vegetation, land use history, effects of previous natural and land-use related disturbances, and distribution and abundance of species and populations throughout the watershed. These factors strongly influence the structure and functioning of aquatic and riparian habitat (Naiman et al. 1992). Effective protection strategies for riparian and aquatic habitat on federal lands must accommodate the wide variability in landscape conditions present across the Pacific Northwest. Watershed analysis plays a key role in the Aquatic Conservation Strategy, ensuring that aquatic system protection is fitted to specific landscapes.

Watershed analysis is a systematic procedure for characterizing watershed and ecological processes to meet specific management and social objectives. This information then may guide management prescriptions, including setting and refining boundaries of riparian and other reserves, developing restoration strategies and priorities, and revealing the most useful indicators for monitoring environmental changes. Watershed analysis is a stratum of ecosystem planning applied to watersheds of approximately 20-200 square miles (fig. V-23). It is a key component in watershed planning, a process for melding social expectations with the biophysical capabilities of specific landscapes.

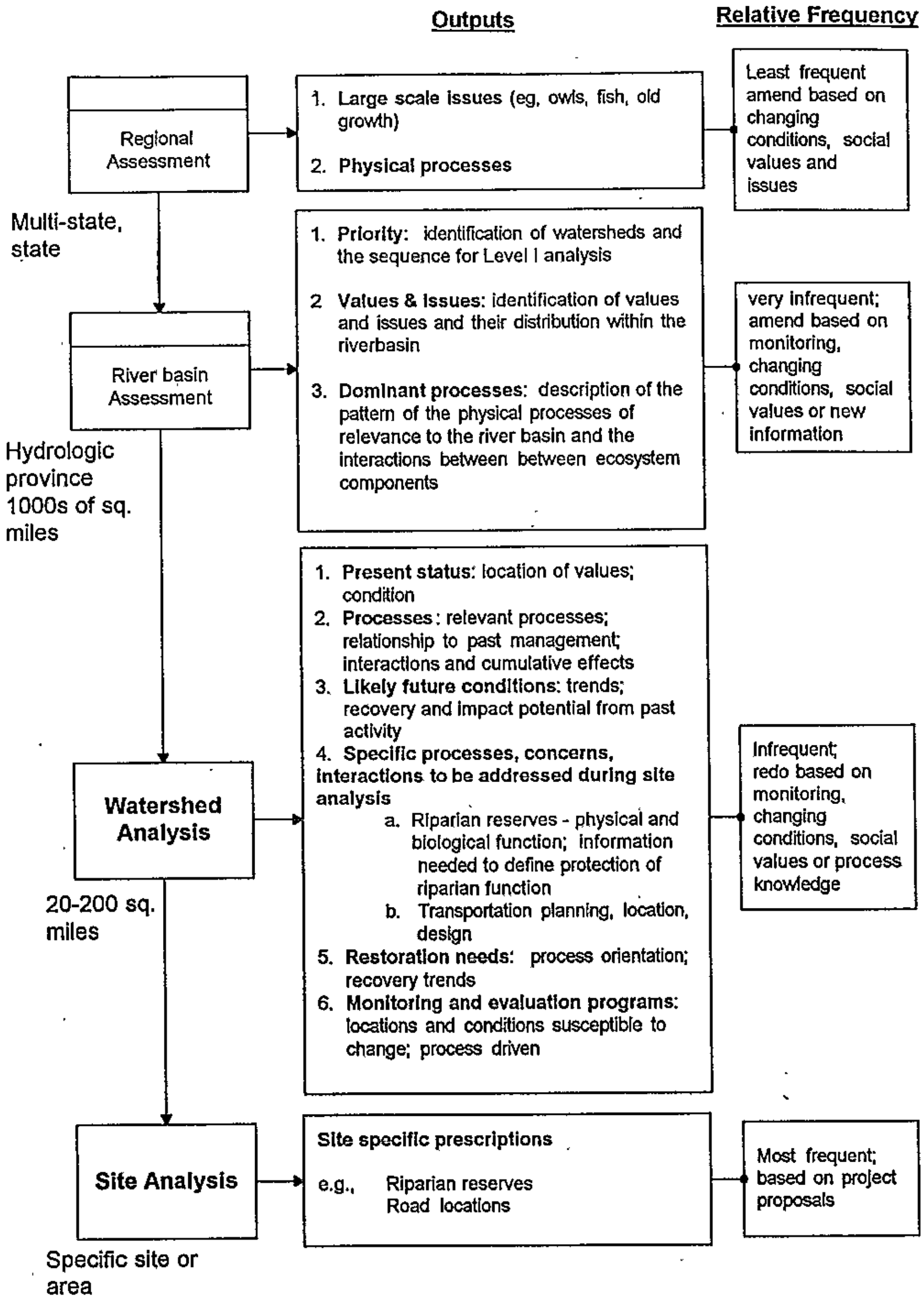

Figure V-23. Context for Watershed Analysis.

Fully implementing ecosystem planning will require many iterations of experimentation and learning, and we cannot yet foresee in detail how organizations and institutions will evolve to accomplish it. But because of the critical role of watershed analysis in providing for aquatic and riparian habitat protection, we focus here on the role watershed analysis plays in implementing the Aquatic Conservation Strategy.

Description of watershed analysis. In brief, watershed analysis is a set of technically rigorous and defensible procedures designed to provide information on what processes are active within a watershed, how those processes are distributed in time and space, what the current upland and riparian conditions of the watershed are, and how all of these factors influence riparian habitat and other beneficial uses. The analysis is conducted by an interdisciplinary team consisting of geomorphologists, hydrologists, soil scientists, biologists and other specialists as needed. Information used in this analysis includes: maps of topography, stream networks, soils, vegetation, geology; sequential aerial photographs; field inventories and surveys, including landslide, channel, aquatic habitat, and riparian condition inventories; census data on species presence and abundance; disturbance and land use history; and other historical data (e.g., streamflow records, old channel surveys). A more thorough discussion on watershed analysis can be found in appendix V-I.

Watershed analysis is organized as a set of modules that examine biotic and abiotic processes influencing aquatic habitat and species abundance (i.e., landslides, surface erosion, peak and low streamflows, stream temperatures, road network effects, woody debris dynamics, channel processes, fire, limiting factor analysis for key species, and so on). Results from these modules are integrated into a description of current upland, riparian, and channel conditions, maps of location, frequency, and magnitude of key processes, and location and abundance of key species. This information, in turn, is used at the site level, to set appropriate boundaries of Riparian Reserves, plan land-use activities compatible with disturbance patterns, design road transportation networks that pose minimal risk, identify what and where restoration activities will be most effective, and establish specific parameters and activities to be monitored.

While watershed analysis can provide essential information for designing land-use activities over the entire watershed, it will also highlight uncertainties in knowledge or understanding that need to be addressed. More detailed site-specific project-level analysis is conducted to provide the information and designs needed for specific projects (e.g., road siting or timber sale layout) so that riparian and aquatic habitats are protected.

Describing the full watershed analysis procedure is beyond the scope of this report. A technical team consisting of physical scientists and biologists from the U.S. Forest Service, Bureau of Land Management, and universities are writing a comprehensive handbook to set protocols and direct watershed analysis activities. The first draft of this handbook is scheduled to be available by July 15, 1993 (appendix V-I).

Relation to other approaches. Numerous procedures have been used over the past several decades to address watershed environmental concerns on private and federal lands. Some recent procedures developed for federal lands attempt to address cumulative effects; examples include the Equivalent Clearcut Area, Equivalent Roaded Area, U.S. Forest Service Region 1 and Region 4 Sediment-Fish Model, California Department of Forestry Questionnaire, and Aggregated Recovery Percentage. Most of these methods rely on relatively simple indices related to the area of lands impacted by roads, clearcuts, or other land use activities. A somewhat more sophisticated approach was recently developed to evaluate cumulative risk of multiple projects in the Snake River basin (U.S. Forest Service 1991). This method used a broader set of hillslope and channel indices along with intensity of past practices to evaluate watershed condition and estimate effects from future activities. This analysis ultimately rested, however, on a set of matrices that combined indices qualitatively to produce a final assessment of the risk of future impacts.

These methods all suffer from a similar set of problems: unclear logic used in weighting or combining individual elements, reliance on simple indices to explain complex phenomena, and assumptions of direct or linear relations between land use intensity and watershed response. They typically do not consider how key processes are distributed over watersheds within a given landscape and, in many cases, do not distinguish between physiographic provinces, which can vary widely in the importance of individual processes. Furthermore, most of these approaches lack any method to validate their assumptions or results.

Watershed analysis is emerging as a new standard for assessing watershed condition and land use impacts. The process described here builds on newer, more comprehensive approaches, including the Water Resources Evaluation of Nonpoint Silvicultural Sources program, the watershed analysis procedure developed by the Washington State Timber, Fish and Wildlife program, and the cumulative effects methods being developed by the National Council on Air and Stream Improvement. Analysis modules in watershed analysis are patterned after the first two approaches because a modular approach allows flexibility in selecting methods appropriate to a particular watershed and facilitates modification of specific techniques as improved methods become available. Unique aspects of the watershed analysis procedure described here include explicit consideration of biological as well as physical processes, and the joint consideration of upland and riparian zones.

Watershed analysis is a relatively new concept and has not yet been adopted on U.S. Forest Service or Bureau of Land Management. We are aware of U.S. Forest Service examples of watershed analysis that focus on physical processes. The best, though unpublished, example analyzes the physical setting of the 19,000 acre Augusta Creek. This analysis was undertaken by the Blue River Ranger District and Cascade Center for Ecosystem Management on the Willamette National Forest (see appendix V-I). Another example is the Draft Environmental Impact Statement for the Elk River Wild and Scenic River on the Siskiyou National Forest. There are undoubtedly many other examples of projects that incorporate key elements of watershed analysis on Forest Service and Bureau of Land Management lands though perhaps under different names.

Role of watershed analysis in aquatic options. Watershed analysis holds great promise as a means of effectively implementing ecosystem planning and management on a watershed basis. Ultimately, information gained through watershed analysis will be vital to adaptive management over broad physiographic regions. Developing the institutional capacity to absorb and respond to new information generated by watershed and other analyses represents a significant challenge for the next decades. We have indicated that watershed analysis is only required in Key Watersheds prior to land management. Ultimately however, watershed analysis should be conducted in all watersheds on federal lands as a basis for ecosystem planning and management. When current Land Management Plans are revised, information gathered through watershed analysis will, in part, be the basis of these revisions.

Watershed Restoration

Stream and riparian systems have been significantly degraded by past management actions, including selective or complete cutting of streamside forests, removal of woody debris from channels, and construction of roads that increase streamflow and sediment production. Therefore, Watershed Restoration shall be an integral part of a program to aid recovery of fish habitat, riparian habitat, and water quality. The most important elements of a restoration program are control and prevention of road-related runoff and sediment production; restoration of riparian vegetation condition; and restoration of in-stream habitat complexity. Other restoration opportunities exist, such as meadow and wetland restoration and mine reclamation, and these may be quite important in some areas. Regionally however, these opportunities are much less extensive than the three listed above. A detailed discussion of Watershed Restoration is found in appendix V-J.

Roads. Federal lands within the range of the northern spotted owl contain approximately 110,000 miles of roads (table V-2). Much of this network adversely affects water quality and peak flows. The capacity of Forest Service and Bureau of Land Management to maintain roads has declined dramatically as both appropriated and traffic-generated funds for maintenance and timber-purchaser-conducted maintenance have been reduced. Without an active program to identify and correct road problems, habitat damage will continue for decades. Well-established practices to control road generated erosion and peak flows can drastically reduce risks of future habitat damage. In watersheds containing high quality habitat and limited road networks, large amounts of habitat can be secured with small expenditures to upgrade and remove roads (Harr and Nichols 1993).

Road treatments range from full decommissioning (closing and stabilizing a road to eliminate potential for storm damage and need for maintenance) to simple road upgrading, which leaves the road open. Upgrading can involve practices such as removal of earth from locations with high potential to trigger landslides, modification of road drainage systems to reduce the extent to which the road functions as an extensions of the stream network, and reconstructing stream crossings to reduce the risk and consequences of failure.

Decisions to apply a given treatment depend on the value and sensitivity of downstream uses, transportation needs, social expectations, "treatability" of the problems, costs, and other factors. Watershed analysis, including the use of sediment budgets, provides a framework for considering benefit to cost relations in a watershed context. Thus, the magnitude of regional restoration needs will be based on watershed analysis.

Riparian vegetation. Active silvicultural programs may be necessary to restore large conifers Riparian Reserves. Appropriate practices may include planting unstable and potentially unstable areas such as streamside landslides and flood terraces, thinning densely-stocked young stands to encourage development of large conifers, releasing young conifers from overtopping hardwoods, and reforesting shrub- and hardwood-dominated stands with conifers. These practices can be implemented along with silvicultural treatments in uplands areas, although the practices may differ in objective and, therefore, design.

There has never been a regionwide assessment of need or opportunity for watershed restoration through riparian silviculture. However, there are over 200,000 miles of streams on public lands in the range of the northern spotted owl, and this suggests that substantial opportunity exists for improving watershed condition through riparian silviculture. Current research provides direction for designing effective programs.

In-stream habitat structures. In-stream restoration, based on accurately interpreted physical and biological processes and deficiencies, can be an important component of an overall program for restoring fish and riparian habitat. In-stream restoration measures are inherently short term and must be accompanied by watershed-wide practices to achieve long-term restoration. Maintaining desired levels of channel habitat complexity, for example, may best be achieved in the short term with introduced structures. However, a healthy riparian forest should be the source of large woody debris to the channel in the long-term.

In-stream restoration will be accompanied by riparian and upslope restoration and not used by itself if watershed restoration is to be successful. Also, use of in-channel structures should not be viewed as a substitute for habitat protection (Reeves et al. 1991). They will not be used as mitigation for risky land-management activities and practices. Priority must be given to protecting existing good habitat.

Implementing a restoration program. The balance of efforts among these three elements of watershed restoration varies with location within a watershed and from one physiographic province to another. In-stream woody debris structures, for example, have greatest likelihood of being effective in channels with slope less than two degrees and those not dominated by large boulders. Removal of roads and full recontouring of hillslopes has been most extensively employed in the Redwood Creek area, northern California, where sediment yields are high, roads have been major sediment sources, and the management objective has been to convert tractor-yarded clearcuts to National Park land. Other measures may be more useful elsewhere in the Pacific Northwest, such as simple road decommissioning or riparian silviculture.

Restoration shall be based on watershed analysis and planning. This is essential to identify areas of greatest benefit to cost and greatest likelihood of success. Watershed analysis can also be used as a medium to develop cooperative projects involving various land owners. In many watersheds the most critical restoration needs are on private lands downstream of federal ownership.

A viable, effective program must employ all restoration components and must be long term. Inventory, analysis, the National Environmental Policy Act process, implementation, and monitoring all take time. Without adequate investment in each of these steps, restoration efforts will be ineffective -- ample evidence demonstrates this point. Funding and management commitment to a 10-year program is essential.

Implementation of the Aquatic Conservation Strategy

Ecosystem planning needs to be conducted at four spatial scales: regional, province/river-basin, watershed, and site. The *region* for the purposes of this report is the Pacific Northwest, encompassing the range of the northern spotted owl. *Provinces* are areas of common geology, climate, and physiography in which technical information from one area can be widely extrapolated. Their scale is comparable to that of major *river basins*, such as the Klamath, Umpqua, or Willamette, or groups of small coastal watersheds with similar beneficial-use and resource-value issues. Provinces may overlap several river basins, and river basins may contain parts of several physiographic provinces. *Watersheds* are sub-basins of 20-200 square miles and are the scale at which Watershed Analyses are conducted. *Sites* are areas of variable size but typically range from tens to hundreds of acres, where specific activities, such as timber harvest, watershed restoration, silvicultural treatments, road construction, or other management activities, take place. Sites will typically require project-level analysis for planning ecologically appropriate resource management activities.

The four key components of the Aquatic Conservation Strategy (Riparian Reserves, Key Watersheds, watershed analysis, and Watershed Restoration) should be addressed in the four spatial scales of implementation. Key Watersheds and Riparian Reserves will be identified commensurate with the option chosen to implement the regional strategy. Watershed Analyses are the building blocks for provincial conservation strategies and for planning activities at the watershed scale. Provincial plans will begin to identify restoration goals and priorities. Watershed Analyses will define restoration priorities and strategies and enable design of appropriate restoration activities.

Interagency teams will be convened to guide implementation of the regional strategy and to conduct analyses and prepare plans for physiographic provinces and watersheds. These teams would include the land management agencies (U.S. Forest Service and Bureau of Land Management) and the resource regulatory agencies (National Marine Fisheries Service, U.S. Fish and Wildlife Service, and the U.S. Environmental Protection Agency).

For each of the options, the Forest Ecosystem Management Assessment Team evaluated the ability of federal lands to provide sufficient quality, distribution, and abundance to allow populations of fish species to stabilize, well distributed across forest lands. In considering the effects of any federal land management option on anadromous fish, two key points are important: (1) there may be other factors, such as over harvest, disease, hatchery practices, and other habitat impacts such as hydropower and irrigation developments that have caused and continue to affect the declines of anadromous salmonid populations; and (2) a plan for managing federal lands will not necessarily fix problems on nonfederal land, and anadromous fish are, in many cases, adversely impacted by nonfederal actions. For these reasons, it is not possible to determine whether this regional level conservation strategy would preclude listing of fish species under the Endangered Species Act.

If fish species listed under the Endangered Species Act are present within the northern spotted owl's range, the land management agencies will need to consult on the effects of their actions pursuant to Section 7 of the Act in this multiscale context. Consultation may be needed at three levels: (1) on the final regionwide plan; (2) then during the implementation phase, on the provincial, watershed, or other management plans (that step down the regionwide plan): and (3) on individual actions. These consultations will likely be necessary because there will be insufficient detail in the regionwide plan to adequately assess impacts of actions at the provincial, watershed, or individual level. During all phases, informal consultation can be provided, as necessary.

Role of Nonfederal Lands

A critical implementation aspect is that ecosystem management is most successful when all federal and nonfederal landowners and agencies that affect a watershed participate. Federal landowners currently have sufficient incentives (i.e., statutes, regulations, and litigation) to manage lands for viable fish habitat and fish populations. However, the incentives for nonfederal landowners and regulators currently are lacking. Some mechanisms identified by the Federal Ecosystem Management Assessment Team for encouraging ecosystem management on nonfederal ownership of include physiographic province and watershed analyses and planning and implementation of the Endangered Species Act, if listed species are present.

Watersheds provide a rational and effective spatial scale for citizens to participate in natural resource decision making. Watersheds encompass a wide diversity of ownerships, issues, and viewpoints. Because much of the historical habitat for anadromous fish species is on nonfederal lands, planning discussions for a watershed should include all landowners in the watershed (state, tribes, and private). Although provincial and watershed plans would be developed for federal lands, the provincial teams should have representation from the states and tribes in assessing related ecosystem problems and necessary actions for state and private lands in the watersheds. State and federal actions should be integrated for optimal environmental effectiveness.

The Endangered Species Act also has several mechanisms for encouraging and requiring nonfederal participation in ecosystem management. The provincial planning process could produce such agreements or understandings as prelisting conservation agreements between the U.S. Fish and Wildlife Service or National Marine Fisheries Service and federal or nonfederal land managers; anticipated timber harvest schedules on nonfederal lands; and Endangered Species Act Section 10 habitat conservation plans. The provincial and watershed planning process is also intended to facilitate working with the states on Section 4(d) rules for improved clarity and certainty under the "take" provisions of the Endangered Species Act.

If Section 7 consultations are necessary for listed species, the effects of the federal action will be evaluated with the cumulative effects of nonfederal actions to determine whether there may be a jeopardy or destruction or adverse modification of critical habitat action. The Endangered Species Act defines cumulative effects as those of future state or private activities not involving federal activities that are reasonably certain to occur within the action area of the federal action subject to consultation. It follows that the degree to which future nonfederal activities impact listed species will affect the federal land management agencies' ability to avoid jeopardy consultations. Thus, there is also powerful incentive for federal land managers to work closely with nonfederal groups in ecosystem planning.

Riparian Protection on State and Private Lands

Although the Bureau of Land Management and the U.S. Forest Service will likely invest heavily in protecting the remaining aquatic and riparian habitat, the federal government cannot be solely responsible for ensuring the viability of migratory fish species. Unless state and private lands receive protection sufficient to prevent further degradation and to promote habitat recovery, benefits derived from federal efforts will be diminished.

Best management practices are tactics used to protect water quality and the beneficial uses of water including fish and water-dependent wildlife on state and private lands. Oregon and Washington both have forest practice acts and regulations that include Best Management Practices intended to protect aquatic riparian habitats. However, California Forest Practices Rules have not yet been certified as Best Management Practices under the Clean Water Act.

Three scenarios are presented and examined in this report for managing riparian areas on federal lands. See the descriptions of plan options for detailed discussion of Riparian Reserves and applicable Standards and Guidelines (appendix V-F). All three scenarios are more restrictive of management activities and thus, are more protective of water quality, fish habitat, and riparian areas than state requirements.

Two major differences between current state requirements and proposed federal requirements are apparent. First, the states allow significant harvest within the riparian management areas. Second, the width of the protective buffers are smaller in state programs. This is particularly true for intermittent and smaller perennial streams. None of the states require protection of riparian areas for intermittent streams. The proposed federal Aquatic Conservation Strategy provides protection through Riparian Reserves that are sufficient to maintain important functions of large wood delivery, leaf and particulate organic matter input, shade, riparian microclimate, slope stability, water quality and riparian wildlife habitat (figs V-12 and V-13). See appendix V-K for detailed description of state forest practices.

Timber harvest disturbance on nonfederal lands will probably continue at 1980's levels (fig. II-18). Current state forest practice rules do not adequately protect ecological effectiveness nor provide any margin for error to accommodate natural disturbances or uncertainties in knowledge. Thus, reliance on federal lands to supply habitat for aquatic species and fish stocks will increase. Federal lands currently provide most of the highest quality water and fish habitat within the range of the northern spotted owl. Habitat conditions on private and state lands are inadequate to provide well distributed, stabilized populations of salmonids. If measures are not taken to improve management practices on state and private lands, options for federal land management may become more limited. To succeed, the federal Aquatic Conservation Strategy should be accompanied by companion strategies for nonfederal lands. Although any aquatic conservation strategy employed on state and private lands should have the same components (Riparian Reserves, Key Watersheds, watershed analysis, and Restoration) as the federal strategy, these is not necessary that they be identically administered.

Monitoring

General considerations. Watershed analysis will provide the decision framework for a variety of planned ecosystem management actions within watersheds. Specific actions may include habitat restoration, correction of sedimentation problems, road management, timber harvesting, development of a recreation facility or any of a multitude of activities. Monitoring will be an essential component accompanying these management actions and will be guided by the watershed analysis.

General objectives of monitoring will be to (1) determine if Best Management Practices have been implemented (2) determine the effectiveness of management practices at multiple scales, ranging from individual sites to watersheds and (3) validate whether ecosystem functions and processes have been maintained as predicted. In addition, monitoring will provide feedback to fuel the adaptive management strategy.

Specific monitoring objectives will derive from results of the watershed analysis and be tailored to each watershed. Specific locations of unstable and potentially unstable areas, roads, and harvest activities will be identified. In addition, the spatial relationship of potentially unstable areas and management actions to sensitive habitats such as wetlands will be determined. This information provides a basis for targeting watershed monitoring activities to assess outcomes associated with risks and uncertainties identified during watershed analyses.

Under natural conditions, river and stream habitats on federal forest lands exhibit an extremely wide diversity of conditions depending on past disturbance, topography, geomorphology, climate and other factors. Consequently, monitoring of riparian areas must be dispersed among the various landscapes rather than concentrated at a few sites and then extrapolated to the entire forest (Gregory 1990). Logistic and financial constraints require a stratified monitoring program that includes:

- Post-project site review.
- Reference sub-drainages.
- Basin monitoring.
- Water quality network.
- Landscape integration of monitoring data.

A stratified monitoring program examines watersheds at several spactial and temporal scales. Information is provided on hillslope, floodplain, and channel functions, water quality, fish and wildlife habitat and populations, and vegetation diversity and dynamics.

Water quality parameters. Parameters selected for monitoring depend on the activities planned for a given watershed relative to forestry practices. Two of the most important activities related to water quality are impacts of timber harvest and road related operations. Details on the selection of water quality parameters and interactions can be found in MacDonald et al. (1991). In addition to chemical and physical parameters, biological criteria may be appropriate to monitor using techniques such as Rapid Bioassessment Protocols for macroinvertebrates (Plafkin et al. 1989) or the index of biotic integrity for fish diversity (Karr, 1981; Ohio EPA, 1988).

Long term monitoring in reference watersheds. Long-term systematic monitoring in selected watersheds will be necessary to provide reference points for effectiveness and validation monitoring. Reference watersheds should represent a range of forest and stream conditions which have been exposed to natural and induced disturbance. Requirements for reference evaluation areas are discussed in Gregory and Ashkenas (1990). Reference watersheds, sub-basins, and sites will be selected as part of the overall adaptive management strategy proposed for implementing this plan.

Study plans will be developed in cooperation with a cross section of team members from the Provincial Teams and local interdisciplinary teams. Long-term data sets from reference watersheds will provide an essential basis for adaptive management and a gauge by which to assess trends in stream condition.

Specific monitoring plans must be tailored for each watershed. Significant differences in type and intensity of monitoring will occur based on watershed characteristics and management actions. For example, carefully targeted restoration activities may only require effectiveness monitoring of single activities, whereas watershed scale restoration would be accompanied by extensive riparian and in-stream monitoring. Specific monitoring design can best be accomplished by the local interdisciplinary teams working in cooperation with state programs. Pooling the monitoring resources of federal and state agencies is a necessity to provide interagency consistency and to increase available resources.

Monitoring will be conducted and results will be documented, analyzed and reported by the agency responsible for land management in any particular watershed. Reports will be reviewed by local interdisciplinary teams. In addition, water resource regulatory agencies may review results to determine compliance with appropriate standards and Provincial Teams should assess results against overall basin strategies. A cross-section of team members that includes participants from states and regulatory agencies should assess monitoring results and recommend changes in Best Management Practices or the mechanisms for Best Management Practice implementation.

Effects of Options on Aquatic Ecosystems

We assessed the likelihood of attaining a set of outcomes for habitat of individual races/species/groups of fish on federal lands for each option. This outcome-based scale was developed to express the range of possible trends and future habitat conditions on federal land (table IV-7). Each of four outcomes, labeled A through D, describes a biological condition that is observable and mutually exclusive of the other three outcomes. In *outcome A*, habitat is of sufficient quality, distribution, and abundance to allow the species' population to stabilize, well distributed across federal lands. (Note that the concept of well distributed must be based on knowledge of the species distribution, range, and life history). In *outcome B*, habitat is of sufficient quality, distribution, and abundance to allow the species' population to stabilize, but with significant gaps in the historic species distribution on federal land. These gaps cause some limitation in interactions among local populations. (Note that the significance of gaps must be judged relative to the species distribution, range, and life history, and the concept of metapopulations). In *outcome C*, habitat only allows continued species existence in refugia, with strong limitations on interactions among local populations. In *outcome D*, habitat conditions result in species extirpation from federal land.

The panelists were asked to assign 100 "likelihood votes" (or points) across the four outcomes in the scale. A panelist could express complete certainty in a single outcome for a species/option combination by allocating all 100 points to a single outcome. The panelist could express complete uncertainty by assigning 25 votes to each of the outcomes, indicating that each outcome was equally likely. Greater detail on outcomes and rating scales are described in chapter IV.

We compared options by assessing the likelihood of each to achieve outcome A. However, there is no single such level that represents a viable ecosystem or habitat, or a viable population for all species and circumstances. The level was chosen here as a point of comparison only; other levels -- for example, a 95 percent likelihood of achieving outcome A, or a 60 percent likelihood of Option B -- could also be chosen for comparing options. The information on likelihoods is available and is amenable for such additional comparisons.

Methods Specific to Fish

In assessing the options we considered five factors: (1) assessments for the individual races/species/groups made by the expert panel (see chapter IV for description of expert panels); (2) amount of Riparian Reserves and type and level of land-management activity allowed within in them; (3) extent of other reserves (e.g, Congressionally Withdrawn Areas, Late-Successional Reserves) and type and level of land management allowed within them; (4) presence of a watershed restoration program (as described previously); and (5) prescriptions for management of Matrix lands.

We considered the first three factors equally in determining the score for an outcome under each option. We believed that these components most strongly influence the preservation, maintenance, and restoration of aquatic ecosystems and habitat.

The expert panel also assessed the likelihood of attaining the set of outcomes for habitat of the individual races/species/groups of fish for each option. The panel was presented with descriptions of the outcomes and options. They were also asked to partition out the effects of factors such as habitat conditions on nonfederal lands, land ownership patterns, and oceanic conditions. Each panelist made their own assessment. Like the Terrestrial Ecosystem Assessment (chapter IV), the expert panel was only asked to assess Options 1, 3, 4, 5, 7, 8, and 9. We then used this information as part of our assessment of the options. They were not asked to consider Options 2, 6 and 10. Assessment of these options was done by the Aquatic Ecosystem Group.

Ecological functions and processes required for the creation and maintenance of fish habitat were provided by Riparian Reserves. The greater the amount of Riparian Reserves, the more it contributed to the ranking. Riparian Reserves 1 (see previous descriptions) provide the fullest suite of functions and processes (see figs. V-12 - V-14) and thus contributed to higher ratings than did Riparian Reserves 2 and 3. Area of Riparian Reserves under each option is shown in table V-4.

In our assessments, we also assumed that the boundaries of Riparian Reserves, particularly in intermittent streams, could change following watershed analysis. This does not imply, however, that watershed analysis may always reduce the boundaries of Riparian Reserves in intermittent streams; it is expected that actual boundaries may vary considerably among watersheds. We assumed that the boundaries in other stream types would not vary appreciably. In all cases we assumed final Riparian Reserves would provide the necessary range of ecological functions and processes that create and maintain good fish habitat.

We believed that Reserves such as Congressionally Withdrawn Areas and Late-Successional Reserves construed two benefits to aquatic habitat and ecosystems. These are areas where land-management activity would be limited. They would thus provide a high level of protection for all streams within them. This would in turn provide the ecological functions and processes necessary for the creation and maintenance of fish habitat. Additionally, streams in Reserves could serve as cores of good habitat in a landscape with large areas of poor habitat. They would be refugia and population centers for recolonization as degraded areas recovered in the future. This would be particularly important for locally distributed fish species and races. The greater the amount of these reserves the greater would be the level of protection for existing aquatic ecosystems and habitat.

The area of reserved land in key watersheds is very important for fish habitat protection. Tier 1 Key Watersheds have different percentages of reserves within them depending on the option and the state (see appendix V-H for greater detail). In the state of Washington the percentage of Tier 1 Key Watersheds in reserves excluding Riparian Reserves ranges from 81-87 percent across all options. In Oregon the range is wider from 55 percent of Key Watersheds in a reserve status in option 7 to 84 percent in Option 1. The remaining options cluster between 66-70 percent reserves in Oregon Tier 1 Key Watersheds. Reserves in California Tier 1 Key Watersheds varied from 69 percent in Option 7 to 88 percent in Option 1. Reserves in Tier 1 Key Watersheds across the forests of the northern spotted owl and ranged from 70 percent in option 7 to 86 percent in Option 1, with most options clustering between 74-77 percent. The percent of Tier 1 Key Watersheds in the Matrix ranged from 8 percent in Option 1 to 28 percent in Option 7. Options 2-5 and 9 ranged between 12-15 percent Matrix in these Key Watersheds (see appendix V-H for greater detail).

Tier 2 Key Watersheds are found primarily in the Cascades of Washington and Oregon. Watersheds in these areas tend to be more stable or have less risk from landslides. California has no Tier 2 Key Watersheds. In Washington the percent of Tier 2 Key Watersheds in reserve status ranges between 60-84. Option 9 has 60 percent of Tier 2 Key Watersheds in a reserve status and 18 percent in an Adaptive Management Area status. In Oregon, Option 1 provided the greatest percentages of reserves to Tier 2 Key Watersheds at 80 percent. Tier 2 Key Watersheds in option 7 had 52 percent in a reserve status. The percent area of Tier 2 Key Watersheds in the Matrix varied from 13 in Option 1 to 40 in Option 7. For Washington and Oregon combined Option 1 had 82 percent of Tier 2 Key Watersheds in reserve status and Options 7 and 9 had 62 percent. (See appendix V-H for greater detail.)

The other factors, watershed restoration and Matrix management prescriptions, were given less weight. However, we and the expert panel acknowledged that a comprehensive watershed restoration program was necessary for restoring aquatic habitat particularly in the short-term. Among options, Matrix management prescriptions were weighted according to the area of the Matrix and required management guidelines (e.g., rotation length, green tree retention). The greater the green tree retention requirements and/or the longer the rotation, the greater the contribution to the likelihood rating.

The expert panel was presented with 19 races/species/groups of fish to consider. A total of 29 species were contained in these groupings (table V-10). Of these species, five were then being considered for status under the Endangered Species Act, and one other was identified in the professional literature as in need of special management consideration because of low or declining populations.

Members of the expert panel decided to fully evaluate only seven of the 19 races/species/groups presented originally. Reasons for not considering the 12 races/species/groups were: (1) insufficient information on the ecology to make a valid assessment; (2) limited distribution of the species/group/races on federal lands within the

Table V-10. Fish races/species/groups presented to but not considered by expert panel.

	Reason not considered		
Fish Species	Insufficient information on ecology	Limited distribution on federal lands	Possible effects from land-management practices on federal lands negligible
Pacific lamprey	X		
Sockeye salmon [a]		X	
Pink salmon [a]		X	
Chum salmon [a]		X	
Redband trout			
White River, OR	X		
McCloud River, CA [b]	X		
Jenny Creek, OR	X		
Mountain whitefish	X		
Dolly varden		X	
Umpqua squawfish		X	X
Umpqua chub	X	X	
Oregon chub [b]	X	X	
Olympic mudminnow [b]	X		
Salish sucker [c]	X		
Jenny Creek sucker [b]	X		
Reticulate sculpin	X		
Paiute sculpin	X		
Riffle sculpin	X		
Shorthead sculpin	X		
Torrent sculpin	X		
Mottled sculpin	X		
Coastrange sculpin	X		
Longnose dace	X		
Millicoma dace	X		

a Some stocks within region of the northern spotted owl listed by Nehlsen et al. (1991) as in need of special management considerations because of low or declining populations.

b Candidate for listing under Federal Endangered Species Act.

c Listed by Williams et al. (1991) as in need of special management considerations because of low or declining populations.

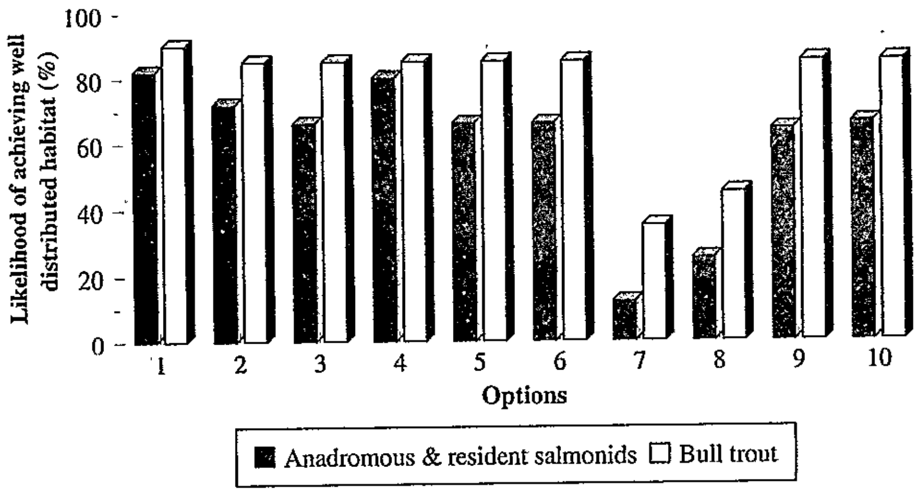

Figure V-24. Assessment of the percent likelihood of achieving aquatic habitat of sufficient quality, distribution and abundance to allow fish species to stabilize well distributed across federal lands. The salmonids grouping is an average of six separate assessments. The range around the mean for each option was within plus or minus 5 percent.

range of the northern spotted owl; and (3) judging from available information, possible habitat alterations that may occur as result of land-management practices on federal lands would have no or negligible effect on the habitat of the species/group/race. The panel commented on what they believed may be the potential outcome of an option on some races/species/groups for which they had limited knowledge. We evaluated only the seven races/species/groups fully considered by the expert panel.

All fish in the species/groups for which assessments were made are salmonids. Most are distributed in streams of late-successional forests on federal lands throughout the range of the northern spotted owl. They use a wide size range of streams, from larger streams by chinook salmon to small, headwater streams by resident cutthroat and rainbow trout. All require clean gravels to reproduce successfully, cool water (generally less than 68°F), and diverse and complex habitat. Bjornn and Reiser (1991) discuss specific requirements of the individual species. As indicated previously in the chapter, habitat features for these fish are susceptible to impacts from land-management practices, and so these fish are reasonable indicators of ecosystem health.

RESULTS

Our assessments of the options are shown in table V-11. Options 1 and 4 had the highest likelihood of attaining outcome A (i.e., habitat will be widely distributed on federal lands throughout the range of the northern spotted owl); the likelihood was 80 percent or higher for all race/species/groups (fig. V-24). The relatively high likelihood for these options was because of the large amount of area in reserves (table V-4) and the Riparian Reserve 1 strategy on all federal lands within the range of the northern spotted owl.

Options 2, 3, 5, 6, 9, and 10 generally had a 60-70 percent likelihood of attaining outcome A for all races/species/groups. These options had a smaller likelihood of attaining outcome A than Options 1 and 4 because of a combination of less area in Reserves and the Riparian Reserve 2 scenario, which has Interim Riparian Reserves of one-half of a site potential tree in intermittent streams outside Key Watersheds.

The likelihood of outcome A for bull trout was 85 percent in each of Options 2, 3, 4, 5, 6, 9, and 10. As far as we could discern from available distribution maps, the vast majority of, if not all, bull trout habitat on federal land within the range of the northern spotted owl was contained within Key Watersheds. The high level of protection provided by the Riparian Reserves and the extent of other reserves in Key Watersheds resulted in a high level of protection to bull trout habitat.

Resident rainbow and cutthroat trout had the lowest likelihood of attaining outcome A, 60 percent, for options 2, 3, 5, 6, 9, and 10. These fish inhabit small, headwater streams. We believed that the prescribed Riparian Reserve 2 boundaries outside Key Watersheds reduced the level of protection for the habitat of these fish. It is likely that habitats of other fish found in these streams, such as many of the sculpins and longnose dace would be similarly affected by these options.

The likelihood of achieving outcome A for fish habitat is lower for Options 2, 3, 5, 6, 9, and 10 than for Options 1 and 4. However, we think all options except Option 7 and 8 will reverse the trend of degradation and begin recovery of aquatic ecosystems and habitat on federal lands within the range of the northern spotted owl. Even if changes in land management practices and comprehensive restoration are initiated, it is possible that no option will completely recover all degraded aquatic systems within the next 100 years. The likelihood of attaining a functioning late-successional/old growth ecosystem in the next 100 years is reduced because some characteristics of these terrestrial ecosystems will not be obtained for at least 200 years (see chapter IV). Similarly, we expect that degraded aquatic ecosystems will not be fully functional in 100 years. Faster recovery rates are probable for aquatic ecosystems under Options 1 and 4 than other options. Option 1 and 4 would reduce disturbance across the landscape due to application of a larger Late-Successional Reserve network and use of Riparian Reserve 1 scenario, that requires wider interim Riparian Reserves for intermittent streams in non-Key watersheds than in other scenarios.

Options 7 and 8 had the lowest likelihoods of attaining outcome A for all races/species/groups (table V-11). The likelihood of attaining outcome A for Option 7 was from 10-15 percent, the exception being bull trout, which was 35 percent. Option 7 was ranked low primarily because of the low amount of riparian areas and the amount of activity that was allowed within them in Bureau of Land Management land management plans and in many forest plans. It should be noted that these assessments reflect assessments for forest plans as a group and not for individual plans, which varied tremendously. During the life of the plan, many individual plans stated that fish habitat would continue to degrade due to management activities, other plans provide non-degraded conditions as well as watershed restoration.

Likelihoods of attaining outcome A were slightly higher for Option 8 than for Option 7 but were less than for the other options. Likelihoods of attaining outcome A ranged from 20-25 percent for all groups except bull trout, which was 45 percent, in Option 8.

Table V-11. Projected future likelihoods of habitat outcomes for selected fish races/species/groups under land management options. Likelihood values are expressed as percentages that total 100 for each option.

Fish race/species/group	1	2	3	4	5	6	7	8	9	10
Coho Salmon										
Outcome A	80	70	65	80	65	65	10	20	65	65
Outcome B	15	20	25	15	25	25	20	25	20	25
Outcome C	5	10	10	5	10	10	50	35	15	10
Outcome D	0	0	0	0	0	0	20	10	0	0
Fall Chinook Salmon										
Outcome A	85	75	70	80	70	70	15	30	65	70
Outcome B	15	20	25	15	20	25	25	35	25	25
Outcome C	0	5	5	5	10	5	45	35	10	5
Outcome D	0	0	0	0	0	0	15	0	0	0
Spring Chinook Salmon/Summer Steelhead Trout										
Outcome A	85	75	70	80	70	70	15	30	65	70
Outcome B	15	20	25	15	20	25	25	35	25	25
Outcome C	0	5	5	5	10	5	45	35	10	5
Outcome D	0	0	0	0	0	0	15	0	0	0
Winter Steelhead Trout										
Outcome A	80	70	65	80	65	65	10	25	65	65
Outcome B	15	20	25	15	25	25	20	30	25	25
Outcome C	5	10	10	5	10	10	50	35	10	10
Outcome D	0	0	0	0	0	0	20	10	0	0
Sea-run Cutthroat Trout										
Outcome A	80	70	65	80	65	65	10	25	65	65
Outcome B	15	20	25	15	25	25	15	25	25	25
Outcome C	5	10	15	5	15	15	45	45	15	15
Outcome D	0	0	0	0	0	0	30	10	0	0
Resident Rainbow/Cutthroat Trout										
Outcome A	80	70	60	80	60	60	10	20	60	60
Outcome B	15	20	25	15	25	25	15	25	25	25
Outcome C	0	10	15	5	15	15	45	45	15	15
Outcome D	0	0	0	0	0	0	30	10	0	0
Bull Trout										
Outcome A	90	85	85	85	85	85	35	45	85	85
Outcome B	10	15	15	15	15	15	35	25	15	15
Outcome C	0	0	0	0	0	0	20	25	0	0
Outcome D	0	0	0	0	0	0	10	5	0	0

A - Well Distributed B - Locally Restricted C - Restricted to Refugian D - Extirpation

Option 8 has a lower likelihood of attaining outcome A than did options other than 7 because of the reduced size of Riparian Reserves (table V-4), particularly for intermittent streams.

This viability assessment of federal habitat does not directly correspond to population viability of the species considered. This is due, in part, to impacts or cumulative effects from nonfederal activities and to activities in other habitat sectors where the species might spend a portion of their life cycles. Furthermore, with anadromous fish, there is very limited science available to establish direct relationships between land-management actions and population viability due, in part, to other impacts such as predation and artificial propagation and the difficulty of translating these impacts into population numbers.

Mitigations

The higher likelihood of attaining outcome A for aquatic habitat on federal land under Options 1 and 4 stems from combining lower timber harvest levels with wider interim Riparian Reserve widths on non-Key Watershed intermittent streams than under any other options. For example, Option 9 received a 65 percent likelihood of attaining outcome A for fish habitat while Options 1 and 4 received greater than 80 percent likelihood of achieving outcome A. Option 9 designates 2.2 times more acres in the Matrix than Option 1 and 1.6 times more than Option 4. Under Option 9, 22 percent of the remaining late-succession forest is in the Matrix compared to zero percent in Option 1. In addition, Riparian Reserve 2 scenario is applied rather than the Riparian Reserve scenario 1 used in Options 1 and 4.

The primary difference between Riparian Reserve 1 and 2 scenarios is the interim width required for Riparian Reserves on intermittent streams in non-Key Watersheds. Interim Riparian Reserves for these streams in non-Key Watersheds are delineated using one site-potential tree height in Riparian Reserve 1 and one-half a site potential height in Riparian Reserve 2. In non-Key Watersheds, land-management activities can proceed outside Riparian Reserves before conducting a watershed analysis, thus the risk to aquatic and riparian habitat is, in part, determined by the interim width of these reserves.

To increase the likelihood of achieving outcome A for fish habitat of all races/species/groups to 80 percent or greater in Options 2, 3, 5, 6, 9, and 10, we recommend two possible strategies. One strategy is to replace the Riparian Reserve 2 scenario used in these options with the Riparian Reserve 1 scenario. Application of Riparian Reserve 1 scenario provides greater protection for fish habitat in non-Key Watersheds.

Major beneficiaries of such an action would be coastal area National Forests (Six Rivers, Siskiyou, Siuslaw, and Olympic National Forests) and Bureau of Land Management Districts (Salem, Eugene, and Coos Bay Districts). These coastal areas have a large number of at-risk anadromous salmonid stocks (appendix V-C), large areas of unstable land (figs V-1 - V-3), and a relatively small proportion of the total area in Key Watersheds compared to more inland areas (fig. V-25).

Key Watersheds (Tier 1 & 2)

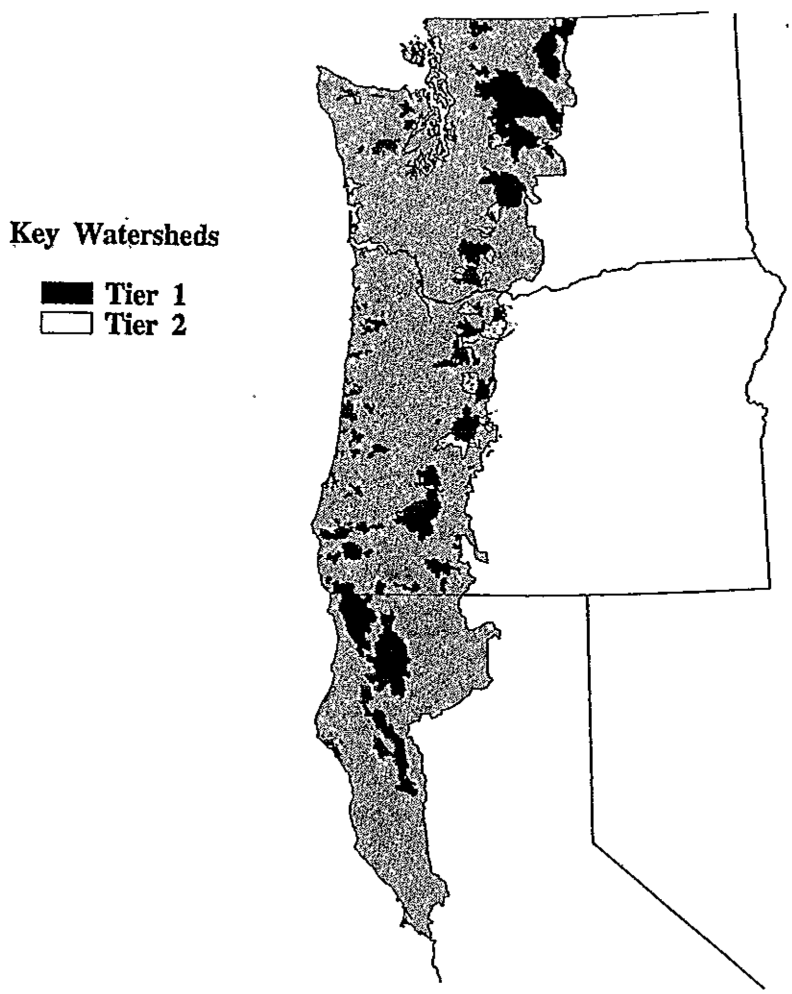

Figure V-25. Distribution of Key Watersheds within the range of the northern spotted owl.

A second mitigation strategy is to provide greater protection for Key Watersheds. This could be achieved by removing Key Watersheds from the timber-suitable base. Thus, land-management activities in these watersheds would be reduced, diminishing the potential for management generated disturbance. This additional protection is particularly important in the short-term since the relatively small amount of good habitat that remains is predominantly found in Key Watersheds.

Either of these mitigation strategies would probably be sufficient to increase the likelihood of achieving outcome A for fish habitat above 80% for all options except Option 7.

Summary and Conclusions

We have developed a conservation strategy for aquatic and riparian ecosystems based on scientific understanding of the functional links between stream and wetland ecosystems and adjacent terrestrial vegetation. Riparian forests may influence habitat structure and food resources of stream systems for lateral distances exceeding a tree height. Tree height distance away from the stream is a meaningful indicator of an area that is crucial for providing aquatic habitat components, including wood and shade. We defined a site-potential tree as the average maximum height of the tallest dominant trees (200 years or more) on a given site. In the owl forests, a site potential tree was modeled at 250 feet for the Oregon Coast and 170 feet for all other riparian forests west of the Cascades.

Another critical linkage within stream systems is the downstream movement of material and disturbances. Small, steep intermittently-flowing channels are often sources of large wood and boulders that enter larger, fish-bearing streams. Intermittent channels are also sites of land management-initiated debris flows originating from channel heads or road failures, which can severely degrade aquatic habitat. Intermittent streams have a defined channel that shows evidence of sediment deposition and scour. In this exercise, we estimated the number of these intermittent streams to be 90 percent greater than estimated in Forest Plans and Johnson et al. (1991).

The Aquatic Conservation Strategy has the following elements:

- Riparian Reserves to maintain ecological functions and protect stream and riparian habitat and water quality.

- A network of 162 Key Watersheds to protect at-risk fish stocks (139 Tier 1 Key Watersheds) or basins with outstanding water quality (23 Tier 2 Key Watersheds). No new roads will be constructed in all inventoried roadless areas in Key Watersheds to prevent further effects of roads as sources of sediment and flood flows.

- Watershed analysis, which is a procedure for planning further protection or management, including restoration practices within a basin.

- Restoration to speed ecosystem recovery in areas of degraded habitat and to prevent further degradation.

The Aquatic Conservation Strategy for Options 1 - 6 and 8 - 10 is summarized in table V-12.

Table V-12. Summary of Aquatic Conservation Strategy.

Component	Role in Conservation Strategy
Riparian Reserves	• Portions of the landscape where riparian dependent and stream resources receive primary emphasis
	• Designated for all permanently flowing streams, lakes, wetlands greater than one acre, and intermittent streams
	• Includes the body of water, inner gorge, all riparian vegetation, 100-year floodplain, landslides and landslide prone areas
	• Interim widths will be at least some fraction of a site potential tree or a prescribed slope distance (See Table V-5)
	• Standards and Guidelines prohibits programmed timber harvest, and manages roads, grazing, mining and recreation to achieve objectives of the Aquatic Conservation Strategy
Key Watersheds	• Tier 1 - Selected for directly contributing to anadromous salmonid and bull trout conservation
	• Tier 2 - May not contain at risks fish stocks but were selected as sources of high quality water
	• Inside roadless areas - no new roads will be built
	• Outside roadless areas - at a minimum, there will be no net increase in roads in Key Watersheds
	• Receives highest priority in restoration programs
Watershed Analysis	• A systematic procedure to characterize watersheds. The information guides management prescriptions, setting and refining Riparian Reserve boundaries, development of restoration strategies and monitoring programs.
	• Required in Key Watersheds prior to resource management
	• Required in all roadless areas prior to resource management
	• Recommended in all other watersheds
	• Required to change Riparian Reserve boundaries in all watersheds
Watershed Restoration	• Restore watershed processes to recover degraded habitat
	• Focus on road removal and upgrading
	• Silviculture treatments may be used to restore large conifers in Riparian Reserves
	• Restore channel complexity. In-stream structures should only be used in the short term and not as mitigation for poor land management practices

Riparian Reserves

Riparian Reserves are portions of watersheds where riparian-dependent resources receive primary emphasis and where special Standards and Guidelines apply. Riparian Reserves include those portions of a watershed that are directly coupled to streams and rivers, that is, the portions of a watershed that directly affect streams, stream processes, and fish habitats. Every watershed in National Forests and Bureau of Land Management Districts within the range of the northern spotted owl will have Riparian Reserves. Land allocated to Riparian Reserve status varies between options from 0.62 to 2.88 million acres depending on the forest management reserve alternative (table V-4).

Three scenarios were developed that define interim widths of Riparian Reserves (table V-5). One of these scenarios were used in each option. All options recognize at least three categories of water: 1) fish-bearing streams and lakes; 2) permanently flowing nonfish-bearing streams and wetlands greater than one acre; and 3) intermittent streams and wetlands smaller than one acre.

The greatest difference among scenarios is in interim widths defined for intermittent streams. In both Riparian Reserve scenarios 1 and 3 the interim widths on intermittent streams do not vary between Key and non-Key Watersheds. However, the interim widths for these streams prescribed in scenario 1 are six times greater than in scenario 3 (table V-5). In Riparian Reserve scenario 2, interim widths within Tier 1 Key Watersheds are the same as in scenario 1. In all other watersheds, scenario 2 widths are one half those defined for scenario 1.

All options except Option 7 and 8 include either Riparian Reserve 1 or 2 scenarios. Both Riparian Reserve 1 and 2 institute an anti-degradation policy for aquatic systems on federal lands. Interim Riparian Reserves on all permanently flowing streams are wide enough to provide the full suite of ecological functions (figs V-12 - V-13) and include the floodplain, inner gorges, and unstable and potentially unstable lands. For non-Key Watersheds, interim reserve widths for Riparian Reserve 1 and 2 on intermittent streams are one or one-half site potential tree, respectively. Although these interim Riparian Reserve widths were estimated to be sufficient for providing full ecological effectiveness (fig. V-14), we assumed that there would be a greater risk to aquatic systems with the narrower reserves. In addition, the recovery rate may be slower in non-Key than in Key Watersheds due to less area in Late-Successional and other reserves and limited restoration funds.

Key Watersheds

A system of Key Watersheds that serve as refugia is critical for maintaining and recovering habitat for at-risk stocks of anadromous salmonids and resident fish species. These refugia include areas of good habitat as well as areas of degraded habitat. Areas in good condition would serve as anchors for the potential recovery of depressed stocks. Those of lower quality habitat have a high potential for restoration and will become future sources of good habitat with the implementation of a comprehensive restoration program.

We identified a network of 162 Key Watersheds (fig. V-25) located on federal lands including both Tier 1 Key Watersheds, selected specifically for directly contributing to the conservation of habitat for at-risk anadromous salmonids, bull trout, and resident fish species, and Tier 2 Key Watersheds, which are important sources of high quality water. These Key Watersheds vary in acreage in reserve status by option: The 139 Tier 1 Key Watersheds range between 70 - 86 percent in reserve status excluding Riparian Reserves. The 23 Tier 2 Key Watersheds ranged between 62 - 82 percent in reserve status, excluding Riparian Reserves. The Key Watershed network occupies 36 percent of the federal land within the range of the northern spotted owl, or about 8.6 million acres.

We have indicated that all watersheds will recover watershed, riparian, and aquatic processes, however, Key Watersheds should recover at a faster rate than others (fig. V-26). The large percent of Key Watersheds in Late-Successional and other reserved acres, interim Riparian Reserves of one site-potential tree on intermittent streams in Tier 1 Key Watershed, and identification of Key Watersheds as priority sites for restoration increase the recovery rate in Key Watersheds.

It is important to consider the regional context of Key Watersheds. The Key Watershed network in northern California and the Cascades of Oregon and Washington is robust in terms of adjacency to wilderness watersheds, numbers and size of watersheds included and having a relatively even distribution of watersheds (fig. V-25). The Key Watershed network on the coasts of Oregon, Washington, and northern California is characterized by smaller and more isolated watersheds. Key Watersheds on the Olympic Peninsula and Siuslaw National Forest are well anchored by reserves. However, from the Humptulips River in Washington to the southern boundary the northern spotted owl range in California, major gaps in high quality habitat exist. The most productive forests in the region are contained in these coastal areas, which has resulted in intensive timber harvest on nonfederal lands. Therefore, Key Watersheds take on increased importance in these coastal areas given the likely continuation of intensive management on nonfederal forest lands, lack of state agricultural and forest practice regulations adequate to protect and restore aquatic ecosystems, and the large number of at-risk coastal salmonid species and stocks.

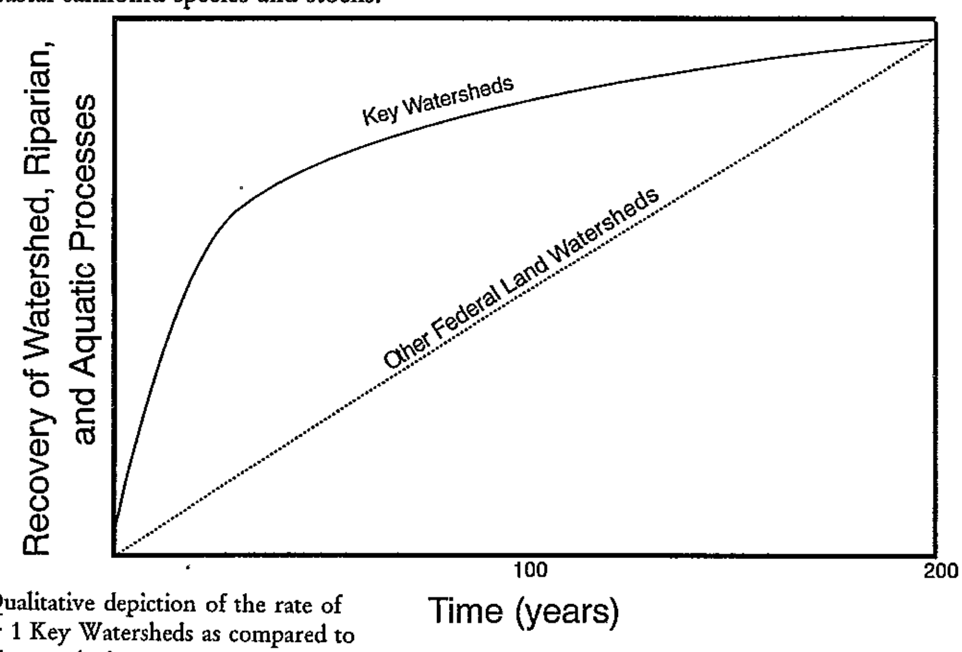

Figure V-26. Qualitative depiction of the rate of recovery for Tier 1 Key Watersheds as compared to other federal land watersheds. Faster recovery is due to the area of reserved lands, Riparian Reserves, and priority for restoration efforts.

Management activities in roadless areas will increase the risk of aquatic and riparian habitat damage and potentially impair the capacity of Key Watersheds to function as intended and to contribute to achieving Aquatic Conservation Strategy Objectives. In order to protect the best habitat in Key Watersheds, all options except 7 and 8 stipulate no new roads will be constructed in roadless areas within Key Watersheds and watershed analysis must be completed for all watersheds within which a roadless area lies before management activities proceed in that roadless area.

Most timber-suitable roadless acreage can be harvested either directly from existing roads or using helicopters. Two miles is considered to be the economically operable distance for helicopter logging at today's lumber prices (Johnson et al. 1993, in prep.). Under Option 9, between 5000-10,000 acres of the timber-suitable Matrix of all inventoried roadless areas are beyond two miles from a road. We estimated that there were no suitable acres for timber harvest in roadless areas within Key Watersheds that were further than this distance from existing roads. Thus, the requirement that no roads will be constructed in roadless areas within Key Watersheds should have no impact on total regional probable sale quantity. If all timber-suitable roadless remains unroaded in Option 9, then the estimated reduction for the total regional probable sale quantity is less than 0.2 percent.

Watershed Analysis

In planning for ecosystem management and establishing Riparian Reserves to protect and restore riparian and aquatic habitat, the overall watershed condition and the suite of processes operating there need to be considered. Watershed condition includes not only the state of the channel and riparian zone, but also the condition of the uplands, distribution and type of seral classes of vegetation, land use history, effects of previous natural and land-use related disturbances, and distribution and abundance of species and populations throughout the watershed. Watershed analysis is a systematic procedure for characterizing watershed and ecological processes to meet specific management and social objectives. This information then guides management prescriptions, including setting and refining boundaries of riparian and other reserves, sets restoration strategies and priorities, and reveals the most useful indicators for monitoring environmental changes. Watershed analysis is a stratum of ecosystem planning applied to watersheds of approximately 20-200 square miles. It provides a process for linking nonfederal and federal land coordination and planning.

Restoration

Watershed restoration must be an integral part of a program to aid recovery of fish habitat, riparian habitat, and water quality. The most important elements of a restoration program are: 1) control and prevent road-related runoff and sediment production; 2) improve the condition of riparian vegetation; and, 3) improve habitat structure in stream channels.

Of particular concern is that the federal lands within the northern spotted owl's range contain approximately 110,000 miles of roads. Much of this network adversely affects water quality and peak flow levels. The capacity of the U.S. Forest Service and Bureau of Land Management to maintain roads has declined dramatically as both appropriated and traffic-generated funds for maintenance and timber purchaser-conducted maintenance have been reduced. Without an active program of identifying and correcting problems, habitat damage will continue for decades.

Assessments of Future Habitat

In assessing the options, we considered five factors: (1) assessments of habitat conditions for the individual races/species/groups made by the "Expert" Panel; (2) amount of Riparian Reserves and type and level of land-management activity allowed within in them; and (3) extent of other reserves (e.g., Congressionally designated withdrawals, Late-successional Reserves, etc.); and type and level of land management activity allowed within them; (4) presence of a watershed restoration program; and (5) prescriptions for management of Matrix lands.

The analysis rated the sufficiency, quality, distribution and abundance of habitat to allow the species populations to stabilize across federal lands. In this assessment, Options 1 and 4 had the highest likelihood, 80 percent or greater, of attaining sufficient quality, distribution and abundance of habitat to allow the race/species/group to stabilize, well-distributed across federal lands (table V-12). The relatively high likelihood for these options was because of the large amount of area in reserves and the extent of Riparian Reserves on all federal lands within the range of the northern spotted owl.

Options 2, 3, 5, 6, and 9 generally had a 60-70 percent likelihood of attaining outcome A for all races/species/groups. These options had a smaller likelihood of attaining this outcome than Options 1 and 4 because of a combination of less area in reserves and smaller Riparian Reserves. Options 7 and 8 had the lowest likelihoods of attaining outcome A for all races/species/groups. The likelihood for Option 7 ranged from 10-15 percent. Option 7 was ranked low primarily because of the low amount of riparian reserves and the amount of activity that was allowed within them in Bureau of Land Management Land Management Plans and in many Forest Plans. Likelihoods for Option 8 obtaining outcome A ranged from 20-25 percent for all groups. Again, the reduced likelihood was due to reduced size of riparian reserves, particularly in intermittent streams.

The likelihood of achieving outcome A for fish habitat is lower for Options 2,3,5,6,9, and 10 than for Options 1 and 4. However, we think all options except Option 7 an 8 will reverse the trend of degradation and begin recovery of aquatic ecosystems and habitat on federal lands within the range of the northern spotted owl. Even if changes in land management practices and comprehensive restoration are initiated, it is possible that no option will completely recover all degraded aquatic system within the next 100 years.

This assessment of Federal habitat does not directly correspond to population viability of the affected species. This is due, in part, to impacts or cumulative effects on species viability from nonfederal activities and to activities in other habitat sectors where the species might spend portions of their life cycle. Furthermore, with anadromous fish, there is very limited science available to establish direct relationships between land management actions and population viability due, in part, to other impacts such as predation and artificial propagation and the difficulty of translating these impacts into population numbers.

Finally, in considering the effects of any federal land management option on aquatic resources, two key points are important: 1) there are potentially other factors such as overutilization, disease, artificial propagation practices and other habitat impacts such as hydropower and irrigation developments that have degraded and continue to degrade aquatic habitat; and 2) a plan for managing federal lands will not solve problems caused on nonfederal land, and aquatic resources, for example, anadromous salmonids are adversely impacted by nonfederal actions. Ecosystem management cannot be successful without participation of all federal and nonfederal landowners and agencies that affect a watershed. The federal agencies must foster a partnership for ecosystem management with these entities in order to ensure conservation and prevent further degradation of the region's aquatic resources.

Probable Sale Quantity Implications of Mitigation

To increase the likelihood of achieving outcome A for fish habitat of all races/species/groups to 80 percent or greater in Options 2, 3, 5, 6, 9, and 10, we recommend two possible strategies. One strategy is to replace the Riparian Reserve 2 scenario used in these options with the Riparian Reserve 1 scenario. Application of Riparian Reserve 1 scenario provides greater protection for fish habitat in non-Key Watersheds. If Riparian Reserve 1 scenario were applied to Option 9, the probable sale quantity would be reduced approximately ten percent for federal lands within the range of the northern spotted owl (Johnson et al. 1993).

If the Riparian Reserve 2 scenario were replaced by Riparian Reserve 1 only in coastal areas, then the probable sale quantity for all federal lands within the range of the northern spotted owl would be reduced by 3-4 percent (30-40 million board feet) (Johnson et al. 1993). The Siuslaw National Forest would have the largest relative decrease in probable sale quantity.

A second mitigation strategy is to provide greater protection for Key Watersheds. This could be achieved by removing Key Watersheds from the timber-suitable base. Removing Key Watersheds from the timber base would decrease the potential sale quantity for Options 2, 3, 5, 6, 9, and 10 by approximately 15-20 percent (Johnson et al. 1993).

Proposed Screening Procedure for Short-term Sale Program and Volume Under Contract to Minimize Aquatic Ecosystem Impacts

A proposal is being developed to screen "Sold and Awarded Sales" and "Prepared Sales" to reduce effects on aquatic ecosystems. Our primary focus is directed toward the impact of sales in these two categories on moderate and high risk fish stocks in Key Watersheds and inventoried roadless areas. We believe the long-term risk to these fish stocks and water quality in other basins from sold sales is probably minimal. To reduce risks in non-Key Watersheds, prepared sales should be adjusted to interim widths of Riparian Reserves before proceeding. We recommend that a review team be assembled to screen these sales. The team should be interdisciplinary and include fish biologists, geomorphologists, or other physical scientists from various federal agencies and universities. The following approach addresses only aquatic concerns. Obviously, a complete analysis of these sales must take into account marbled murrelet, northern spotted owl and other considerations.

Summary of suggested approach:

For non-Key Watersheds, outside of roadless areas:

- Proceed with Sold and Awarded Sales.

- Adjust prepared sales, based on a site analysis, to interim widths of Riparian Reserves before proceeding.

For Key Watersheds and Inventoried Roadless Areas:

- Sold and Awarded Sales.

- If Moderate or High Risk fish stocks are not present, conduct a site analysis before proceeding.

- If Moderate or High Risk fish stocks are present, conduct an indepth review of sales and proceed unless an *unacceptably high physical risk* is present and sale cannot be adequately adjusted.

- Prepared sales

- If Moderate or High Risk fish stocks are not present and a low physical risk exists, adjust based on a site analysis to interim widths of Riparian Reserves before proceeding.

- If Moderate or High Risk fish stocks are present, adjust based on a site analysis to interim widths of Riparian Reserves unless degree of physical risk warrants a watershed analysis before proceeding.

Much of the data required by this suggested approach is available. For example, stocks at risk (appendix V-C) and Key Watersheds (appendix V-H) have been identified. It is the duty of the interagency review team to determine how risk is defined; define thresholds such as 'Unacceptably High Physical Risk'; develop components of the site analysis; and ascertain when field review of sales is required. Undoubtedly, coordination with the technical team developing the Watershed Analysis Handbook will be necessary. All new sales must conform to the Aquatic Conservation Strategy.

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Appendix V-A
Physiographic Provinces and Subprovinces

The physiographic provinces (also referred to as "provinces" or "geoclimatic provinces") incorporate physical, biological and environmental factors that shape broad-scale landscapes. Physiographic provinces reflect differences in geology (e.g., uplift rates, and recent volcanism, tectonic disruption) and climate (e.g., precipitation, temperature, and glaciation). These factors result in broad-scale differences in soil development and natural plant communities. Within each province, variable characteristics of rock stability affect steepness of local slopes, soil texture, soil thickness, drainage patterns, and erosional processes. Thus, physiographic provinces have utility in the description of both terrestrial and aquatic ecosystems.

Because terrestrial and aquatic ecosystems are dominated by different processes, the aquatic and terrestrial ecosystems working groups have used different physiographic province boundaries. In addition, state administrative boundaries have been incorporated into the provinces to reflect differences in land use and areas of analysis for past and current documents, including the Forest Ecosystems Management Assessment. Physiographic or geoclimatic provinces which integrate physical processes for both terrestrial and aquatic ecosystems are required. The hierarchy of provinces and subprovinces shown on figure V-A-1 is based on the criteria discussed below.

<u>Province boundaries</u> (shown in bold lines) are based on long-term influences of geology and climate which are independent of the current climate. Past/current volcanism, glaciation, and tectonism/metamorphism have created physiographic effects on climate and dispersal patterns as well as physical (chemical and mechanical) processes.

<u>Subprovince boundaries</u> (shown in dashed lines) are based on the influence of the current climatic setting on soil development and biological processes.

<u>Administrative (state) boundaries</u> (shown in dotted lines) are retained to accommodate the description of land use patterns and analysis of data completed by the Forest Ecosystem Management Assessment Team.

Olympic Peninsula Province

The Olympic Peninsula in northwestern Washington is a mountainous region isolated on three sides by water and on the fourth side by an extensive region of cutover state and private lands (the Western Washington Lowlands). Streams flow outward from a central core of rugged mountains onto gently sloping lowlands. Landforms have been influenced by glaciation; main rivers flow in broad, U-shaped valleys, and peaks are surrounded by cirques. Steep slopes developed on resistant rocks are subject to narrow, shallow rapid landslides (debris flows) originating from the heads of stream channels. Debris flows commonly scour steep tributary streams and deposit debris in fans on the valley floors. Unconsolidated glacial deposits are subject to accelerated stream bank erosion and landslides.

Vegetation and climate on the peninsula include a mixture of coniferous rain forests on the western slopes of the Olympic Mountains and relatively dry Douglas-fir forests in the rain shadow on the eastern slopes. This region is home to many species associated with late-successional/old-growth forests, including spotted owls, goshawks, marten and marbled murrelets. Although only a few nests have been found, large numbers of marbled murrelets are resident offshore and apparently nest on the peninsula. The dark, interior forest race of the northern goshawk occurs on the peninsula and may represent a unique subspecies.

The Olympic National Park occupies the interior of the Olympic Peninsula. It is surrounded by the Olympic National Forest, which is surrounded by extensive areas of private land, Indian reservations, and state owned lands. Much of the Olympic National Park consists of high-elevation forests and subalpine areas. However, lowland valleys within the park contain significant areas of late-successional/old-growth forest.

The Olympic National Forest is characterized by a fragmented mixture of clearcuts, young plantations, and natural forests ranging from young stands to stands more than 500 years old. The southern edge of the National Forest includes an extensive area referred to as the "Shelton Sustained Yield Unit," which was largely clearcut between 1960 and 1985. The National Forest includes several small wilderness areas on the east slope of the Olympic Range adjacent to the National Park. Most private lands, state lands, and Indian reservation lands on the peninsula have been clearcut within the last 80 years. Some of the latter areas are now being clearcut for the second time.

Puget/Willamette Trough Province

Western Washington Lowlands Subprovince (Puget Sound section)

Puget Sound is a depressed, glaciated area that is now partially submerged. Unconsolidated deposits of alluvial and glacial materials are subject to accelerated stream bank erosion and landslides. This area also includes extensive agricultural and metropolitan areas.

Willamette Valley Subprovince

The Willamette Valley includes the lowland valley area, which lies within a broad structural depression between the Coast Range and Cascade Range in western Oregon. The Willamette River meanders northward along a very gentle valley slope. Unconsolidated deposits of alluvial and glacial materials are subject to accelerated stream bank erosion and landslides. This area, which was originally covered by of a mosaic of lowland coniferous and deciduous forests and native prairie grasslands, was mostly cleared in the 1800's and early 1900's and converted to farmland, residential areas and metropolitan areas. Land ownership is largely private.

North Cascades Province

Western Washington Cascades Subprovince (North section) and Eastern Washington Cascades Subprovince (North section)

The North Cascades exhibit extremely high relief in comparison to other provinces (fig. V-1). Glaciers have carved deep and steep-sided valleys into both resistant and weak rocks. Tributaries flow at high angles into broad U-shaped valleys such as that occupied by Lake Chelan. Steep slopes are subject to debris flows from the heads of stream channels. Unconsolidated glacial and volcanic deposits are subject to accelerated stream bank erosion and landslides.

Lower and middle elevation forests of the Western Washington Cascades Subprovince (north section) consist primarily of Douglas-fir and western hemlock. The higher elevations support forests of silver fir and mountain hemlock. Although some National Parks and wilderness areas within this region include significant areas of mid-elevation late-successional/old-growth forest, most are dominated by high elevation areas of alpine or subalpine vegetation. The Eastern Washington Cascades Subprovince (north section) is dominated by mixed-conifer forests and ponderosa pine forests at mid- to lower elevations and by true fir forests at higher elevations.

High Cascades Province

The province consists of volcanic landforms with varying degrees of glaciation. Lava flows form relatively stable plateaus, capped by the recent Cascade volcanoes. Drainages are generally not yet well-developed or otherwise disperse into highly permeable volcanic deposits. Geologically recent volcanic deposits are subject to large debris flows when saturated by snowmelt.

Eastern Washington Cascades Subprovince (South section) and Eastern Oregon Cascades Subprovince

The higher elevations support forests of silver fir and mountain hemlock. Although some National Parks and wilderness areas within this region include significant areas of mid-elevation late-successional/old-growth forest, most are dominated by high elevation areas of alpine or subalpine vegetation. This area is dominated by mixed-conifer forests and ponderosa pine forests at mid- to lower elevations and by true fir forests at higher elevations.

Land ownership patterns include a mixture of Forest Service, private, state, Indian, National Park Service and Bureau of Land Management lands. Forests in this region are highly fragmented due to a variety of natural factors (e.g., poor soils, high fire frequencies, and high elevations) and human-induced factors (i.e., clearcutting and selective harvest).

Before the advent of fire suppression in the early 1900's, wildfires played a major role in shaping the forests of this region. Intensive fire suppression efforts in the last 60 years have resulted in significant fuel accumulations in some areas and shifts in tree species composition. These changes may have made forests more susceptible to large high severity fires and to epidemic attacks of insects and diseases. Any plan to protect late-successional/old-growth forests in this area must include considerable attention to fire management and to the stability of forest stands.

California (South) Cascades Subprovince

The California Cascades Subprovince includes the extreme southern end of the Cascades Range, which extends into California. Forests in this region are dominated by mixed conifer or ponderosa pine associations on relatively dry sites. Ownership is mixed with some areas of consolidated Forest Service lands and some areas of intermixed Forest Service and private lands. Forests are highly fragmented due to natural factors and harvest activities.

Fire plays an important role in the California Cascades in maintaining fire-adapted pine communities. Because of modern fire suppression, mixed conifer communities have increased, gradually replacing pine-dominated stands. If the objective is to manage a portion of the landscape in fire-dependent old-growth forests, then management must include understory thinning and understory burning.

Western Cascades Province

The Western Cascades are distinguished from the High Cascades by older volcanic activity and longer glacial history. Ridge crests at generally similar elevations are separated by steep, deeply dissected valleys. Complex eruption materials juxtapose relatively stable lava flows and volcanic deposits that weather to thick soils and are subject to earthflows. Unconsolidated alluvial and glacial deposits are subject to stream bank erosion and landslides. Tributary channels flow at large angles into wide, glaciated valleys. This region is dominated by humid forests of Douglas-fir and western hemlock.

Western Washington Cascades Subprovince (South section) and Western Oregon Cascades Subprovince

Forests of these subprovinces consist primarily of Douglas-fir and western hemlock at lower to middle elevations. Land ownerships include a mixture of private and state lands, National Forests. The Bureau of Land Management administers extensive areas in the Western Oregon Cascades Province. Private and state lands within this area are mostly cutover, whereas Federally administered lands still include significant areas (albeit highly fragmented) of late-successional/old-growth forest. Forests at the southern section of the subprovince are largely replaced by mixed conifer forests of Douglas-fir, grand fir and incense cedar.

A large proportion of the known spotted owl population in Washington and Oregon occurs in the Western Cascades. In Washington, old-growth forests on Federal lands in the Western Cascades are also important nesting habitat for marbled murrelets.

Washington/Oregon Coast Range Province

The southern part of the province generally consists of steep slopes with narrow ridges developed on resistant sedimentary rocks. Westward flowing streams erode headward to mountain passes on the east side of the Coast Range. Many of the higher peaks are composed of resistant igneous rocks. Steep, highly dissected slopes are subject to debris flows. Tributary channels join at relatively low angles, which allow debris flows to travel for long distances. In the area drained by the Wilson and Trask Rivers in Oregon, weaker rocks form gentle slopes with thick soils that are subject to large, thick, slow-moving landslides (earthflows). Earthflows may constrict or deflect stream channels, creating local low-gradient stream reaches upstream.

Western Washington Lowlands Subprovince (Coast section)

The Western Washington Lowlands Subprovince includes western Washington south of the Olympic Peninsula. This area is largely in state and private ownership and has been almost entirely clearcut within the last 80 years. It is now dominated by a mixture of recent clearcuts and young stands on cutover areas. Forests on cutover areas are dominated by even-aged mixtures of Douglas-fir, western hemlock and red alder. The.

Western Washington Lowlands includes a major portion of the breeding range of the marbled murrelet in Washington.

Oregon Coast Range Subprovince

The subprovince includes the coastal mountains of western Oregon, from the Columbia River south to the Middle Fork of the Coquille River. This area is dominated by forests of Douglas-fir, western hemlock and western redcedar. The southern half of the subprovince includes a mixture of private lands, Forest Service lands and Bureau of Land Management lands. The northern half is largely in private and state ownership. Heavy cutting and several extensive wildfires during the last century have eliminated most old-growth forests in the northern end the province. Older forests in the southern half of the province are highly fragmented, especially on Bureau of Land Management lands, which are typically intermixed with cutover private lands in a checkerboard pattern of alternating square-mile sections.

Before the advent of fire suppression, the subprovince was subject to frequent fires. As a result, many of the remaining natural forests consist of a mosaic of mature stands and remnant patches of old-growth trees. Because it is isolated and heavily cutover, the area is of concern for spotted owls, marbled murrelets, and anadromous fish.

Klamath/Siskiyou Province

The Klamath/Siskiyou province is located in southwestern Oregon and northwestern California. The province is rugged and deeply dissected. Tributary streams generally follow the northeast-southwest orientation of rock structure created by accretion of rocks onto the continent. Variable materials juxtapose steep slopes subject to debris flows and gentle slopes subject to earthflows. Scattered granitic rocks are subject to debris flows and severe surface erosion. High rates of uplift have created steep streamside hillslopes known as inner gorges, especially near the coast.

Oregon Klamath Subprovince and California Klamath Subprovince

This area is dominated by mixed conifer and mixed conifer/hardwood forests. Land ownerships include a mixture of Forest Service, Bureau of Land Management, private and state lands. Forests are highly fragmented by natural factors (e.g., poor soils, dry climate, and wildfires) and human-induced factors (e.g., harvest and roads). Much of the historical harvest in this area has been selective cutting rather than clearcutting. As a result, many stands that were logged in the early 1900's include a mixture of old trees left after harvest and younger trees that regenerated after harvest. Hillslope and channel disturbance due to mining activities began in the 1850's and still continues.

Much of the area within the Province is characterized by high fire frequencies. Any plan to protect late-successional/old-growth forests in these areas must include careful consideration of fire management.

East Klamath/Siskiyou Subprovince

Climatic and vegetation gradients indicate that this additional subprovince be added to the classification, but it has not been incorporated into the present analysis.

Franciscan Province

California Coast Range Subprovince and Oregon Franciscan Subprovince

The Oregon Franciscan Subprovince includes a coastal strip that extends from south of Coos Bay to the Oregon/California border. Geologic and climatic factors indicate that this additional subprovince be added to the classification, but it has not been incorporated into the present analysis. The California Coast Range Subprovince includes the coastal strip that extends from the Oregon border south to Marin County, California.

The Franciscan Province consists of accreted rocks, with structural discontinuities reflected in general stream orientations of northwest-southeast. Relatively rapid tectonic uplift has caused the dissected stream channels to become incised, creating inner gorges. Weak rocks are highly fractured along numerous faults and contacts and are weathered to deep soils that are subject to extensive earthflows. Sediment transport rates are among the highest in the world.

This area is dominated by redwood forests and mixed forests of Douglas-fir and hardwoods. Most of the area is privately owned, but Forest Service lands, Bureau of Land Management lands and state and Federal parks are also present. This area includes the coastal fog belt in which grow the last remaining stands of old-growth redwoods. Considerable numbers of spotted owls occur on private lands in the area. In addition, this is an important nesting area for murrelets.

Appendix V-B
Common and Scientific Names of Fish Discussed in the Chapter

Chinook salmon	*Oncorhynchus tshawystcha*
Coho salmon	*O. kisutch*
Sockeye salmon	*O. nerka*
Chum salmon	*O. keta*
Pink salmon	*O. gorbuscha*
Steelhead trout	*O. mykiss gairdneri*
Sea-run Cutthroat trout	*O. clarki clarki*
Rainbow trout	*O. mykiss*
Redband trout	*O. mykiss spp.*
Cutthroat trout	*O. clarki*
Pacific lamprey	*Lampetra tridentata*
Bull trout	*Salvelinus confluentus*
Dolly varden	*S. malma*
Mountain whitefish	*Prosopium williamsoni*
Umpqua chub	*Oregonichthys kalawatsèti*
Oregon chub	*Oregonichthys crameri*
Umpqua squawfish	*Ptychocheilus umpquae*
Olympic mudminnow	*Novumbra hubbsi*
Longnose dace	*Rhinichthys cataractae*
Millicoma dace	*R. cataractae spp.*
Reticulate sculpin	*Cottus perplexus*
Paiute sculpin	*C. beldingi*
Riffle scuplin	*C. gulosus*
Shorthead sculpin	*C. confusus*
Torrent sculpin	*C. rhotheus*
Mottled sculpin	*C. bairdi*
Coastrange sculpin	*C. aleuticus*
Jenny Creek sucker	*Catostomus rimiculus spp.*
Salish sucker	*Catostomus sp.*
Klamath short-nose sucker	*Chasmistes brevirostris*
Lost River sucker	*Deltistes luxatus*
Redside shiner	*Richardsonius balteatus*

Appendix V-C
At-Risk Anadromous Fish Stocks

This appendix: 1) Identifies the risk rating criteria for the individual stocks listed in different reports (table V-C-1); 2) gives the total numbers of individual at-risk stocks of anadromous salmonid found on federal and nonfederal lands within the range of the northern spotted owl (table V-C-3). The list was compiled from: Nehlsen et al. (1991), Higgins et al. (1992), Nickelson et al. (1992), and Washington Department of Fisheries et al. (1992).

Although the risk ratings are not exactly comparable between reports, we compiled them in the following way:

Table V-C-1. Risk rating criteria.

Risk Rating	Nehlsen et al.	Higgins et al.	Nickelson et al.	Washington Dept. of Fisheries et al.
0	–	–	–	Extinct
1	High Risk of Extinction (A)	High Risk of Extinction (A)	Special Concern	Critical
2	Moderate Risk of Extinction (B)	Moderate Risk of Extinction (B)	Depressed	Depressed
3	Special Concern (C)	Special Concern (C)	–	–
4	–	–	Unknown	Unknown
5	–	–	Healthy	Healthy

Table V-C-2. Number of stocks at risk (a) on federal and nonfederal lands within the range of the northern spotted owl.

Race	Forest Service (b)	Bureau of Land Management (b) (c)	National Park Service (c)	Total on federal lands	Total on Nonfederal lands
Spring/Summer Chinook salmon	39	3	0	42	1
Fall Chinook salmon	32	2	1	35	3
Coho salmon	59	11	1	71	27
Sockeye salmon	1	0	2	3	3
Chum salmon	21	2	1	24	4
Pink salmon	5	0	0	6	1
Winter Steelhead	34	4	0	38	16
Summer Steelhead	35	0	0	35	0
Sea-run Cutthroat trout	4	1	0	5	0
Total	231	23	5	259	55

[a] At risk is defined here as stocks rated as either 1 or a 2 by one or more of the reports used in constructing this chart.
[b] Includes basins in which the Forest Service and/or BLM land is not accessed by anadromous fish due to natural barriers, dams, or placement of federal land within basin. Many of these are important in maintaining water quality for anadromous fish runs.
[c] Counts basins in which the BLM or National Park Service manages land only if the Forest Service does not.

APPENDIX C: At-Risk Anadromous Fish Stocks

This appendix: 1) Identifies the risk rating criteria for the individual stocks listed in different reports (table V–C1); 2) gives the total numbers of individiual at–risk stocks of anadromous salmonid found on federal and nonfederal lands within the range of the northern spotted owl (table V–C3). The list was compiled from: Nehlsen et al. (1991), Higgins et al. (1992), Nickelson et al. (1992), and Washington Department of Fisheries et al. (1992).

Although the risk ratings are not exactly comparable between reports, we compiled them in the following way:

Table V-C-1. Risk rating criteria.

Risk Rating	Nehlsen et al.	Higgins et al.	Nickelson et al.	Washington Dept. of Fisheries et al.
0	--	--	--	Extinct
1	High Risk of Extinction (A)	High Risk of Extinction (A)	Special Concern	Critical
2	Moderate Risk of Extinction (B)	Moderate Risk of Extinction (B)	Depressed	Depressed
3	Special Concern (C)	Special Concern (C)	--	--
4	--	--	Unknown	Unknown
5	--	--	Healthy	Healthy

Table V-C-2. Number of stocks at risk (a) on federal and nonfederal lands within the range of the northern spotted owl.

Race	Forest Service (b)	Bureau of Land Management (b) (c)	National Park Service (c)	Total on federal lands	Total on Nonfederal lands
Spring/Summer Chinook salmon	39	3	0	42	1
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Coho salmon	59	11	1	71	27
Sockeye salmon	1	0	2	3	3
Chum salmon	21	2	1	24	4
Pink salmon	5	0	0	6	1
Winter Steelhead	34	4	0	38	16
Summer Steelhead	35	0	0	35	0
Sea-run Cutthroat trout	4	1	0	5	0
Total	231	23	5	259	55

a At risk is defined here as stocks rated as either 1 or a 2 by one or more of the reports used in constructing this chart.

b Includes basins in which the Forest Service and/or BLM land is not accessed by anadromous fish due to natural barriers, dams, or placement of federal land within basin. Many of these are important in maintaining water quality for anadromous fish runs.

c Counts basins in which the BLM or National Park Service manages land only if the Forest Service does not.

Table V-C-3. Anadromous salmonid stocks at risk within the range of the northern spotted owl.

Race Stock	Nehlsen et al.	Higgins et al.	Nickelson et al.	WA Dept. of Fisheries et al.	BLM Districts	National Forests	Key Watersheds
Winter Chinook							
California							
Sacramento (E)	see footnote				Ukiah	Shasta-Trinity(A), Mendocino(A and/or B)	
Spring/Summer Chinook							
California							
Klamath/Salmon (spr)	1	1			Ukiah	Six Rivers, Klamath, Shasta-Trinity, (Hoopa Indian Res.)	CF-143-146,149-154 CF-156-161
Trinity (spr)		3			Ukiah	Six Rivers, Shasta-Trinity	CF-143-146,153,154
S. Fk. Trinity (spr)		1				Six Rivers, Shasta-Trinity	CF-145,153
Smith (spr)	1	1				Six Rivers	CF-155,OF-44
Oregon							
Coquille (spr)	1		2		Coos Bay, Roseburg	Siskiyou	OU-59;OB-60,61
S. Umpqua (spr)	1		2		Roseburg, Medford	Umpqua	OU-86
Siuslaw (spr)			4		Eugene	Siuslaw	OF-68-70
Alsea (spr)	3		5		Salem, Eugene	Siuslaw	OU-73;OB-74,75
Siletz (spr/su)	3		5		Salem	Siuslaw	OU-77;OB-78
Nestucca (spr)			1		Salem	Siuslaw	OB-79;OF-80-82
Tillamook Bay							
Trask (spr)			1		Salem, (Tillamook SF)		OB-85
Wilson (spr)			1		Salem, (Tillamook SF)		OB-84
Kilchis (spr)			1		Salem, (Tillamook SF)		OB-83
Nehalem (su)	3		5		Salem, (Tillamook SF) (Clatsop SF)		
Columbia							
Willamette (spr)	3				Salem, Eugene	Willamette, Mt. Hood	OF-110,112-116; OB-117;OU-110
Sandy (spr)	1				Salem	Mt. Hood	OU-127;OF-128
Hood (spr)	1				Prineville	Mt. Hood	OF-119
Washington							
Yakima							
Upper Yakima (spr)				2		Wenatchee	WF-11
Naches (spr)				2		Wenatchee	WF-11-13
American (spr)				2		Wenatchee	WF-13
Wenatchee (su)				5	Spokane	Wenatchee	WF-15-18
Chiwawa (spr)				2		Wenatchee	WF-18
Lt. Wenatchee (spr)				2		Wenatchee	WF-18
Nason Cr. (spr)				2		Wenatchee	
White (spr)				2		Wenatchee	WF-18
Entiat (spr)				2	Spokane	Wenatchee	WF-19
Methow (su)	2			2	Spokane	Okanogan	WF-20-22
Methow (spr)				2	Spokane	Okanogan	WF-20-22
Twisp (spr)				2	Spokane	Okanogan	WF-20
Lost (spr)				2		Okanogan	WF-21
Chewack (spr)				2		Okanogan	WF-22
Okanogan (su)	3			2	Spokane	Okanogan	
WA Coast							
Grays Harbor/Chehalis							
Satsop (su)				2		Olympic, (Olympic NP)	WF-34
Wynoochee (spr)	1			5		Olympic, (Olympic NP)	WF-33
Quinault (spr)				2		Olympic, (Olympic NP), (Quinault Indian Res.)	WF-41
Queets (spr)				2		Olympic, (Olympic NP), (Quinault Indian Res.)	
Clearwater (spr)				2		(Quinault Indian Res.)	
Quillayute (su)				4		Olympic, (Olympic NP)	WF-40
Quill./Bogachiel (su)				4		Olympic, (Olympic NP)	
Calawah (su)				4		Olympic, (Olympic NP)	
Strait of Juan de Fuca							
Elwha (spr)	1					Olympic(A), (Olympic NP)	WF-39
Dungeness (spr) (SASSI is for spr/su)	1			1		Olympic, (Olympic NP)	WF-38
Hood Canal							
Dosewallips (spr)	1					Olympic, (Olympic NP)	WF-37
Skokomish	1					Olympic, (Olympic NP), (Skokomish Indian Res.)	WF-35,42

Table V-C-3. (Continued).

Race Stock	Nehlsen et al.	Higgins et al.	Nickelson et al.	WA Dept. of Fisheries et al.	BLM Districts	National Forests	Key Watersheds
Spring/Summer Chinook (continued)							
Puget Sound							
Puyallup							
White (spr)	2			1		Mt. Baker-Snoqualmie, (Mt. Rainier NP)	WF-23
White (su/fall)				4		Mt. Baker-Snoqualmie, (Mt. Rainier NP)	WF-23
Lake Washington							
N.Lk.Wa. tribs. (su/fall)				4			
Cedar (su/fall)				4		(City of Seattle)	
Snohomish (su)				2		Mt. Baker-Snoqualmie	WF-24,25
Stillaguamish (su)				2	Spokane	Mt. Baker-Snoqualmie	WF-26-28
Stillaguamish (spr)	1				Spokane	Mt. Baker-Snoqualmie	WF-26-28
Skagit							
Lower Sauk (su)				2		Mt. Baker-Snoqualmie	WF-29
Suiattle (spr)				2		Mt. Baker-Snoqualmie	WF-30
Upper Cascade (spr)				4		Mt. Baker-Snoqualmie, (N. Cascades NP)	
Nooksack							
N. Fk. Nooksack	1			1		Mt. Baker-Snoqualmie, (N. Cascades NP), (Lummi Indian Res.)	WF-32
S. Fk. Nooksack	1			1		Mt. Baker-Snoqualmie, (Lummi Indian Res.)	WF-31
Fall Chinook							
California							
Mattole	1	1			Ukiah, Arcata, (King Range NCA)		CB-162
Russian	1						
Bear		3					
Eel		3			Ukiah, (Humboldt Redwoods SP)	Mendocino, Six Rivers, (Round Valley Indian Res.)	CF-140-142,147
Lower Eel (H)	2				Ukiah, (Humboldt Redwoods SP)	Six Rivers(B)	CF-147
Humboldt Bay tribs.	1	1			Ukiah		
Mad	2	3			Ukiah	Six Rivers	CF-148
Little R.		3					
Redwood Cr.	2	3			Ukiah	Six Rivers(B), (Redwood NP)	
Klamath							
Lower Klamath tribs. (G)	2	2			Ukiah	Six Rivers, (Hoopa Indian Res.)	CF-151
Trinity	3				Ukiah	Six Rivers, Shasta-Trinity	CF-143-146 153,154
S. Fk. Trinity		3				Six Rivers, Shasta-Trinity	CF-145,153
Scott	3	3			Ukiah	Klamath	
Shasta	1	1			Ukiah	Shasta-Trinity(A), Klamath(A)	
Smith	2					Six Rivers, Siskiyou	
Oregon							
Winchuck	2		2			Siskiyou	OF-45
Chetco			1		Coos Bay	Siskiyou	OF-46;OB-47
Pistol	2		2		Coos Bay	Siskiyou	
Hunter Cr.	1		2		Coos Bay	Siskiyou	
Rogue							
Lower Rogue tribs. (I)	1		2		Coos Bay	Siskiyou	OF-51-54,56;OU-55
Illinois			2		Medford	Siskiyou	OF-51-54,56;OU-55
Euchre Cr.	1		2		Coos Bay	Siskiyou	
Elk			1		Coos Bay	Siskiyou	OF-57
Sixes			1		Coos Bay	Siskiyou	OF-58
New R.							
Floras Cr.			4		Coos Bay		
Coos	3		5		Coos Bay, (Elliot SF)		OB-62
Big Cr.			4			Siuslaw	OF-71
Yachats	2		4		Salem	Siuslaw	OF-72
Beaver Cr.			4		Salem	Siuslaw	
Yaquina	3		5		Salem	Siuslaw	OF-76
Drift Cr. (Siletz Bay)			4		Salem	Siuslaw	OU-77
Schooner Cr.			4		Salem	Siuslaw	
Salmon			1		Salem	Siuslaw	
Neskowin Cr.			4			Siuslaw	
Nehalem			5		Salem, (Tillamook SF),		

Table V-C-3. (Continued).

Race Stock	Nehlsen et al.	Higgins et al.	Nickelson et al.	WA Dept. of Fisheries et al.	BLM Districts	National Forests	Key Watersheds
					(Clatsop SF)		
Fall Chinook (continued)							
Salmonberry			4		(Tillamook SF), (Clatsop SF)		
Columbia							
Sandy	1					Mt. Hood(B)	OU-127;OF-128
Hood	1				Prineville	Mt. Hood	OF-119
L.Columbia (small tribs.)	1				Salem, Prineville, Spokane	Mt. Hood, Gifford Pinchot(B)	OF-118,120;WF-3
Washington							
Cowlitz	1					Gifford Pinchot(A)(C)	WF-7-10
Toutle						Gifford Pinchot	
Green				2		Gifford Pinchot, (Mt. St. Helens NVM)	
S. Fk. Toutle				2		Gifford Pinchot, (Mt. St. Helens NVM)	
Washougal	1					Gifford Pinchot(B)	
Wind (tule)				2		Gifford Pinchot	WF-1
White Salmon (SASSI rating for tule)	1			2		Gifford Pinchot(B)	WF-5
WA Coast							
Willapa Bay							
North R.							
Fall R. (early)				2			
Grays Harbor							
Johns/Elk/S. Bay tribs.				4			
Copalis				4			
Moclips				4		(Quinault Indian Res.)	
Raft				4		(Quinault Indian Res.)	
Ozette R.	1					(Olympic NP)	
Strait of Juan de Fuca							
Dungeness	1					Olympic, (Olympic NP)	WF-38
Hoko				2			
Hood Canal							
Dosewallips	1					Olympic, (Olympic NP)	WF-37
Duckabush	1					Olympic, (Olympic NP)	WF-36
Puget Sound							
Puyallup	3			4		Mt. Baker-Snoqualmie, (Puyallup Indian Res.), (Muckleshoot Indian Res.)	WF-23
Snohomish				2		Mt. Baker-Snoqualmie	WF-24,25
Bridal Veil Cr.				4			
Stillaguamish				2	Spokane	Mt. Baker-Snoqualmie	WF-26-28
Skagit							
Lower Skagit mainstem and tribs.				2	Spokane	Mt. Baker-Snoqualmie, (N. Cascades NP)	
Coho							
California							
Russian		1					
CA small coastal N. of S.F.	2						
Pudding Cr.		1					
Gualala		1					
Garcia		1					
Navarro		3					
Albion		3					
Big		3			(Jackson SF)		
Noyo		3					
Ten Mile		3					
Bear		3					
Little		3					
Wilson Cr.		3				(Redwood NP)	
Mattole		1			Ukiah, Arcata, (King Range NCA)		CB-162
Eel		3			Ukiah	Mendocino, Six Rivers (Round Valley Indian Res.)	CF-140-142,147
Humboldt Bay tribs.		3					
Mad		1			Ukiah	Six Rivers	CF-148
Redwood Cr.		3			Ukiah	Six Rivers(B), (Redwood NP)	
Klamath	3				Ukiah	Six Rivers, Klamath, Shasta-Trinity,	CF-143-146,149-154, 156-161

Table V-C-3. (Continued).

Race	Stock	Nehlsen et al.	Higgins et al.	Nickelson et al.	WA Dept. of Fisheries et al.	BLM Districts	National Forests	Key Watersheds
Coho (continued)							(Hoopa Indian Res.)	
	Lower Klamath tribs. (G)		3				Six Rivers, (Hoopa Indian Res.)	CF-151
	Trinity		3			Ukiah	Six Rivers, Shasta-Trinity	CF-143-146,153,154
	Scott		1			Ukiah	Klamath	
Oregon								
	Small OR coastal tribs.			2		Coos Bay, Eugene, Salem	Siskiyou, Siuslaw	OF-71
	Winchuck	1		2			Siskiyou	OF-45
	Chetco	1		2		Coos Bay	Siskiyou	OF-46;OB-47
	Pistol	1		2		Coos Bay	Siskiyou	
	Hunter			2		Coos Bay	Siskiyou	
	Rogue	1				Coos Bay, Medford	Siskiyou, Rogue River	OF-48-54,56,98-101; OU-55,96,97
	Lower Rogue (I)			2		Coos Bay	Siskiyou	OF-49
	Middle Rogue (J)			2		Medford, Coos Bay	Siskiyou, Rogue River	OF-48,50,98-101;
	Upper Rogue (K)			2		Medford	Rogue River	OU-96,97
	Illinois			2		Medford	Siskiyou	OF-51-54,56;OU-55
	Applegate			2		Medford	Rogue River	OF-98-101
	Euchre Cr.			2		Coos Bay	Siskiyou	
	Elk	1		2		Coos Bay	Siskiyou	OF-57
	Sixes	1		2		Coos Bay	Siskiyou	OF-58
	New R.							
	New R. tribs.			2		Coos Bay		
	Floras Cr.	1				Coos Bay		
	Coquille	2		5		Coos Bay	Siskiyou	OU-59;OB-60,61
	S. Fk. Coquille			2		Coos Bay	Siskiyou	OU-59
	Coos	2		5		Coos Bay		OB-62
	Millicoma			2				
	Tenmile Cr.			2			Siuslaw	
	Umpqua	2				Coos Bay, Roseburg, Medford	Siuslaw, Umpqua	OF-63,65,66,87-89, 91,92;OB-64,67,93, 94;OU-86,90
	Lower Umpqua			2		Coos Bay	Siuslaw	OF-63,65,66; OB-64,67
	Smith			2		Coos Bay, Roseburg, Eugene	Siuslaw	OF-65,66;OB-67
	N. Umpqua			1		Roseburg	Umpqua	OF-87-89,91,92; OU-90
	S. Umpqua			2		Roseburg	Umpqua	OU-86
	Siuslaw	2		2		Eugene	Siuslaw	OF-68-70
	N. Fk. Siuslaw			2		Eugene	Siuslaw	OF-68
	Yachats	2		2		Salem	Siuslaw	OF-72
	tribs. S. of Alsea			2		Coos Bay, Eugene, Salem	Siskiyou, Siuslaw	OF-71
	Alsea	2		5		Salem	Siuslaw	OU-73;OB-74,75
	Drift Cr. (Alsea)			5		Salem	Siuslaw	OU-73
	tribs. N. of Alsea			2		Salem	Siuslaw	
	Beaver Cr.	2		2		Salem	Siuslaw	
	Yaquina			2		Salem	Siuslaw	OF-76
	Schooner Cr.			4		Salem	Siuslaw	
	Siletz	2		2		Salem	Siuslaw	OB-78
	Drift Cr. (Siletz Bay)			4		Salem	Siuslaw	OU-77
	Salmon	2		2		Salem	Siuslaw	
	Nestucca	2		2		Salem	Siuslaw	OB-79;OF-80-82
	Little Nestucca			2		Salem	Siuslaw	
	tribs. S. of Tillamook Bay (and N. of Alsea)			2		Salem	Siuslaw	
	Tillamook Bay	2				Salem, (Tillamook SF)		
	small Tillamook Bay tribs.			4		Salem		
	Trask			2		Salem, (Tillamook SF)		OB-85
	Wilson			2		Salem, (Tillamook SF)		OB-84
	Kilchis			2		Salem, (Tillamook SF)		OB-83
	Miami			2		(Tillamook SF)		
	Tillamook			2		Salem		
	tribs. N. of Tillamook Bay			4		Salem		

Table V-C-3. (Continued).

Race	Stock	Nehlsen et al.	Higgins et al.	Nickelson et al.	WA Dept. of Fisheries et al.	BLM Districts	National Forests	Key Watersheds
Coho (continued)								
	Nehalem	2				Salem, (Tillamook SF), (Clatsop SF)		
	Lower Nehalem			2		(Tillamook SF)		
	N. Fk. Nehalem			1		(Tillamook SF), (Clatsop SF)		
	Salmonberry			4		(Tillamook SF), (Clatsop SF)		
	Upper Nehalem			2		Salem, (Tillamook SF), (Clatsop SF)		
	Elk Cr.	2		2				
	Necanicum	2		2				
	Columbia							
	Willamette							
	Clackamas	2				Salem	Mt. Hood	OF-121-125; OU-126
	Sandy	1				Salem	Mt. Hood	OU-127;OF-128
	Hood	1				Prineville	Mt. Hood	OF-119
	L. Columbia tribs.	1				Salem, Prineville, Spokane	Mt. Hood, Gifford Pinchot	OF-118,120;WF-3
	L. Columbia small tribs. above Bonneville Dam				2	Prineville, Spokane	Mt. Hood, Gifford Pinchot	OF-118,120;WF-3
	Washington							
	Grays R.				2			
	Skamokawa Cr.				2			
	Elochoman				2			
	Mill Cr.				2			
	Abernathy Cr.				2			
	Germany Cr.				2			
	Cowlitz				2		Gifford Pinchot(A)(C)	WF-7-10
	Toutle				2		Gifford Pinchot	
	S. Fk. Toutle				2		Gifford Pinchot	
	Green				2		Gifford Pinchot	
	Coweeman				2			
	Kalama				2		Gifford Pinchot (B), (Mt. St. Helens NVM)	
	Lewis				2	Spokane	Gifford Pinchot (A)	WF-2,6
	E. Fk. Lewis				2	Spokane	Gifford Pinchot	WF-2
	Salmon Cr.				2			
	Washougal	1			2	Spokane	Gifford Pinchot (B)	
	WA Coast							
	Willapa Bay	1			4			
	Copalis				4			
	Moclips				4		(Quinault Indian Res.)	
	Quinault				4		Olympic, (Olympic NP), (Quinault Indian Res.)	WF-41
	Raft				4		(Quinault Indian Res.)	
	Queets				5		Olympic, (Olympic NP), (Quinault Indian Res.)	
	Clearwater				5	Spokane	(Quinault Indian Res.)	
	Hoh				5	Spokane	(Olympic NP)	
	Goodman/Mosquito Crs.				4		(Olympic NP)	
	Kalaloch Cr.				4		(Olympic NP)	
	Lake Ozette	3					(Olympic NP)	
	Ozette R.				4		(Olympic NP)	
	Sooes/Waatch				4		(Makah Indian Res.)	
	Strait of Juan de Fuca							
	Sekiu /Sail				2			
	Clallam				4			
	Pysht /Twin /Deep				2		Olympic	
	Lyre	1			4		Olympic	
	Elwha	1			5		Olympic(A), (Olympic NP)	WF-39
	Morse Cr.				2		(Olympic NP)	
	Dungeness				2		Olympic, (Olympic NP)	WF-38
	Sequim Bay				2		Olympic	
	Discovery Bay				1		Olympic	
	Hood Canal							
	Duckabush				2		Olympic, (Olympic NP)	WF-36
	Dosewallips R				5		Olympic, (Olympic NP)	WF-37
	SE Hood Canal				2			

Table V-C-3. (Continued).

Race	Stock	Nehlsen et al.	Higgins et al.	Nickelson et al.	WA Dept. of Fisheries et al.	BLM Districts	National Forests	Key Watersheds
Coho (continued)								
	Dewatto				2			
	NE Hood Canal				2			
	Quilcene/Dabob Bays				2		Olympic	WF-43
	Puget Sound							
	Chambers Cr.	1			5			
	Puyallup				2		Mt. Baker-Snoqualmie, (Puyallup Indian Res.), (Muckleshoot Indian Res.)	WF-23
	Duwamish /Green							
	Newaukum Cr.				2			
	Lake Washington							
	Lk.Wa./Sammamish tribs.				2			
	Cedar				4		(City of Seattle)	
	Snohomish				2	Spokane	Mt. Baker-Snoqualmie	WF-24,25
	Snoqualmie				5	Spokane	Mt. Baker-Snoqualmie	WF-24
	Skykomish				5		Mt. Baker-Snoqualmie	WF-25
	Stillaguamish				2	Spokane	Mt. Baker-Snoqualmie	WF-26-28
	Deer Cr.				4		Mt. Baker-Snoqualmie	WF-27
	Skagit				2	Spokane	Mt. Baker-Snoqualmie, (N. Cascades NP), (Ross Lake NRA)	WF-29,30
	Baker				4		Mt. Baker-Snoqualmie, (N. Cascades NP)	
	N. Puget Sound tribs.				4			
	Nooksack	1			4	Spokane	Mt. Baker-Snoqualmie, (Lummi Indian Res.), (N. Cascades NP)	WF-31,32
	Sumas/Chilliwack				4		Mt. Baker-Snoqualmie, (N. Cascades NP)	
Sockeye								
	Columbia							
	Washington							
	Okanogan	3			5	Spokane	Okanogan	
	Wenatchee	3			5	Spokane	Wenatchee	WF-15,16,18,19
	WA Coast							
	Quillayute							
	Lk. Pleasant				4		Olympic	WF-40
	Ozette R.				2		(Olympic NP)	
	Lake Ozette	2					(Olympic NP)	
	Puget Sound							
	Lake Washington							
	Lk. Washington Beach				2			
	Lk. Wa./Sammamish tribs.				2			
	Cedar				2		(City of Seattle)	
	Skagit							
	Baker	1			1		Mt. Baker-Snoqualmie, (N. Cascades NP)	
Chum								
	Oregon							
	Elk	1				Coos Bay	Siskiyou(D)	OF-57
	Sixes	1				Coos Bay	Siskiyou(D)	OF-58
	Coquille			1		Coos Bay	Siskiyou	OU-59,OB-60-61
	Coos	1		1		Coos Bay		OB-62
	Umpqua	1				Coos Bay, Roseburg, Medford	Siuslaw(B), Umpqua(B)	OF-63,65,66,87-89; 91,92;OB-64,67,93, 94;OU-86,90
	Lower Umpqua & Smith			1		Coos Bay	Siuslaw(B)	OF-63,65,66; OB-64-67
	Yachats			1		Salem	Siuslaw(B)	OF-72
	Alsea	1		1		Salem	Siuslaw	OU-73
	Yaquina	1		5		Salem	Siuslaw	OF-76
	Siletz	1		1		Salem	Siuslaw(B)	OB-78
	Drift Cr. (Siletz Bay)			1		Salem	Siuslaw(B)	OU-77
	Salmon			1		Salem	Siuslaw(B)	
	Neskowin			1			Siuslaw(B)	
	Sand Cr.			1			Siuslaw(B)	
	Nestucca	2		5		Salem	Siuslaw	OF-80-82;OB-79
	Little Nestucca			1		Salem	Siuslaw	
	Netarts	2						

Table V-C-3. (Continued).

Race	Stock	Nehlsen et al.	Higgins et al.	Nickelson et al.	WA Dept. of Fisheries et al.	BLM Districts	National Forests	Key Watersheds
Chum (continued)								
	Tillamook Bay	2				Salem, (Tillamook SF)		
	3 sm. Tillamook Bay tribs.			4				
	Miami			5		(Tillamook SF)		
	Kilchis			5		Salem, (Tillamook SF)		OB-83
	Wilson			5		Salem, (Tillamook SF)		OB-84
	Trask			5		Salem, (Tillamook SF)		OB-85
	Tillamook			5		Salem		
	Necanicum			4				
	Columbia							
	L. Columbia small tribs.	2				Salem, Prineville, Spokane	Mt. Hood, Gifford Pinchot	OF-118,120;WF-3
	Washington							
	Hamilton Cr. (fall)				2			
	Grays R. (fall)				2			
	Washougal	1					Gifford Pinchot (B)	
	WA Coast							
	Queets (fall)				4	Spokane	Olympic, (Olympic NP), (Quinault Indian Res.)	
	Hoh (fall)				4	Spokane	(Olympic NP)	
	Quillayute				4		Olympic, (Olympic NP)	WF-40
	Ozette R. (SASSI rating for fall)	1			4		(Olympic NP)	
	Hood Canal (su)	2			1		Olympic, (Olympic NP), (Skokomish Indian Res.)	
	Lower Skokomish (fall)				4		Olympic, (Skokomish Indian Res.)	WF-35
	Strait of Juan de Fuca							
	Elwha (fall)	1			4		Olympic(A), (Olympic NP)	WF-39
	Hoko/Clallam/ Sekiu (fall)				4			
	Lyre (fall)				4		Olympic	
	Dungeness/ E. Strait tribs. (fall)				4		Olympic, (Olympic NP)	WF-38
	Sequim Bay (su)				2		Olympic	
	Discovery Bay (su)				1		Olympic	
	Puget Sound							
	Puyallup/Carbon (fall)				4		Mt. Baker-Snoqualmie(B), (Mt. Rainier NP), (Puyallup Indian Res.), (Muckleshoot Indian Res.)	WF-23
	Hylebos Cr. (fall)				4			
	Henderson Inlet (fall)				4			
	Chambers Cr. (su)	2			0			
	Snohomish							
	Snoqualmie (fall)				4	Spokane	Mt. Baker-Snoqualmie	WF-24,25
	Duwamish-Green	1			4		Mt. Baker-Snoqualmie(B)	
	Skagit							
	L. Skagit tribs. (fall)(L)				4	Spokane	Mt. Baker-Snoqualmie	
	Nooksack							
	Mainstem/ S. Fk. (fall)				4	Spokane	Mt. Baker-Snoqualmie, (Lummi Indian Res.)	WF-31
+	Sumas/Chilliwack (fall)				4		Mt. Baker-Snoqualmie(B),	
Pink								
	California							
	Russian	1						
	Washington							
	Hood Canal							
	Skokomish	1					Olympic, (Olympic NP), (Skokomish Indian Res.)	WF-35
	Dosewallips				2		Olympic, (Olympic NP)	WF-37
	Strait of Juan de Fuca							
	Elwha	1			1		Olympic(A), (Olympic NP)	WF-39
	Dungeness	2					Olympic, (Olympic NP)	WF-38
	Upper Dungeness				2		Olympic, (Olympic NP)	WF-38
	Lower Dungeness				1		Olympic	WF-38
	Nooksack							
	N.Fk. & M.Fk. Nooksack				4	Spokane	Mt. Baker-Snoqualmie, (Lummi Indian Res.)	WF-32
	S. Fk. Nooksack				4		Mt. Baker-Snoqualmie, (Lumni Indian Res.)	WF-31

Table V-C-3. (Continued).

Race	Stock	Nehlsen et al.	Higgins et al.	Nickelson et al.	WA Dept. of Fisheries et al.	BLM Districts	National Forests	Key Watersheds
Winter Steelhead								
	California							
	Sacramento	1				Ukiah	Shasta-Trinity (A),	
	Oregon							
	Chetco			2		Coos Bay	Siskiyou	OF-46,OB-47
	Pistol			2		Coos Bay	Siskiyou	
	Rogue			5		Coos Bay, Medford	Siskiyou, Rogue River	OF-48-56,98-101; OU-96,97
	Illinois	2		2		Medford	Siskiyou	OF-51-54,56;OU-55
	Sixes			2		Coos Bay	Siskiyou	OF-58
	Coos			2		Coos Bay		OB-62
	Umpqua							
	Smith			2		Coos Bay	Siuslaw	OF-65,66;OB-67
	N. Umpqua			5		Roseburg	Umpqua	OF-87-89,91,92; OU-90
	Siuslaw	3		2		Eugene	Siuslaw	OF-68-70
	Big Cr.	3					Siuslaw	OF-71
	Tenmile Cr.	3		2			Siuslaw	OF-71
	Yachats	3		2		Salem	Siuslaw	OF-72
	Alsea	3		2		Salem	Siuslaw	OU-73;OB-74,75
	Yaquina	3				Salem	Siuslaw	OF-76
	Siletz	3		2		Salem	Siuslaw	OB-78
	Salmon	3		2		Salem	Siuslaw	
	Nestucca	3		2		Salem	Siuslaw	OF-80-82;OB-79
	Tillamook Bay	3				Salem, (Tillamook SF)		
	Miami			2		(Tillamook SF)		
	Kilchis			2		Salem, (Tillamook SF)		OB-83
	Wilson			2		Salem, (Tillamook SF)		OB-84
	Trask			2		Salem, (Tillamook SF)		OB-85
	Nehalem			2		(Tillamook SF), (Clatsop SF)		
	Salmonberry			2		(Tillamook SF), (Clatsop SF)		
	Necanicum			1				
	Columbia							
	Willamette							
	Calapooia	3				Eugene	Willamette	
	Clackamas	2				Salem	Mt. Hood	OF-121-125; OU-126
	Hood	1				Prineville	Mt. Hood	OF-119
	Fifteenmile Cr.	2				Prineville	Mt. Hood	OF-118
	L. Columbia small tribs. below Bonneville Dam	2				Salem, Spokane	Mt. Hood, Gifford Pinchot	
	L. Columbia small tribs. above Bonneville Dam	1				Spokane, Prineville	Mt. Hood, Gifford Pinchot	OF-118,120;WF-3
	Washington							
	Mill Cr.				2			
	Abernathy Cr.				2			
	Germany Cr.				2			
	Grays R.	3			2			
	Skamokawa Cr.				4			
	Elochoman	3			2			
	Cowlitz	2			2	Spokane	Gifford Pinchot (A)(C)	WF-7-10
	Toutle	3					Gifford Pinchot	
	Mainstem/N.Fk. Toutle				2		Gifford Pinchot, (Mt. St. Helens NVM)	
	Green				2		Gifford Pinchot, (Mt. St. Helens NVM)	
	Coweeman	3			2			
	Kalama	3			5		Gifford Pinchot(B), (Mt. St. Helens NVM)	
	Lewis	3					Gifford Pinchot (A)	WF-2,6
	E. Fk. Lewis				2		Gifford Pinchot	WF-2
	Mainstem/N.Fk. Lewis				2	Spokane	Gifford Pinchot(A), (Mt. St. Helens NVM)	WF-6

Table V-C-3. (Continued).

Race	Stock	Nehlsen et al.	Higgins et al.	Nickelson et al.	WA Dept. of Fisheries et al.	BLM Districts	National Forests	Key Watersheds
Winter Steelhead (continued)								
	Salmon Cr.				2			
	Washougal	2					Gifford Pinchot (B)	
	Mainstem Washougal				4		Gifford Pinchot (B)	
	W.Fk. of N.Fk. Washougal				4	Spokane	Gifford Pinchot(B)	
	Wind	1			4		Gifford Pinchot	WF-1
	White Salmon	1			2		Gifford Pinchot(B)	WF-5
	Hamilton Cr.				4			
	WA Coast							
	Willapa Bay							
	North/Smith Cr.				4			
	Palix				4			
	Nemah				4			
	Bear				4			
	Grays Harbor							
	Chehalis							
	Skookumchuck/ Newaukum				2			
	Satsop				2		Olympic	WF-34
	S. Harbor				4			
	Copalis				4			
	Raft				4		(Quinault Indian Res.)	
	Kalaloch Cr.				4		(Olympic NP)	
	Mosquito Cr.				4		(Olympic NP)	
	Goodman Cr.				4		(Olympic NP)	
	Ozette				4		(Olympic NP)	
	Sooes/Waatch				4		(Makah Indian Res.)	
	Strait of Juan de Fuca							
	Sail				4			
	Sekiu				4			
	Clallam				4			
	Lyre				4		Olympic, (Olympic NP)	
	Salt Cr./Independents				4		(Olympic NP)	
	Elwha				2		Olympic(A), (Olympic NP)	WF-39
	Morse Cr./Independents				2			
	Dungeness				2		Olympic, (Olympic NP)	WF-38
	Sequim Bay				4		Olympic	
	Discovery Bay				2		Olympic	
	Hood Canal							
	Dewatto	1			2			
	Tahuya	2			2			
	Union				4			
	Skokomish	3			2		Olympic, (Skokomish Indian Res.)	WF-35
	Hamma-Hamma				4		Olympic	
	Duckabush				2		Olympic, (Olympic NP)	WF-36
	Dosewallips				2		Olympic, (Olympic NP)	WF-37
	Quilcene/Dabob Bays				4		Olympic	WF-43
	Puget Sound							
	E. Kitsap				4			
	Case/Carr Inlets				4			
	Hammersley Inlet				4			
	Totten Inlet				4			
	Eld Inlet				4			
	Lake Washington	2			2		Mt. Baker-Snoqualmie	
	Skagit							
	Cascade				4	Spokane	Mt. Baker-Snoqualmie, (N. Cascades NP)	
	Samish	3			2			
	Dakota Cr.				4			
	Nooksack	3			4	Spokane	Mt. Baker-Snoqualmie, (N. Cascades NP), (Lummi Indian Res.)	WF-31,32
	N. Fk. Nooksack				4		Mt. Baker-Snoqualmie, (N. Cascades NP), (Lummi Indian Res.)	WF-32
	S. Fk. Nooksack				4		Mt. Baker-Snoqualmie, (Lummi Indian Res.)	WF-31
	M. Fk. Nooksack				4	Spokane	Mt. Baker-Snoqualmie, (N. Cascades NP), (Lummi Indian Res.)	

Table V-C-3. (Continued).

Race	Stock	Nehlsen et al.	Higgins et al.	Nickelson et al.	WA Dept. of Fisheries et al.	BLM Districts	National Forests	Key Watersheds
Summer Steelhead								
	California							
	Eel	2				Ukiah	Mendocino, Six Rivers, (Round Valley Indian Res.)	CF-140-142,147
	Van Duzen		1			Ukiah	Six Rivers(A)	
	M. Fk. Eel		3			Ukiah	Mendocino, Six Rivers	CF-140-142
	N. Fk. Eel		1			Ukiah	Six Rivers, Mendocino	CF-147
	Mad	1	1				Six Rivers	CF-148
	Redwood Cr.	1	1			Ukiah	Six Rivers(B)	
	Klamath	2					Klamath, Six Rivers, Shasta-Trinity, (Hoopa Indian Res.)	CF-143-146,149-154, CF-156-161
	Middle Klamath tribs. (F)		1			Ukiah	Six Rivers, Klamath	CF-149,150, CF-158-160
	Salmon		1			Ukiah	Klamath	CF-156,157
	Trinity							
	S. Fk. Trinity		1				Shasta-Trinity, Six Rivers	CF-145,153
	New River		2				Shasta-Trinity	CF-146
	Upper Trinity		1				Shasta-Trinity	CF-143,144
	N. Fk. Tinity		2			Ukiah	Shasta-Trinity	CF-143
	Smith	1					Six Rivers, Siskiyou	CF-155;OF-44
	Oregon							
	Rogue	2		2		Coos Bay, Medford	Siskiyou, Rogue	OF-48-54,56,98-101; OU-55,96,97
	Siletz	2		2		Salem	Siuslaw	OB-78
	Columbia							
	Hood	2				Prineville	Mt. Hood	OF-119
	L. Columbia small tribs. above Bonneville Dam	1				Spokane, Prineville	Mt. Hood, Gifford Pinchot	OF-118,120;WF-3
	Washington							
	Cowlitz	1				Spokane	Gifford Pinchot(A)(C)	WF-9
	Kalama				2		Gifford Pinchot(B), (Mt. St. Helens NVM)	
	Lewis							
	N. Fk. Lewis	1			2		Gifford Pinchot(A), (Mt. St. Helens NVM)	
	E. Fk. Lewis	3			4	Spokane	Gifford Pinchot	WF-2
	Washougal	1				Spokane	Gifford Pinchot(B)	
	Mainstem Washougal				4		Gifford Pinchot(B)	
	W.Fk. of N.Fk. Washougal				4	Spokane	Gifford Pinchot(B)	
	Rock Cr.				4	Spokane	Gifford Pinchot(B)	
	Wind	2			2		Gifford Pinchot	WF-1
	Panther Cr.				2		Gifford Pinchot	WF-1
	Trout Cr.				2		Gifford Pinchot	WF-1
	White Salmon	1			2	Spokane	Gifford Pinchot(B)	WF-5
	Yakima				2	Spokane	Wenatchee	WF-11-14
	Wenatchee	3			2	Spokane	Wenatchee	WF-15,16,18
	Entiat	1			2	Spokane	Wenatchee	WF-19
	Methow/Okanogan				2	Spokane	Okanogan	WF-20-22
	Methow	1				Spokane	Okanogan	WF-20-22
	Okanogan	1				Spokane	Okanogan	
	WA Coast							
	Grays Harbor							
	Chehalis				4	Spokane, (Capitol SF)	Olympic	WF-33,34
	Humptulips				4		Olympic	WF-41
	Quinault				4		Olympic, (Olympic NP), (Quinault Indian Res.)	
	Queets							
	Clearwater				4	Spokane	(Quinault Indian Res.)	
	Hoh				4	Spokane	(Olympic NP)	
	Quillayute							
	Calawah				4		Olympic, (Olympic NP)	
	Bogachiel				4		Olympic, (Olympic NP)	
	Sol Duc				4		Olympic, (Olympic NP)	WF-40
	Strait of Juan de Fuca							
	Elwha				2		Olympic(A), (Olympic NP)	WF-39
	Dungeness				2		Olympic, (Olympic NP)	WF-38
	Hood Canal							
	Dosewallips				4		Olympic, (Olympic NP)	WF-37
	Duckabush				4		Olympic, (Olympic NP)	WF-36

Table V-C-3. (Continued).

Race	Stock	Nehlsen et al.	Higgins et al.	Nickelson et al.	WA Dept. of Fisheries et al.	BLM Districts	National Forests	Key Watersheds
Summer Steelhead (continued)								
	Skokomish				4		Olympic, (Olympic NP), (Skokomish Indian Res.)	WF-35
	Snohomish							
	Snoqualmie							
	Tolt	1			2		Mt. Baker-Snoqualmie	
	Skykomish							
	N. Fk. Skykomish				4		Mt. Baker-Snoqualmie	WF-25
	Stillaguamish/Deer Cr.	1				Spokane	Mt. Baker-Snoqualmie	WF-26-28
	S. Fk. Stillaguamish				4		Mt. Baker-Snoqualmie	WF-26
	Canyon Cr.				4		Mt. Baker-Snoqualmie	WF-26
	Deer Cr.				1		Mt. Baker-Snoqualmie	WF-27
	Skagit							
	Cascade				4	Spokane	Mt. Baker-Snoqualmie, (N. Cascades NP)	
	Sauk				4	Spokane	Mt. Baker-Snoqualmie	WF-29,30
	Finney Cr.				4		Mt. Baker-Snoqualmie	
	Nooksack							
	S. Fk. Nooksack	2			4	Spokane	Mt. Baker-Snoqualmie, (Lummi Indian Res.)	WF-31
Sea-run Cutthroat Trout								
	California							
	CA coastal streams	2				Ukiah	Six Rivers, Trinity, Mendocino	CF-155;CB-162
	Lower Eel (H)		3			Ukiah, (Humboldt Redwoods SP)	Six Rivers	
	Lower Klamath		3			Ukiah	Six Rivers, (Hoopa Indian Res.)	CF-151
	Mad		3			Ukiah	Six Rivers	CF-148
	Wilson Cr.		3				(Redwood NP)	
	Oregon							
	OR coastal streams	2				Salem, Coos Bay,	Siskiyou, Siuslaw	OF-44,46,57,58,63, 65,66,68-72,76, 80-82;OB-47,60,61, 62,64,67,74,75,78, 79,83-85;OU-59, 73,77
	Columbia							
	Hood	1					Mt. Hood	OF-119
	L.Columbia small tribs. below Bonneville Dam	2				Salem, Spokane	Mt. Hood, Gifford Pinchot	OF-118,120;WF-3
	Washington							
	Elochoman	3						
	Cowlitz	3					Gifford Pinchot(A)	WF-7-10
	Toutle	3					Gifford Pinchot, (Mt. St. Helens NVM)	
	Coweeman	3						
	Kalama	3					Gifford Pinchot(B), (Mt. St. Helens NVM)	
	Washougal	3				Spokane	Gifford Pinchot(B)	
	Rock Cr.	1				Spokane	Gifford Pinchot(B)	
	WA coastal & Puget Sound tribs. (except tribs. to Grays Harbor & Hood Canal)	3				Spokane	Olympic, Mount Baker-Snoqualmie, (Olympic NP)	WF-38-40
	Grays Harbor & Hood Canal tribs.	3				Spokane	Olympic, (Olympic NP)	WF-35-37,43

Footnotes

a No anadromous fish run on Forest Service land due to dam blocking access.
b Forest Service or Bureau of Land Management manage headwaters above the extent of anadromy
c Anadromous fish access to Forest Service land blocked by dam but trucking of anadromous fish currently occurring.
d Possibly extinct.
e Stock is listed federally as threatened and by the state of California as endangered.
f Dillon, Elk, Indian, Clear, Red Cap, and Bluff Creeks (Higgins et al.).
g Below Weitchpec (Higgins et al.).
h Below N.Fk. Eel R. (Higgins et al.).
i Below Illinois R. (Oregon Department of Fish &Wildlife, Provisional list of wild fish populations.)
j Illinois R. to Gold Ray dam (Oregon Department of Fish and Wildlife, Provisional list of wild fish populations.)
k Above Gold Ray dam (Oregon Department of Fish and Wildlife, Provisional list of wild fish populations.)
l Below Sauk R.

Appendix V-D
Status of Water Quality

Every two years each state reviews all available information on water quality as part of a statewide water quality assessment. This assessment is required by section 305(b) of the Clean Water Act.

The 305(b) report assesses state waters (estuaries, lakes, rivers streams, wetlands) to determine whether the quality is high enough to support the beneficial uses of each individual water body. Beneficial uses include salmon (and other fish) migration, spawning, rearing and harvest, wildlife habitat, provision of domestic water supplies, and other uses identified in the water quality standards for each state. The assessments also identify the specific problems or pollutants which affect beneficial uses and the source of the pollutant. These reports assess both point and nonpoint pollutant sources.

We are becoming increasingly aware that many water quality problems are attributable to nonpoint sources (NPS) of pollution. Principal sources include stormwater, agriculture, forestry, construction, recreation, transportation, municipal and industrial activities. Major effects include temperature changes, excess nutrients, bacterial contamination, sedimentation, lowered dissolved oxygen, flow alteration and habitat alteration. States also perform statewide assessments of nonpoint source pollution as required by section 319 of the Clean Water Act. In Region 10 of EPA (Alaska, Oregon, Washington and Idaho) 60-70 percent of pollutants originate from NPS (Edwards et al. 1992).

In rural areas, including forest lands, nonpoint sources are the major pollutant problem. Problems include erosion and sedimentation, elimination of riparian vegetation which directly alters wildlife habitat and leads to temperature increases in rivers and streams, and other major habitat changes.

Section 303 of the Clean Water Act directs the states to adopt water quality standards and criteria as necessary to protect designated beneficial uses for the waters of the state. The designated agencies in the states develop and apply water quality standards and criteria for the state's waters in order to protect identified beneficial uses as delineated in states administrative rules (CWA § 303(c)(2), 40 CFR § 131.3). Criteria may be constituent concentrations, levels, or narrative statements representing water quality supporting a particular use.

Where application of current best management practices or technology based controls are not sufficient to achieve designated water quality standards, the water body is classified as "water quality limited." Under section 303 (d) of the Clean Water Act states must list those waters which are water quality limited and establish total maximum daily loads (TMDL) for these waters.

EPA has oversight responsibility for state implementation of this requirement and in the absence of state action is required to prepare TMDLs. To date, 159 water bodies in Oregon, Washington and Idaho have been included on the 303(d) lists.

Development of a TMDL consists of two key steps: 1) determination of a water body's loading capacity for a pollutant of concern, and 2) allocation of the available loading capacity to point and nonpoint sources of pollution, after consideration of any natural inputs. A TMDL must also include a margin of safety to account for any uncertainty due to a lack of information.

TMDLs fit very well into the context of watershed analysis, planning and management. They provide a basis to evaluate problems in a watershed, define the management targets for the stressors, establish implementation schedules, and establish monitoring requirements. Development of a TMDL requires the same processes proposed in the watershed analysis and currently applied cumulative effects analyses; it thus appears that TMDL requirements could be met by the interdisciplinary analytic approaches defined in the watershed analysis.

Status of water quality is summarized below for California, Washington and Oregon, the states where northern spotted owl habitat occurs. However, the assessment and summary includes information statewide since the entire state has relevancy to stocks of anadromous fish which are endangered or at risk. Data availability and accessibility varies greatly for each state. Where possible, information is provided to indicate water quality conditions on federal lands compared to state and private lands with emphasis on conditions within the range of the northern spotted owl and identified fish stocks endangered or at risk.

It is apparent that water quality problems from land use activities are severe on all ownerships. It is also clear that comprehensive improvement in support of beneficial uses such as fisheries habitat will require protection and restoration in complete watersheds, not limited by ownership boundaries.

Oregon

Oregon includes over 100,000 miles of rivers and streams. Of these, the Oregon Department of Environmental Quality has evaluated about 24,000 miles. Rivers have been evaluated based on water quality standards and categorized on the basis of whether they currently support designated beneficial uses. Estimates made in 1992 identify 12,652 miles as fully supporting or unknown, 8702 as partially supporting, and 7755 as not supporting beneficial uses (Oregon Department of Environmental Quality 1992). This data includes impairment from both point and nonpoint pollutants sources. For over 50 stream segments the state has determined that technology based controls will not be sufficient to meet water quality standards. These have been placed on the state 303(d) list.

Assessment has also been made specifically for nonpoint sources both in terms of pollutant source and cause of water quality impairment. Of 27,700 miles assessed, approximately 15,400 miles were reported to be either severely or moderately impacted by nonpoint source pollution (Edwards et al. 1992). Over 20 percent of these waters are affected by range activities and between 15 and 20 percent are affected by agriculture and a similar amount are affected by silviculture. Between 10 and 20 percent of the cause of water quality impairment is from habitat alteration, flow alteration, temperature, and siltation all of which are problems associated with forest practices.

Activities contributing to nonpoint source have also been estimated for each basin in the state. Range, agriculture and forestry activities produce the greatest impacts in terms of miles of river affected (Table V-D-1).

Oregon Stream Conditions on Federal Lands

Table V-D-2 is a summary of the known conditions of streams on federal lands in Oregon. Based on a total of 15,200 stream miles surveyed in the state of Oregon, 30 percent or 4,600 miles are moderately to severely impaired on federal lands. On federal lands within the range of the spotted owl, 25 percent or 1,900 miles of streams are moderately to severely impaired on federal lands.

Table V-D-3 is a summary of water quality parameters causing stream impairment on federal lands in the state of Oregon. The parameter reported as being the leading cause of impairment is sediment, with over 3532 stream miles impaired on federal land statewide. In the range of the spotted owl, 1413 miles are impaired due to sediment and 3726 miles on private land.

Temperature is an important cause of impairment on 7342 miles statewide. On federal lands 3071 miles are impaired due to temperature. On federal lands in the range of the spotted owl 973.1 miles are impaired and 2545 miles are impaired on private lands with owl habitat.

Turbidity, erosion and structure (bank stability) problems result in 7846 miles of impaired streams on federal land, with 1802 miles in the range of the owl. Of lesser importance to water quality impairment are nutrients and low dissolved oxygen.

Washington

The most recent statewide water quality assessment for Washington was completed in 1992. Individual assessments were conducted for 798 water bodies including lakes, estuaries rivers and streams. Of the over 40,000 miles of rivers and streams in Washington, 5,600 segments were evaluated representing 14 percent of all rivers and streams in the state (Washington Department of Ecology 1992).

Results of the 1992 assessment indicated that over 75 percent of water quality impairment in waters evaluated was related to nonpoint sources. Major NPS categories affecting surface water quality and aquatic resources in Washington include agriculture, forest practices, stormwater, on-site sewage systems, surface mining, and boats and marinas.

In rivers and streams, bacteria and thermal changes have the greatest impact on the water quality of the state's rivers and streams. Other substances having moderate to high impacts include metals, siltation, suspended solids, organic enrichment, low dissolved oxygen, and nutrients. Agriculture, particularly irrigated crop production and animal keeping, has a greater impact on rivers and streams than any of the other major nonpoint source categories. Based on current analysis, impacts from forest practices and rangeland activities are moderately low; however, these percentages reflect the relative paucity of assessment information for these sources statewide, and probably underestimate the extent of their influences, (Edwards et al. 1992).

Based on the 1992 statewide assessment over 3,000 miles of rivers and streams in Washington did not fully support designated beneficial uses (Table V-D-4) water bodies, the state has determined that technology based controls will not be sufficient to meet water quality standards.

It is estimated that about 470 miles of rivers and streams were impaired by silviculture activities and about 1210 total miles of streams were impaired on federal lands being evaluated in this report. Of the 1210 miles, 1094 were within the range of the northern spotted owl.

California

Within the State of California, the range of Northern Spotted Owl lies in the North Coastal and the Klamath Basins, 13 hydrologic Units that are assessed for water quality by the California North Coast Regional Water Quality Control Board. In those 13 Hydrologic Areas the North Coast Board has evaluated the attainment of Clean Water Act goals of aquatic habitat and contact recreation in 174 river and stream waterbodies. Water quality in approximately 88 of those waterbodies has been evaluated as being impaired. In four of the river or stream waterbodies within the range of the Northern Spotted Owl, Clean Water Act Regulations require that Total Maximum Daily Loads (TMDL) calculations for point and nonpoint sources of pollution be produced. Of the 24 waterbodies listed, 13 have nonpoint source pollution problems directly or indirectly related to present or historical logging practices.

U.S. Forest Service Lands

Forest management plans prepared by the U.S. Forest Service contain Best Management Practices including Standards and Guidelines and mitigating measures for protecting and enhancing water quality and beneficial uses affected by forestry practices. The Washington State Department of Ecology and the Forest Service cooperate in support of a full time coordinator to facilitate water quality management on Forest Service lands in Washington. An inventory has been completed of available data, water quality studies, and program evaluation has been completed. When forest plans are finalized, water quality standards, mitigation measures, and monitoring will be included in a statewide document with specified reporting and information sharing requirements. Requirements in the statewide document should be consistent with the options proposed in this report.

Table V-D-1. Suspected nonpoint sources of water quality problems in rivers where beneficial uses are not fully supported - Summary by basin of river miles affected by each source (1988 assessment).

River miles impacted by more than one source are counted separately for each source

	Nonpoint source									
Basin	Agriculture	Range	Forestry	Storm water Combined Sewers	Construction	Transport	Mining	Recreation	Natural	Other
North coast/L.Columbia	475	315	615	135	185	325	295	425	480	0
Mid coast	350	195	545	10	85	20	90	295	115	0
Umpqua	365	415	820	110	30	375	185	135	270	0
South Coast	430	180	625	40	15	75	135	15	215	0
Rogue	615	250	545	225	270	165	300	215	637	0
Willamette	720	495	585	680	485	400	420	1,225	480	5
Sandy	5	5	115	5	10	0	0	120	55	0
Hood	120	100	155	10	0	40	0	100	40	0
Deschutes	705	970	520	210	190	65	110	675	205	0
John Day	1,120	1,315	1,035	5	0	0	125	685	985	0
Umatilla/Walla Walla	620	670	140	70	50	40	45	85	75	0
Grande Ronde	390	805	680	55	60	340	135	540	70	5
Powder/Burnt	235	890	340	30	5	125	285	265	55	0
Malheur	450	630	80	70	35	0	10	270	60	0
Owyhee	230	295	30	0	0	0	145	165	35	0
Malheur Lake	160	820	270	0	0	135	0	540	75	0
Goose & Summer Lakes	145	445	145	0	0	10	0	10	90	0
Klamath	470	510	335	20	0	0	0	210	290	0
Total	7,605	9,305	7,580	1,675	1,420	2,115	2,280	6,005	4,232	10

Note: The information in this table was based on DEQ's nonpoint source assessment which was completed in 1988. The assessment is a data base which contains monitored data (based on actual sampling, including the results of DEQ's ambient monitoring) and evaluated data (based on a combination of data, observation, and professional judgment). The evaluated data were largely provided by other agencies and have not yet been verified by DEQ. The mileage numbers should therefore be treated as estimates. Updates of the assessment are planned. In this assessment, most of the information received was for major first-order streams where problems existed. If no problems were reported for a particular stream segment, that segment was grouped with the "fully supported" segments. Streams with "moderate" water quality problems were classified as "partially supported." Streams with "severe" water quality problems were classified as "not supported."

From: Oregon Department of Environmental Quality Nonpoint Source Statewide Management Program for Oregon April 1991.

Table V-D-2. State of Oregon stream condition on federal lands.

	Statewide			Spotted owl range		
	Federal ownership	Miles	(%)	Federal ownership	Miles	(%)
Severe Impairment	BLM	800	(14.7)	BLM	200	(7.5)
	FS	800	(13.4)	FS	300	(14.0)
	Non federal	4,100	(71.8)	Non federal	1,800	(78.5)
Sub-total:		5,700	100		2,300	100
Moderate Impairment	BLM	1,100	(13.4)	BLM	400	(8.5)
	FS	1,900	(21.3)	FS	1,000	(22.2)
	Non federal	5,700	(65.3)	Non federal	3,300	(69.3)
Sub-total:		8,700	100		4,700	100
Other	BLM	100	(10.0)	BLM	100	(11.6)
	FS	200	(26.3)	FS	100	(21.0)
	Non federal	500	(63.7)	Non federal	400	(67.4)
Sub-total:		800	100		600	100
Total:		15,200			7,600	

From: 1988 Oregon statewide assessment of nonpoint sources of water pollution.

Table V-D-3. Stream miles impaired on Federal lands in Oregon by water quality parameter.

Water quality parameter	Lands statewide			Federal land owl range		
	BLM	FS	Non federal	BLM	FS	Non federal
1. Temperature	1,600	1,500	4,300	300	600	2,500
2. Turbidity	1,300	1,500	6,400	300	800	3,000
3. Sedimentation	1,500	2,000	7,400	400	1,000	3,800
4. Erosion	1,400	1,500	6,700	200	500	2,600
5. Structure	1,000	1,000	3,600	300	500	1,500
6. Nutrients	300	200	2,800	46	60	1,400
7. Low DO	200	200	1,900	26	15	700
Total:	7,300	7,900	33,100	1,572	3,475	15,500

From: 1988 Oregon statewide assessment of nonpoint sources of water pollution.

Table V-D-4. Total length of rivers not fully supporting designated uses affected by various source categories.

RIVER (all size units in stream miles)		
Source categories	Major impact	Moderate/minor impact
Point sources - overall	303.80	1,127.82
Industrial point sources	285.20	842.31
Municipal point sources	18.60	592.06
Nonpoint sources - overall	1,163.48	3,215.35
Nonpoint source - unspecified	101.22	3.08
Combined sewer overflow	0.00	51.41
Agriculture - overall	213.57	1,837.76
Agriculture - unspecified	88.49	995.79
Nonirrigated crop production	0.00	4.30
Irrigated crop production	114.23	490.15
Specialty crop production	0.00	65.31
Pasture land	0.00	757.12
Range land	0.00	68.21
Feedlots - all types	0.00	89.70
Aquaculture	0.00	30.41
Animal holding/management areas	10.85	636.78
Manure lagoons	0.00	75.62
Silviculture - overall	101.80	472.84
Silviculture - unspecified	67.50	235.84
Harvesting, restoration, residue management	1.80	247.50
Forest management	2.40	150.50
Road construction/maintenance	30.10	221.20
Construction - overall	0.00	294.81
Construction - unspecified	0.00	0.00
Highway/road/bridge	0.00	21.41
Land development	0.00	287.51
Urban runoff	12.86	521.16

From Washington State Department of Ecology 1992 statewide water habitat assessment

Appendix V-E
Wetlands

Definition and Relation of Wetlands to Riparian Areas

Wetlands and riparian areas are often treated as synonymous in general discussions, and indeed their position in the landscape, interposed between aquatic and upland ecosystems, is frequently similar and overlapping. However, many riparian areas do not meet currently accepted technical criteria for wetlands nor are they inventoried as wetlands under projects such as the National Wetland Inventory of the Fish and Wildlife Service.

Wetlands – whether defined for regulatory jurisdiction (e.g., Clean Water Act regulations) or for technical analysis (e.g., inventory or functional assessment) – are characterized by a combination of hydrology, soils, and vegetation characteristics. Of greatest importance in development of wetland habitats is the presence of surface water or saturated soils for sufficient duration to promote development of plant communities that have a dominance of species adapted to survive and grow under extended periods of soil anaerobiosis.

Formal definition for implementing section 404 of the Clean Water Act is as follows:

> The term wetlands means those areas that are inundated or saturated by surface or ground water at a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs and similar areas (US Environmental Protection Agency).

Detailed technical methods have been developed to assist in identification of wetlands in the field that meet the above definition. Currently, the field manual being used for implementing the Clean Water Act is the "1987 Corps Manual" (U.S. Army Corps of Engineers 1987).

For purposes of conducting the National Wetland Inventory, the Fish and Wildlife Service has broadly defined both vegetated and nonvegetated wetlands as follows:

> Wetlands are lands transitional between terrestrial and aquatic systems where the water table is usually at or near the surface or the land is covered by shallow water. For purposes of this classification wetlands must have one or more of the following three attributes: (1) at least periodically, the land supports predominantly hydrophytes, (2) the substrate is predominantly undrained hydric soil, and (3) the substrate is nonsoil and is saturated with water or covered by shallow water at some time during the growing season of each year (Cowardin et al 1979).

This definition is accompanied by a detailed hierarchial classification comprising five systems: marine, estuarine, riverine, lacustrine, and palustrine. All of the vegetated wetlands within the range of the northern spotted owl are within the palustrine system.

Wetland habitats circumscribed by the above definitions overlap with riparian zones. Most typically, and particularly in forested landscapes, the riparian zone is defined by its spatial relation to adjacent streams or rivers. However, riparian zones are also commonly considered to be lands integrally related to other aquatic habitats such as lakes, reservoirs, intermittent streams, springs, seeps, and wetlands.

Because of such conceptual and definitional vagaries, we get the spatial overlap between wetlands and riparian zones. This then results in only a portion of the riparian zone associated with rivers and streams being considered wetlands. The extent of that portion will depend on the specifics of hydrologic, vegetation, and soil features. The functions of the wetland portion may also be distinct from the nonwetlands. For example, wetlands may provide habitat for specialized plant species or reproductive habitat for amphibians or other organisms that would not be provided by riparian areas.

Wetlands in Forest Ecosystems

While most wetlands within forested ecosystems will be spatially and functionally associated with rivers and streams, some occur more or less in isolation. Isolated wetlands will often be small but frequently have unique characteristics including habitat for specialized plants and animals. Peat systems such as fens and bogs are in this category. In the Pacific Northwest these habitats are typically over 10,000 years of age and are often referred to as the "old growth" wetlands. Specially adapted plant species such as cranberry (Vaccinium oxycoccus), sphagnum mosses and others occur here along with rare and sensitive species such as Gentiana spp.

Most of the wetlands within the forest will be in the riparian zones and the ecological functions will be integral to the nonwetland portion of the riparian zone and to the adjacent river or stream. For this reason, management alternatives in this report consider riparian wetlands within the context of the overall watershed management objectives rather than as discrete landscape entities.

Wetland Functions

Functions of wetlands and riparian areas exhibit considerable overlap, particularly in forested ecosystems are discussed in detail in other sections of this report discusses those functions and processes that relate to maintenance of high quality river and stream habitats. This section focuses on the functions generally attributed to wetlands, with emphasis on water quality, habitat, and biodiversity. This is followed by discussion of specific functions of Northwest forested wetlands and riparian zones.

The National Research Council (1992) has summarized wetland functions under 15 categories:

Flood conveyance -- Riverine wetlands and adjacent floodplain lands often form natural floodways that convey floodwaters from upstream to downstream areas.

Protection from storm waves and erosion -- Coastal wetlands and inland wetlands adjoining larger lakes and rivers reduce the impact of storm tides and waves before they reach upland areas.

Flood storage -- Inland wetlands may store water during floods and slowly release it to downstream areas, lowering flood peaks.

Sediment control -- Wetlands reduce flood flows and the velocity of floodwaters, reducing erosion and causing floodwaters to release sediment.

Habitat for fish and wildlife -- Wetlands are important spawning and nursery areas and provide sources of nutrients for commercial and recreational fin and shellfish industries, particularly in coastal areas.

Habitat for waterfowl and other wildlife -- Both coastal and inland wetlands provide essential breeding, nesting, feeding, and refuge habitats for many forms of waterfowl, other birds, mammals, and reptiles.

Habitat for rare and endangered species -- Although wetlands constitute only about 5 percent of the nation's lands, almost 35 percent of all rare and endangered animal species either are in wetland areas or are dependent on them,

Recreation -- Wetlands serve as recreation for fishing, hunting, and observing wildlife.

Source of water supply -- Wetlands are becoming increasingly important as sources of ground and surface water because of the growth of urban centers and dwindling ground and surface water supplies.

Food production -- Because of their high natural productivity, both tidal and inland wetlands have unrealized food production potential for harvesting of marsh vegetation and aquaculture.

Preservation of historic, archaeological values -- Some wetlands are of archaeological interest. Indian settlements in coastal and inland wetlands served as sources of fish and shellfish.

Education and research -- Tidal, coastal, and inland wetlands provide educational opportunities for nature observation and scientific study.

Source of open space and contribution to aesthetic values -- Both tidal and inland wetland are areas of great diversity and beauty and provide open space for recreational and visual enjoyment.

Water quality improvement -- Wetlands contribute to improving water quality by removing excess nutrients, sediments, and chemical contaminants. They are sometimes used in tertiary treatment of wastewater.

Investigations of these 15 functions have intensified in the past decade. A comprehensive literature review completed by Adamus et al. (1991) references over 1,200 reports and publications related to wetlands. Functions specific to wetlands of the Pacific Region have been summarized by Zedler, Huffman and Josselyn (1985) in cooperation with the National Wetlands Technical Council.

Water Quality Improvement

Water quality benefits of wetlands and riparian zones accrue to adjacent aquatic habitats. Sediments, inorganic nutrients, and organic toxicants are removed from water that flows across wetlands.

Mitsch and Gosselink (1986) summarize the attributes of wetlands and riparian zones that are important in water quality protection include:

1. As water enters wetlands, velocity decreases and sediments and chemicals attached to sediments drop out.

2. Chemical processes result in precipitation and removal of chemicals from water.

3. High production in wetlands can result in uptake of nutrients and eventual burial of the nutrients when plants die.

4. Chemicals are decomposed in wetland sediments.

5. A high amount of contact exists between sediments and water in wetlands, which leads to removal of pollutants from the water.

6. Accumulation of peat in many wetlands can cause burial of chemicals, which effectively isolates them from the biotic environment.

Nonpoint source pollution contributes over 65 percent of pollutant loads to U.S. inland surface waters (Olson 1992). Thus, the above described functions of wetlands are a primary focus for control of nonpoint source pollution. On a global scale, the Pantanal wetlands of Mato Grosso do Sul, Brazil, have been cited as an example of where natural wetlands perform substantial improvement in water quality and quantity (Hammer 1992). Researchers have documented nutrient and sediment removal by riparian and wetland areas in several situations. Mitsch (1992) reports up to 96 percent retention of nutrients by constructed wetlands retained Natural wetlands similar amounts of nutrients. Other studies have indicated that presence of wetlands in the watershed results in decreased surface water concentrations of inorganic suspended solids, fecal coliform, nitrates, ammonium, total phosphorous, and lead (Johnston et al. 1990). For specific wetlands of the Northwest, Reinelt et. al (1990) have demonstrated that wetlands function to remove sediment and nitrates from water that enters and flows through the wetland.

Surface waters close to discharge from wetlands and riparian zones benefit the most. This has important biological implications. For example, small headwater streams can be significant biologically for insect production, fish spawning, and rearing, etc. Small headwater streams are in integral contact with adjacent wetlands and dependent on the wetlands for protection from siltation, toxic chemicals, low summer stream flows, temperature extremes, flood flow attenuation, and elevated water temperatures.

The importance of wetlands in managing nonpoint source pollution is being emphasized by the Environmental Protection Agency and state regulatory agencies (Robb 1992). Much of the basis for establishing the importance of wetlands in nonpoint source pollution, including results of current research, is published in Ecological Engineering (1992). The alternative management options assessed in this report have as a common basis the water quality protection by riparian and wetland area from adverse sediment and nutrient inputs and temperature increases. Forest practices that result in sediment and nutrient delivery to streams and the effects attributable thereto are reviewed elsewhere in this report.

Hydrologic Functions

Riparian and fresh water impounded wetlands have the ability to temporarily detain floodwaters and attenuate flood peaks (Wald and Schaeffer 1986). Wetlands will be most efficient at reducing downstream flooding during typical flood events and efficiency will decrease during major flood events (Wald and Schaeffer 1986). But during dryer seasons, a specific wetland's ability to detain floodwaters and reduce downstream flooding or increase base stream flow depend on the physical dimensions of the wetland and its outlet, and the characteristics of the inflow flood.

Headwater reaches of drainage systems in montane regions frequently contain meadows and bogs. These areas lack forests and have seasonally varying water tables. Soils are typically sandy peats saturated nearly to the ground surface throughout the year. These meadows can intercept considerable snowfall and can increase water yield from high-elevation drainages during snowmelt (Kittredge 1948). They also can retain runoff as ground water or temporary ponds. Such ponding is less common where soils are deep, e.g., the coastal ranges of Oregon and California or where the bedrock is volcanic or highly fractured (the Southern Cascades) (Zedler et al. 1985).

We do not have specific documentation of the importance of mid- to high-elevation meadows in regulating sediment and water transport. However, work in Europe indicates that montane meadows can reduce streamflow during storm events and elevate baseflow levels during dry seasons.

The meadows of the Pacific Coast region occupy positions in the landscape such as small valleys and swales clearly representing ground water discharge zones. Some of these meadows are also likely to act as sources of recharge to shallow aquifers. This affects downslope springs and seeps. Water enters the headwater wetlands where it is temporarily stored and is steadily released at a moderate rate to lower order channels (Zedler et al. 1985).

Similar hydrologic functions can be performed by palustrine wetlands and riparian areas of lower elevations in the forests. Much of the landscape remains intact in that physical alterations such as channelization and levee construction have not occurred. These functions can be protected by the options proposed in this report. Effectiveness of wetlands and riparian areas in lower floodplains has been limited by extensive hydrologic modification from levees, dikes, dams, channelization, etc.

Wildlife Habitat

Wildlife dependency and diversity peak at the terrestrial/aquatic boundary i.e. in riparian areas and wetlands. This coalescence of species and ecological processes is becoming better documented with each scientific study. The water source that produces this ecological epicenter does not relate closely to water quantity or size of water body. Seemingly, a different array of species are adapted to varying water body types and sizes, e.g., lakes, large rivers, perennial streams, intermittent streams, ephemeral streams, seeps, marshes, and bogs.

Wildlife have a disproportionately high use of riparian zones. Brown (1985) reports that 359 of 414 (87 percent) of wildlife species in western Oregon and Washington use riparian zones or wetlands during some season or part of their life cycle. He also states that riparian zones provide more niches than any other type of habitat. Riparian zones provide such habitat requirements as water, cover, food, plant community structure and diversity, increased humidity, high edge-to-area ratios, and migration routes (Carlson 1991). Detailed documentation of the habitat characteristics of forested riparian zones related to vegetative structure has been published by the Washington Department of

Wildlife (Carlson 1990, 1991). Table V-E-1 summarizes the recommended buffer widths along permanently flowing, fish bearing streams for various animals in Washington (Roderick and Miller 1991).

Table V-E-1. Recommended buffer widths on permanently flowing, fish bearing streams for various animals in Washington (from: Roderick and Miller, 1991).

Buffer Width	Species
600 ft. +	bald eagle - nesting, roosting, or perching cavity nesting ducks (wood duck, goldeneye, buffle head, hooded merganser) heron rookery western pond turtle sandhill crane
450 ft.	common loon nesting pileated woodpecker
300-330 ft.	beaver dabbling duck mink
200 ft.	Columbia white-tailed deer spotted frog (western Washington)
165 ft.	lesser scaup nesting harlequin duck
100 ft.	spotted frog in eastern Washington Van Dyke's salamander

Although we do not know for all species the specific habitat requirements provided by wetlands and riparian areas, the importance of undisturbed habitat can be subtle. Habitat requirements are likely to be as complex as those for reproductive and rearing success of salmonoids and other aquatic species. For example, northwest salamanders attach all egg masses to vegetation at precisely the same depth below the water surface. Therefore, any activity that changes water level before hatching could result in partial or complete reproductive failure for the pond, either through desiccation if the water level falls or through changes in temperature or other environmental conditions if water rises (Richter 1993). Chorus frogs exhibit similar subtleties in selecting ponds to avoid predators while ensuring sufficient water depth and food supply for larval maturation (Buskirk and Smith 1993). In many cases the ponds that meet amphibian reproductive requirements are small and either not recorded in wetland inventories or not considered for protection in management prescriptions.

Other species' behavior apparently links closely to riparian areas including intermittent or ephemeral streams. Some species of bats may seek prey within the drainages of the smallest streams, and owls may be able to hunt more efficiently near small streams where noise levels do not interfere with their ability to locate prey.

O'Connell et al. (1993) -- for the Washington State Timber Fish and Wildlife Cooperative Monitoring, Evaluation, and Research -- surveyed current nationwide literature to develop information on riparian and wetland related wildlife species in that state. Their review, with emphasis on the Pacific Northwest, is germane to the forests of Washington, Oregon, and northern California. The rest of this section summarizes the review for several groups of wildlife.

Amphibians. Amphibians in Washington require riparian habitats for foraging, breeding and cover. The importance of the riparian zones to amphibian communities varies with the life history characteristics of each species. For example, some species breed only in mountain streams (tailed frog, Cope's salamander, Pacific giant salamander, and torrent salamander). Others such as the red-legged frog use intermittent waters possibly to reduce vulnerability of eggs and larvae to predators (Hayes and Jennings 1986 cited in O'Connell 1993). The effects of timber harvest on amphibians accrue from physical habitat damage changes in hydrology, water temperature, and substrate characteristics.

Reptiles. Association of Washington reptiles with riparian zones has not been extensively studied in the Pacific Northwest. Clearly, species such as the pond turtles are obligate wetland inhabitants, and the western terrestrial garter snake is largely aquatic. In general, six of 21 reptiles in Washington are associated with riparian or wetland habitats.

Birds. Structural components of the riparian environment seem to be most important for providing sites for feeding, breeding, nesting, roosting and perching. Specific importance of riparian zones to birds depends on climate, vegetation type, time of year, bird species characteristics, water body or stream size, structure, edge to area ratio, and occurrence of favorable microclimates. Food sources for birds in riparian areas include aquatic and wetland plants, invertebrates (insect larvae, mollusks, crustaceans), vertebrates (amphibians, fish), and flying insects.

A number of bird species depend on availability of juvenile Pacific salmon and other prey species that occur in aquatic or riparian habitats. These include common mergansers and a number of raptors such as osprey, bald eagle, and northern harrier. Some 78 species of birds in Washington breed, nest, or feed within riparian zones (O'Connell 1993). Of these species, 23 are obligate riparian inhabitants. The Washington Department of Wildlife (1992) reports 184 bird species associated with wetlands in the eastern part of the state and 127 species in the western part.

Small mammals. Vegetation, soils, and hydrologic conditions in wetland and riparian areas provide specialized microclimates for small mammals. Several mammals such as beaver, muskrat, and nutria are clearly linked to the aquatic and wetland aspects of riparian zones. Others such as water voles, marsh shrew, and water shrew are obligate streamside inhabitants.

Numerous other small mammal species rely on the existence of water, wet soils, or vegetation within the riparian zone for feeding, cover, den construction, or even for physiological reasons. For example, the mountain beaver has an inefficient kidney and therefore requires succulent vegetation and humid burrows (Feldhamer and Rochelle 1982 cited in O'Connell 1993). Other mammals such as the red-backed vole must live near water or wetlands because of poorly developed mechanisms of water conservation (Miller and Getz 1977; Merritt 1981 cited in O'Connell 1993). More than 20 species of Pacific Northwest mammals are either obligate riparian or wetland inhabitants or use such areas for specific purposes during their life cycle.

Bats. Eleven of 14 bat species occurring in the Northwest use forests as primary or secondary habitat (Dalquest 1948 cited in O'Connell 1993). Within the forest, bats seem to be opportunistic rather than restricted to specific habitat types. However, riparian areas are important for foraging and drinking. Aquatic insects are a major component of the diet of bats. In the Cascade and Oregon Coast ranges feeding rates of eight

Myotis species was 10 times higher over water than in forest stands (Thomas and West 1991 cited in O'Connell 1993). Wetlands also provide critical drinking water. Even small ephemeral ponds can be used by some species (Cross 1986 cited in O'Connell 1993). Proximity to aquatic foraging or drinking sites may also be important in selection of roosting habitat although there has been little study of this to date.

Carnivores. River otters and mink are well recognized obligate riparian species. Most other carnivores spend disproportionately large amounts of time in riparian areas due to the abundance of terrestrial, wetland and aquatic prey species. Also, most carnivores will at some times of the year depend on consumption of berries and fruits. These foods are more available in the riparian zone. Availability of food during the breeding season relates directly to reproductive success. As a result, breeding success is higher among carnivores with access to riparian areas. Other important habitat features provided for carnivores are resting and denning sites and movement corridors.

Ungulates. Five species of ungulates occupy forests within the range of the northern spotted owl. For four of the five species riparian zones play a major role in ungulate ecology in forested areas. For the endangered Columbian white-tailed deer, riparian areas are obligate habitats. Riparian habitats also provide important habitat for generalists such as the Rocky Mountain white-tailed deer, Columbian black-tailed deer, sitka black-tailed deer, mule deer, Rocky Mountain elk, and Roosevelt elk. Food, water, and cover are provided. During summer seasons, temperature moderation and availability of water attract ungulates to both wetland and riparian areas.

The O'Connell et al. (1993) review discusses the effects of timber harvest and associated forest practices for 248 terrestrial riparian invertebrate species that occur in the Northwest. Vulnerability ratings are based on an assessment of each species use of the riparian zone (e.g. water, vegetation), habitat specificity, population trend, geographic range, reproductive potential, and population concentration.

Plant Species Biodiversity in Riparian and Wetland Areas

As part of the National Wetland Inventory, the Fish and Wildlife Service in cooperation with other Federal agencies has prepared comprehensive lists of vascular plant species that occur in wetlands and their frequency of occurrence in wetland habitats. While the Pacific Northwest is not rich in wetlands as a percentage of the total landscape (slightly over 2 percent in Washington and Oregon), a relatively large percentage of total plant species in the Northwest occur in wetlands. This is not unlike the coalescence of animal species in riparian and wetland habitats. The significant percentage of plant species that occur in wetlands relative to the small area of wetlands on the landscape is illustrated in Table V-E-2.

Table V-E-2.

	California	Oregon	Washington
Number of vascular plant species in state[a]	6,336	3,636	2,969
Number of species in wetlands	1,933 (30 percent of total in state)	1,622 (45 percent of total in state)	1,515 (51 percent of total in state)
Number of species in riparian areas[b]	1,483 (23 percent of total in state)	1,335 (37 percent of total for state)	1,295 (44 percent of total for state)

[a]From National Wetland Inventory data base for plants that occur in wetlands, 1993.
[b]From National Wetland Inventory data base for plants that occur in wetlands. This estimate is based on a query from the entire list of vascular plant species occurring in wetlands using the key words stream, creek, river, brook, flood plain, alluvial, bottomland, banks, forest, and wood.

Many of the species that occur in wetlands are found there only a small percentage of the time over their geographic range. In most cases they are associated with upland habitats. Their occurrence in wetlands could represent genetically distinct populations or even individuals (Tiner 1991) represent sources of genetic biodiversity.

Regional Significance of Wetlands on Federal Lands

Vegetated wetlands within the range of the spotted owl represent a small portion of the landscape, perhaps as little as 1 percent (National Wetland Inventory 1990). Presence of narrow linear wetlands associated with small streams would increase this somewhat. This small segment of the landscape provides habitat requirements for a disproportionately large number of plant and animal species, some of which are unique to specific wetland types (e.g. plant and animal species associated with peat systems). Added to this are other functions provided by wetlands, e.g., water quality protection and stream flow mediation.

The significance of these wetlands is heightened by their relative rarity in a pristine state. In Washington, over a third of the state's wetlands have been lost (Dahl 1990) and 90 percent of the remaining wetlands are in a degraded state (Washington Department of Wildlife 1992). Incidence of wetland loss and degradation is much greater in flood plains at low elevations, particularly in urban areas. Thus, the forests not only provide habitat for the spotted owl but also function as reservoirs of intact wetlands. Some of these are ancient wetlands dominated by western red cedar or Sitka spruce and specialized wetlands of several thousand years old.

Appendix V-F
Standards and Guidelines for Riparian Reserves

Background

These Standards and Guidelines were developed as a component of a strategy to protect salmon and steelhead habitat on all public lands (US Forest Service, Bureau of Land Management, National Park Service) within the range of Pacific Ocean anadromy. The Standards and Guidelines were developed by a field team of managers and specialists and a technical team of scientists, and ratified by a validation team of managers and field scientists. They have been extensively reviewed and revised by representatives at all organizational levels of both the Bureau of Land Management and the Forest Service, with full participation of the Forest Ecosystem Management Assessment Team - Aquatic/Watershed Group.

The Standards and Guidelines are a minimum set of land management prescriptions necessary to meet Aquatic Conservation Strategy Objectives.

Standards and Guidelines for Riparian Reserves

Once the Riparian Reserve width is established, either based on interim widths or watershed analysis, then land management activities allowed in the Riparian Reserve will be determined by Standards and Guidelines for Riparian Reserves. In general, these standards and guidelines prohibit activities in Riparian Reserves that retard or prevent attainment of the Aquatic Conservation Strategy Objectives.

Timber Management

TM-1. Prohibit timber harvest, including fuelwood cutting, in Riparian Reserves, except as described below. Riparian Reserves shall not be included in calculations of the timber base.

a. Where catastrophic events such as fire, flooding, volcanic, wind, or insect damage result in degraded riparian conditions, allow salvage and fuelwood cutting if required to attain Aquatic Conservation Strategy Objectives.

b. Remove salvage trees only when watershed analysis determines that present and future woody debris needs are met and other Aquatic Conservation Strategy Objectives are not adversely affected.

c. Apply silvicultural practices for Riparian Reserves to control stocking, reestablish and culture stands, and acquire desired vegetation characteristics needed to attain Aquatic Conservation Strategy Objectives.

Roads Management

RF-1. Cooperate with federal, state, tribal, and county agencies to achieve consistency in road design, operation, and maintenance necessary to attain Aquatic Conservation Strategy Objectives.

RF-2. For each existing or planned road, meet Aquatic Conservation Strategy Objectives by:

a. Minimizing road and landing locations in Riparian Reserves.

b. Completing watershed analyses (including appropriate geotechnical analyses) prior to construction of new roads or landings in Riparian Reserves.

c. Preparing road design criteria, elements, and standards that govern construction and reconstruction.

d. Preparing operation and maintenance criteria that govern road operation, maintenance, and management.

e. Minimizing disruption of natural hydrologic flow paths, including diversion of streamflow and interception of surface and subsurface flow.

f. Restricting sidecasting as necessary to prevent the introduction of sediment to streams.

RF-3. Determine the influence of each road on the Aquatic Conservation Strategy Objectives through watershed analysis. Meet Aquatic Conservation Strategy Objectives by:

a. Reconstructing roads and associated drainage features that pose a substantial risk.

b. Prioritizing reconstruction based on current and potential impact to riparian resources and the ecological value of the riparian resources affected.

c. Closing and stabilizing, or obliterating and stabilizing roads based on the on-going and potential effects to Aquatic Conservation Strategy Objectives and considering short-term and long-term transportation needs.

RF-4. New culverts, bridges and other stream crossings shall be constructed, and existing culverts, bridges and other stream crossings determined to pose a substantial risk to riparian conditions will be improved, to accommodate at least the 100-year flood, including associated bedload and debris. Priority for upgrading will be based on the potential impact and the ecological value of the riparian resources affected. Crossings will be constructed and maintained to prevent diversion of streamflow out of the channel and down the road in the event of crossing failure.

RF-5. Minimize sediment delivery to streams from roads. Outsloping of the roadway surface is preferred, except in cases where outsloping would increase sediment delivery to streams or where outsloping is infeasible or unsafe. Route road drainage away from potentially unstable channels, fills, and hillslopes.

RF-6. Provide and maintain fish passage at all road crossings of existing and potential fish-bearing streams.

RF-7. Develop and implement a Road Management Plan or a Transportation Management Plan that will meet the Aquatic Conservation Strategy Objectives. As a minimum, this plan shall include provisions for the following activities:

a. Post-storm inspections and maintenance.

b. During-storm inspections and maintenance.

c. Road operation and maintenance giving high priority to identifying and correcting road drainage problems that contribute to degrading riparian resources.

d. Regulation of traffic during wet periods to prevent damage to riparian resources.

e. Establish the purpose of each road by developing the Road Management Objective.

Grazing Management

GM-1. Adjust grazing practices to eliminate impacts that retard or prevent attainment of Aquatic Conservation Strategy Objectives. If adjusting practices is not effective, eliminate grazing.

GM-2. Locate new livestock handling and/or management facilities outside Riparian Reserves. For existing livestock handling facilities inside the Riparian Reserve, ensure that Aquatic Conservation Strategy Objectives are met. Where these objectives cannot be met, require relocation or removal of such facilities.

GM-3. Limit livestock trailing, bedding, watering, loading, and other handling efforts to those areas and times that will ensure Aquatic Conservation Strategy Objectives are met.

Recreation Management

RM-1. Design, construct, and operate recreation facilities, including trails and dispersed sites, within Riparian Reserves in a manner that contributes to attainment of Aquatic Conservation Strategy Objectives. For existing recreation facilities inside Riparian Reserves, ensure that Aquatic Conservation Strategy Objectives are met. Where Aquatic Conservation Strategy Objectives cannot be met, require relocation or closure of recreation facilities.

RM-2. Adjust dispersed and developed recreation practices that retard or prevent attainment of Aquatic Conservation Strategy Objectives. Where adjustment measures such as education, use limitations, traffic control devices, increased maintenance, relocation of facilities, and/or specific site closures are not effective, eliminate the practice or occupancy.

RM-3. Wild and Scenic Rivers and Wilderness Management plans will address attainment of Aquatic Conservation Strategy Objectives.

Minerals Management

MM-1. Require a reclamation plan, approved Plan of Operations, and reclamation bond for all minerals operations that include Riparian Reserves. Such plans and bonds must address the costs of removing facilities, equipment, and materials; recontouring of disturbed areas to near pre-mining topography; isolation and neutralization or removal of toxic or potentially toxic materials; salvage and replacement of topsoil; and seedbed preparation and revegetation to meet Aquatic Conservation Strategy Objectives.

MM-2. Locate structures, support facilities, and roads outside Riparian Reserves. Where no alternative to siting facilities in Riparian Reserves exists, locate in a way compatible with Aquatic Conservation Strategy Objectives. Road construction will be kept to the minimum necessary for the approved mineral activity. Such roads will be constructed and maintained to meet Roads Management Standards and to minimize damage to resources in the Riparian Reserve. When a road is no longer required for mineral or land management activities, it will be closed, obliterated, and stabilized.

MM-3. Prohibit solid and sanitary waste facilities in Riparian Reserves. If no alternative to locating mine waste (waste rock, spent ore, tailings) facilities in Riparian Reserves exists, and releases can be prevented, and stability can be ensured, then:

a. Analyze the waste material using the best conventional sampling methods and analytic techniques to determine it's chemical and physical stability characteristics.

b. Locate and design the waste facilities using best conventional techniques to ensure mass stability and prevent the release of acid or toxic materials. If the best conventional technology is not sufficient to prevent such releases and ensure stability over the long term, prohibit such facilities in Riparian Reserves.

c. Monitor waste and waste facilities after operations to ensure chemical and physical stability and to meet Aquatic Conservation Strategy Objectives.

d. Reclaim waste facilities after operations to ensure chemical and physical stability and to meet Aquatic Conservation Strategy Objectives.

e. Require reclamation bonds adequate to ensure long-term chemical and physical stability of mine waste facilities.

MM-4. For leasable minerals, prohibit surface occupancy within Riparian Reserves for oil, gas, and geothermal exploration and development activities where contracts and leases do not already exist. Adjust the operating plans of existing contracts to eliminate impacts that retard or prevent the attainment of Aquatic Conservation Strategy Objectives.

MM-5. Sand and gravel mining and extraction within Riparian Reserves will occur only if Aquatic Conservation Strategy Objectives can be met.

MM-6. Develop inspection and monitoring requirements and include such requirements in mineral plans, leases or permits. Evaluate the results of inspection and monitoring to modify mineral plans, leases and permits as needed to eliminate impacts that retard or prevent attainment of Aquatic Conservation Strategy Objectives.

Fire/Fuels Management

FM-1. Design fuel treatment and fire suppression strategies, practices, and activities to meet Aquatic Conservation Strategy Objectives, and to minimize disturbance of riparian ground cover and vegetation. Strategies should recognize the role of fire in ecosystem function and identify those instances where fire suppression or fuel management activities could be damaging to long-term ecosystem function.

FM-2. Locate incident bases, camps, helibases, staging areas, helispots and other centers for incident activities outside of Riparian Reserves. If the only suitable location for such activities is within the Riparian Reserve, an exemption may be granted following a review and recommendation by a resource advisor. The advisor will prescribe the location, use conditions, and rehabilitation requirements. Utilize an interdisciplinary team to predetermine suitable incident base and helibase locations.

FM-3. Minimize delivery of chemical retardant, foam, or additives to surface waters. An exception may be warranted in situations where over-riding immediate safety imperatives exist, or, following a review and recommendation by a resource advisor, when an escape would cause more long-term damage.

FM-4. Design prescribed burn projects and prescriptions to contribute to attainment of Aquatic Conservation Strategy Objectives.

FM-5. Immediately establish an emergency team to develop a rehabilitation treatment plan needed to attain Aquatic Conservation Strategy Objectives whenever Riparian Reserves are significantly damaged by a wildfire or a prescribed fire burning out of prescription.

Lands

LH-1. For hydroelectric and other surface water development proposals, require in-stream flows and habitat conditions that maintain or restore riparian resources, favorable channel conditions, and fish passage. Coordinate this process with the appropriate state agencies. During relicensing of hydroelectric projects, provide written and timely license conditions to Federal Energy Regulatory Commission (FERC) that require flows and habitat conditions that maintain/restore riparian resources and channel integrity. Coordinate relicensing projects with the appropriate state agencies.

LH-2. Locate new facilities outside of Riparian Reserves. For existing support facilities inside the Riparian Reserves that are essential to proper management, provide recommendations to FERC that ensure that Aquatic Conservation Strategy Objectives are met. Where these objectives cannot be met, provide recommendations to FERC that such support facilities should be relocated. Hydroelectric facilities that must be located in the Riparian Reserves will be located, operated, and maintained to eliminate adverse effects that retard or prevent attainment of Aquatic Conservation Strategy Objectives.

LH-3. Issue leases, permits, rights-of-way, and easements to avoid adverse effects that retard or prevent attainment of Aquatic Conservation Strategy Objectives. Adjust existing leases, permits, rights-of-way, and easements to eliminate adverse effects that retard or prevent the attainment of Aquatic Conservation Strategy Objectives. If adjustments are not effective, eliminate the activity. Priority for modifying existing leases, permits, rights-of-way and easements will be based on the actual or potential impact and the ecological value of the riparian resources affected.

LH-4. Use land acquisition, exchange, and conservation easements to meet Aquatic Conservation Strategy Objectives and facilitate restoration of fish stocks and other species at risk of extinction.

General Riparian Area Management

RA-1. Identify and attempt to secure in-stream flows needed to maintain riparian resources, channel conditions, and aquatic habitat.

RA-2 Fell trees in Riparian Reserves when they pose a safety risk. Keep felled trees on-site when needed to meet woody debris objectives.

RA-3. Herbicides, insecticides, and other toxicants, and other chemicals shall be applied only in a manner that avoids impacts that retard or prevent attainment of Aquatic Conservation Strategy Objectives.

RA-4. Locate water drafting sites to minimize adverse effects on stream channel stability, sedimentation, and in-stream flows needed to maintain riparian resources, channel conditions, and fish habitat.

Watershed and Habitat Restoration

WR-1. Design and implement watershed restoration projects in a manner that promotes long-term ecological integrity of ecosystems, conserves the genetic integrity of native species, and attains Aquatic Conservation Strategy Objectives.

WR-2. Cooperate with federal, state, local, and tribal agencies, and private landowners to develop watershed-based Coordinated Resource Management Plans or other cooperative agreements to meet Aquatic Conservation Strategy Objectives.

WR-3. Do not use mitigation or planned restoration as a substitute for preventing habitat degradation.

Fish and Wildlife Management

FW-1. Design and implement fish and wildlife habitat restoration and enhancement activities in a manner that contributes to attainment of Aquatic Conservation Strategy Objectives.

FW-2. Design, construct and operate fish and wildlife interpretive and other user-enhancement facilities in a manner that does not retard or prevent attainment of Aquatic Conservation Strategy Objectives. For existing fish and wildlife interpretative and other user-enhancement facilities inside Riparian Reserves, ensure that Aquatic Conservation Strategy Objectives are met. Where Aquatic Conservation Strategy Objectives cannot be met, relocate or close such facilities.

FW-3. Cooperate with federal, tribal, and state wildlife management agencies to identify and eliminate wild ungulate impacts that are inconsistent with attainment of Aquatic Conservation Strategy Objectives.

FW-4. Cooperate with federal, tribal, and state fish management agencies to identify and eliminate impacts associated with habitat manipulation, fish stocking, harvest and poaching that threaten the continued existence and distribution of native fish stocks inhabiting federal lands.

Appendix V-G
Procedure Used for Determination of Stream Densities

The interim guidelines contained in Appendix 5K of the Scientific Analysis Team (Thomas et al. 1993) report require a variable width Riparian Habitat Conservation Area (now referred to as a Riparian Reserve or RR) for three categories of streams: perennial-fish bearing, perennial-nonfish-bearing, and intermittent. The Scientific Analysis Team (Thomas et al. 1993) prescriptions are intended to include ephemeral channels. To estimate the effects of RRs on Allowable Sale Quantity, we developed a method to estimate the number of miles in each stream category. National Forests in Region 6 (Region 6 National Forests) have data on stream class that allows calculation of the miles of perennial streams which are fish bearing (Class I and II) and which are non-fish bearing (Class III). Region 6 National Forests have estimates of intermittent streams (Class IV) but few Districts have data on each of the perennial categories directly. The major data void was estimates of the intermittent stream miles within each National Forest or Bureau of Land Management District. We estimated the total drainage density for each of the National Forests and Bureau of Land Management Districts using the following procedure.

A total of 56 7.5-minute 1:24,000 U.S. Geological Society topographic quadrangles were sampled to represent different geomorphic areas within the northern spotted owl range of Washington, Oregon, and northern California (Table V-G-1). Figure V-G-1 shows the relative location for each of the sample quads. Existing data on miles of stream length by stream order for Grouse Creek, an area on the Six Rivers National Forest, was also used.

A 25 square kilometer sample area for each National Forest quad was located as follows. Generally, the first intersection of Universal Transverse Mercator tics in the southwest corner of each quad was selected as the starting point. From this point we moved two tics to the east and three to the north to locate an intersection of Universal Transverse Mercator lines that became the southwest corner of the 25-square kilometer square sample area. The rest of the sample area 5 kilometers on a side was then delineated. In one case, the 25-square kilometer sample area was moved southward on the quad to place it within the National Forest land for which it was selected.

Bureau of Land Management sample areas were chosen to represent townships that were entirely under Bureau of Land Management administration and as near to the center of the quad as possible. Occasionally the sample areas were not rectangular due to township delineation. When the sample areas were irregular in shape, the area was "trimmed" to fit a rectangular area within the irregular polygon boundary.

All stream channels within each 25-square kilometer sample area were delineated manually using crenulations of contour lines in the following manner. First-order channels were marked by extending a red line past the last contour line showing a crenulation and halfway to the next contour line. The network of streams marked on the 25-square kilometer sample were color coded for stream order (Strahler, 1957): third-order and higher order streams were colored blue, second-order streams were colored green, and first-order streams remained red. Initially, the Region 6 Geometronics Group digitized the sample quads and attributed by stream order based on the color code. After about 15 of the quads had been manually digitized, the Geometronics group began

Table V-G-1. Selected 7.5 Minute USGS Quads

Forest / BLM District	USGS Quad
Olympic	Mt. Tebo
	Deadman's Hill
Mt. Baker-Snoqualmie	Bedal
	Greenwater
	Pugh Mountain
Gifford Pinchot	Trout Lake
	Smith Creek Butte
	Quartz Creek Butte
	Purcell Mountain
	Blue Lake
Wenatchee	Pyramid Mountain
	Frost Mountain
	Meeks
	Peshastin
	Liberty
Okanogan	Hoodoo Peak
	Tiffany Mountain
Mt. Hood	Three Lynx
	Wolf Peak
	Wanderer's Peak
	* Scoap Peak
Willamette	Coffin Mountain
	Grasshopper Mountain
	Sinker Mountain
	* Gawley Creek
Umpqua	Abbot Butte
	Reynold's Ridge
	Buckeye Lake
	Garwood Butte
Rogue River	Red Blanket Mountain
	Brown Mountain
Siuslaw	* Trask Mountain
	* Kilchis River
	* Glenbrook
	Baldy Mountain
Siskiyou	Onion Mountain
	Mt. Peavine
	Quail Prairie Mountain
Deschutes	Black Butte
Winema	Sun Pass
	Lake of the Woods - North

Forest / BLM District	USGS Quad
BLM - Salem	Jordan
BLM - Salem	Meacham Corner
BLM - Eugene	Walton
BLM - Medford	Daniel's Creek
BLM - Medford	Murphy
BLM - Roseburg	Harrington Creek
BLM - Roseburg	McCullough Creek
Klamath	Happy Camp
	Garner Mountain
Shasta-Trinity	Pony Buck Peak East
	Del Loma
Six Rivers	** Grouse Creek
	Tish Tang Point
	Lonesome Ridge
Mendicino	Hull Mountain
	Leech Lake Mountain

* Represents USFS and BLM lands
** Data provided by the Six Rivers NF

tracing the stream network onto acetate that allowed them to scan the streams manuscripts into a Geographic Information System using LTPLUS software. Stream order was assigned to each segment based on the original color coded map.

Basic data derived from the 25-square kilometer samples was expressed in kilometers of stream in first-, second-, and third-and-higher-order streams per square kilometer. The data are given in Table V-G-2. Data were organized by geoclimatic province in an attempt to discern patterns in stream density by stream order. After discussing about the data and the variability within geoclimatic areas, we decided to use an average of the quads for each Forest rather than the values from the larger geoclimatic areas. The values for stream density on the Klamath National Forest was adjusted based on professional knowledge of the Forests. The Klamath National Forest is divided into a relative flat and dry east side and a steep, wet west side. The Garner Mountain U.S. Geological Society quad on the east side had a very low stream density compared to the Happy Camp quad on the west side. When data from these two quads were averaged together, the overall stream density for the Klamath National Forest was relatively low which is not representative of the Forest overall. The west side stream density was recalculated by averaging the stream densities for the Shasta Trinity and Six Rivers National Forests. These Forests are similar in topography and climate to the west side of the Klamath National Forest.

We multiplied the average sampled stream density of each National Forest within the range of the northern spotted owl by net area of each Forest. Stream densities were estimated for the Siuslaw and Siskiyou National Forests based on other coastal quads, Bureau of Land Management quads, and available research case studies.

The Willamette, the Umpqua, and the Gifford Pinchot National Forests have coded Class IV streams in their Geographic Information System (GIS) layers. We requested that the Forest Hydrologist and Forest GIS group produce 1:24,000 overlays of the stream classification for each of the sample quads. Overlays were used to make comparisons on the UMP and GIP; hardcopy maps were used for the WIL comparisons.

The conclusions we reached through the comparison were:

1. There was no consistent relationship between stream order and stream class.

2. Third-order and greater streams were uniformly accepted as perennial.

3. First-order streams were uniformly accepted as intermittent.

The group agreed that the greatest degree of confidence about stream class was associated with the perennial streams (Class I, II, III). We also agreed that it would be appropriate to estimate the miles of Class IV (intermittent/ephemeral streams) by subtracting the miles of Class I, II, III from an estimate of total stream miles based on the stream densities developed from the quad "window" samples..

Forests updated their 1984 estimates of miles of stream within each stream class. The mileage of fish-bearing streams (Classes I and II) and perennial non-fish-bearing streams (Class III) was subtracted from total stream length to obtain total length of intermittent/ephemeral (Class IV) stream channels in kilometers.

The Bureau of Land Management protocol for designating streams was followed on Bureau of Land Management lands. Third-order streams and above were designated fish-bearing streams, second-order streams were designated perennial non-fish-bearing, and

Table V-G-2. Stream Miles by Stream Order

	USGS Quad Name		Area (sq. km)	Area (sq. mi.)	Miles by Stream Order 1	2	3+	Total	Miles/ sq. mi.	avg.	Area (sq. km)	Km by Stream Order 1	2	3+	Total	km / sq km	avg.
1	Mt. Tebo	OLY	24.96	9.64	38.23	10.23	12.73	61.19	6.35		24.96	61.17	16.37	20.37	97.90	3.92	
2	Deadman's Hill	OLY	24.99	9.65	63.36	16.38	15.04	94.78	9.82	8.09	24.99	101.38	26.21	24.06	151.65	6.07	5.00
3	Bedal	MBS	25.62	9.89	28.85	9.58	8.20	46.63	4.71		25.62	46.16	15.33	13.12	74.61	2.91	
4	Greenwater	MBS	24.97	9.64	57.69	15.80	12.63	86.12	8.93		24.97	92.30	25.28	20.21	137.79	5.52	
5	Pugh Mountain	MBS	25.03	9.66	39.67	9.01	16.51	65.19	6.75	6.80	25.03	63.47	14.42	26.42	104.30	4.17	4.20
6	Trout Lake	GIP	25.31	9.77	29.22	13.35	10.36	52.93	5.42		25.31	46.75	21.36	16.58	84.69	3.35	
7	Smith Creek Butte	GIP	25.02	9.66	73.38	18.20	20.22	111.80	11.57		25.02	117.41	29.12	32.35	178.88	7.15	
8	Quartz Creek Butte	GIP	25.01	9.66	40.66	10.01	10.54	61.21	6.34		25.01	65.06	16.02	16.86	97.94	3.92	
9	Purcell Mountain	GIP	24.99	9.65	43.75	13.35	9.64	66.74	6.92		24.99	70.00	21.36	15.42	106.78	4.27	
10	Blue Lake	GIP	25.20	9.73	32.56	11.86	10.96	55.38	5.69	7.19	25.20	52.10	18.98	17.54	88.61	3.52	4.44
11	Pyramid Mountain	WEN	24.97	9.64	85.35	20.24	14.16	119.75	12.42		24.97	136.56	32.38	22.66	191.60	7.67	
12a	Frost Mountain	WEN	25.00	9.65	28.10	10.18	6.69	44.97	4.66		25.00	44.96	16.29	10.70	71.95	2.88	
12b	Meeks	WEN	25.14	9.71	48.91	12.07	14.66	75.64	7.79		25.14	78.26	19.31	23.46	121.02	4.81	
12c	Peshastin	WEN	25.00	9.65	59.70	10.71	11.17	81.58	8.45		25.00	95.52	17.14	17.87	130.53	5.22	
12d	Liberty	WEN	24.96	9.64	58.07	17.12	17.10	92.29	9.58	8.58	24.96	92.91	27.39	27.36	147.66	5.92	5.30
13	Hoodoo Peak	OKA	25.20	9.73	33.30	11.33	10.64	55.27	5.68		25.20	53.28	18.13	17.02	88.43	3.51	
14	Tiffany Mountain	OKA	24.92	9.62	22.62	6.03	6.53	35.18	3.66	4.67	24.92	36.19	9.65	10.45	56.29	2.26	2.88
15	Three Lynx	MTH	25.02	9.66	41.56	12.10	7.13	60.79	6.29		25.02	66.50	19.36	11.41	97.26	3.89	
16	Wolf Peak	MTH	25.02	9.66	17.61	6.26	1.82	25.69	2.66		25.02	28.18	10.02	2.91	41.10	1.64	
17	Wanderers Peak	MTH	24.97	9.64	48.60	14.76	12.25	75.61	7.84		24.97	77.76	23.62	19.60	120.98	4.84	
18	Soosap Peak	MTH/BLM	24.98	9.64	39.32	11.04	11.55	61.91	6.42	5.80	24.98	62.91	17.66	18.48	99.06	3.97	3.59
19	Coffin Mountain	WIL	24.99	9.65	34.53	18.22	1.54	54.29	5.63		24.99	67.40	33.60	2.46	103.46	4.14	
20	Grasshopper Mountain	WIL	24.96	9.64	28.21	7.18	4.66	40.05	4.16 *		24.96	45.14	11.49	7.46	64.08	2.57	
21	Sinker Mountain	WIL	24.98	9.64	48.46	14.98	11.27	74.71	7.75		24.98	77.54	23.97	18.03	119.54	4.79	
22	Gawley Creek	WIL/BLM	24.97	9.64	31.62	7.07	5.49	44.18	4.58	5.53	24.97	50.59	11.31	8.78	70.69	2.83	3.58
23	Abbot Butte	UMP	24.93	9.63	42.16	14.63	9.32	66.11	6.87		24.93	67.46	23.41	14.91	105.78	4.24	
24	Reynolds Ridge	UMP	24.90	9.61	54.95	11.59	12.92	79.46	8.27		24.90	87.92	18.54	20.67	127.14	5.11	
25	Buckeye Lake	UMP	25.00	9.65	37.04	15.02	11.18	63.24	6.55		25.00	59.26	24.03	17.89	101.18	4.05	
26	Garwood Butte	UMP	25.06	9.68	12.80	5.03	5.44	23.27	2.41	6.02	25.06	20.48	8.05	8.70	37.23	1.49	3.72
27	Red Blanket Mountain	ROR	25.06	9.68	28.89	9.46	6.34	44.69	4.62		25.06	46.22	15.14	10.14	71.50	2.85	
28	Brown Mountain	ROR	25.00	9.65	20.56	7.65	6.00	34.21	3.54	4.08	25.00	32.90	12.24	9.60	54.74	2.19	2.52
29	Trask Mountain	BLM/SIU	25.03	9.66	36.64	14.60	11.54	62.68	6.49		25.03	58.46	23.36	18.46	100.29	4.01	
30	Kilchis River	BLM/SIU	21.60	8.34	43.89	13.81	13.46	71.16	8.53		21.60	70.22	22.10	21.54	113.86	5.27	
31	Glenbrook	BLM/SIU	23.33	9.01	37.28	11.72	4.80	53.80	5.97		23.33	59.65	18.75	7.68	86.08	3.69	
32	Baldy Mountain	SIU	24.98	9.64	40.19	15.66	11.06	66.91	6.94	6.98	24.98	64.30	25.06	17.70	107.06	4.29	4.31
33	Onion Mountain	SIS	24.95	9.63	65.09	17.15	11.82	94.06	9.76		24.95	104.14	27.44	18.91	150.50	6.03	
34	Mt. Peavine	SIS	25.27	9.76	64.59	16.22	13.57	94.38	9.67		25.27	103.34	25.95	21.71	151.01	5.98	
35	Quail Prairie Mountain	SIS	25.02	9.66	38.05	13.29	9.36	60.70	6.28	8.57	25.02	60.88	21.26	14.98	97.12	3.88	5.30
36	Black Butte	DES	24.98	9.64	13.73	3.50	0.61	17.84	1.85		24.98	21.97	5.60	0.98	28.54	1.14	
37	Sun Pass	WIN	25.02	9.66	20.22	9.47	4.47	34.16	3.54		25.02	32.35	15.15	7.16	54.66	2.18	
38	Lake of the Woods-North	WIN	25.04	9.67	13.06	6.49	4.26	23.81	2.46	3.00	25.04	20.90	10.38	6.82	38.10	1.52	1.85
39	Jordan	BLM-SALEM	23.38	9.03	56.33	18.93	11.25	86.51	9.58		23.38	90.13	30.29	18.00	138.42	5.92	
40	Meacham Corner	BLM-SALEM	23.11	8.92	29.70	8.68	8.97	47.35	5.31		23.11	47.52	13.89	14.35	75.76	3.28	
41	Walton	BLM-EUG	22.92	8.85	27.76	10.95	9.80	48.51	5.48		22.92	44.42	17.52	15.68	77.62	3.39	
42	Daniel's Creek	BLM-MED	22.82	8.81	76.14	20.01	16.61	112.76	12.80		22.82	121.82	32.02	26.58	180.42	7.91	
43	Murphy	BLM-MED	24.29	9.38	32.47	9.82	5.56	47.85	5.10		24.29	51.95	15.71	8.90	76.56	3.15	
44	Harrington Creek	BLM-ROS	22.58	8.72	53.91	15.06	11.34	80.31	9.21		22.58	86.26	24.10	18.14	128.50	5.69	
45	McCullough Creek	BLM-ROS	23.41	9.04	55.18	13.90	15.50	84.58	9.36	8.12	23.41	88.29	22.24	24.80	135.33	5.78	5.02
46	Happy Camp	KLA	25.15	9.71	38.66	13.48	12.84	64.96	6.69		25.15	61.86	21.54	20.54	103.94	4.13	
47	Garner Mountain	KLA	25.51	9.85	14.03	6.06	3.76	23.85	2.42	4.56	25.51	22.45	9.70	6.02	38.16	1.50	2.81
48	Pony Buck Peak East	SH-T	24.78	9.57	41.54	12.28	6.95	60.77	6.35		24.78	66.46	19.65	11.12	97.23	3.92	
49	Del Loma	SH-T	24.94	9.63	30.81	5.66	9.48	45.95	4.77	5.56	24.94	49.30	9.06	15.17	73.52	2.95	3.44
	Grouse Creek	SIX	146.55	56.58	NA	NA	NA	NA	8.11		24.70	NA	NA	NA	NA	5.04	
50	Tish Tang Point	SIX	24.70	9.54	30.51	9.41	8.98	48.90	5.13		24.70	48.82	15.06	14.37	78.24	3.17	
51	Lonesome Ridge	SIX	25.22	9.74	29.44	12.04	3.57	45.05	4.63	5.95	25.22	47.10	19.26	5.71	72.08	2.86	3.69
52	Hull Mountain	MEND	25.14	9.71	60.87	18.69	8.17	87.73	9.04		25.14	97.39	29.90	13.07	140.37	5.58	
53	Leech Lake Mountain	MEND	25.06	9.68	59.90	16.83	9.93	86.66	8.96	9.00	25.06	95.84	26.93	15.89	138.66	5.53	5.56

* Adjusted by Harr (Augusta Creek area)

first-order channels were designated intermittent streams. Table V-G-3 contains the lengths of Bureau of Land Management streams by stream order.

Table V-G-3. Miles of Stream by Stream Order for Bureau of Land Management Districts.

District	RMP acres	1	2	3	4	5	6
Salem	393600	+[a]	868	399	192	79	59
Eugene	316592	+	1503	282	130	36	28
Roseburg	419400	+	1592	424	309	88	57
Coos Bay	329583	+	2204	325	156	65	52
Medford	866300	+	6387	1004	400	167	130
Klamath Falls	212000	+	6.3	22	16	1	7

\+ Not considered perennial

Table V-G-4 contains the final tabulation of miles of stream by category and the estimated miles of intermittent and ephemeral streams.

The stream network samples are contained as a set of graphic images (Fig. V-G-2) at the end of this appendix. The samples are organized by major rock stability groups as defined below.

Resistant

Form steep slopes with thin soils, subject to narrow, shallow, rapid landslides (debris flows) from highly unstable areas at the heads of stream channels; stream channel and banks may be scoured for long distances.

Resistant Sediments: Weather relatively rapidly to soil thicknesses that are unstable on steep slopes,

Resistant Other: Weather more slowly and require a longer time to accumulate soils to unstable thicknesses.

Granitics: Where relatively unweathered, steep slopes form and are subject to debris flows. Where granitics are weathered, they are subject to severe surface erosion.

Weak

Form gentle slopes with thick soils that are subject to large, deep, slow landslides (earthflows); may constrict or deflect stream channels.

Intermediate

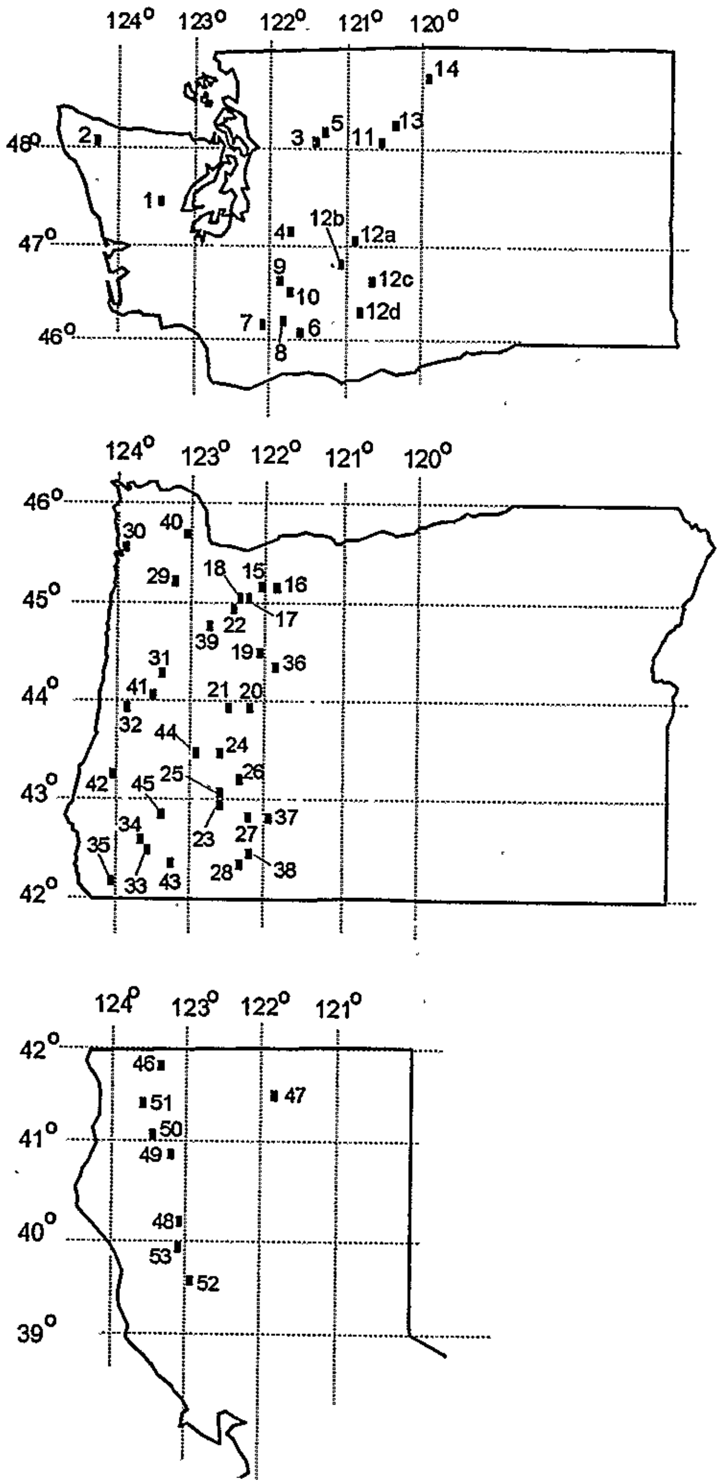
Form moderate slopes with variable soil depths; where soils accumulate on lower slopes, streambank landslides are common in inner gorges.

Intermediate Sediments: Resistant and weak rock types mixed from faulting or sedimentary layers, variable landslide processes.

Serpentinite/Peridotite: Variable internal strength due to local faulting results in variable landslide processes.

Unconsolidated

Loose alluvial, colluvial, glacial, marine terrace, and ash deposits generally located on gentle slopes that are subject to accelerated channel erosion and streambank landslides.



1. Mt Tebo
2. Deadman's Hill
3. Bedal
4. Greenwater
5. Pugh Mountain
6. Trout Lake
7. Smith Creek Butte
8. Quartz Creek Butte
9. Purcell Mountain
10. Blue Lake
11. Pyramid Mountain
12a. Frost Mountain
12b. Meeks
12c. Peshastin
12d. Liberty
13. Hoodoo Peak
14. Tiffany Mountain

15. Three Lynx
16. Wolf Peak
17. Wanderer's Peak
18. Soosap Peak
19. Coffin Mountain
20. Grasshopper Mountain
21. Sinker Mountain
22. Gawley Creek
23. Abott Butte
24. Reynold's Ridge
25. Buckeye Lake
26. Garwood Butte
27. Red Blanket Mountain
28. Brown Mountain
29. Trask Mountain
30. Kilchis River
31. Glenbrook
32. Baldy Mountain
33. Onion Mountain
34. Mt. Peavine
35. Quail Prairie Mountain
36. Black Butte
37. Sun Pass
38. Lake of the Woods - North
39. Jordan
40. Meacham Corner
41. Walton
42. Daniel's Creek
43. Murphy
44. Harrington Creek
45. McCullough Creek

46. Happy Camp
47. Garner Mountain
48. Pony Buck Peak East
49. Del Loma
50. Tish Tang Point
51. Lonesome Ridge
52. Hull Mountain
53. Leech Lake Mountain

Figure V-G-1. Map of sample U.S. Geological Society quad maps used for determining streams densities.

Olympics

Intermediate Sediments

Deadman's Hill
Olympic NF
9.82 mi. / sq. mile
1000 feet (msl)

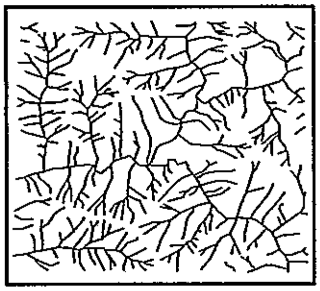
Resistant, other

Mt. Tebo
Olympic NF
6.35 mi. / sq. mile
1800 feet (msl)

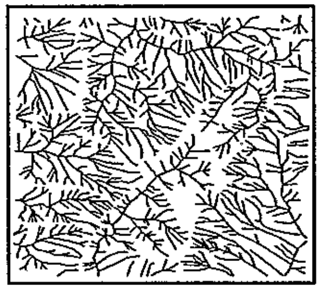
Figure V-G-2. Sample stream density diagrams within the range of the northern spotted owl. (8 pages).

Coast Range (Oregon and Washington)

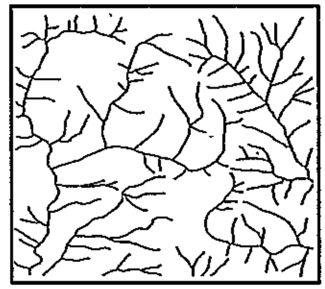
Resistant, other



Kilchis River
BLM/ Siuslaw NF
8.53 mi. / sq. mile
1000 feet (msl)



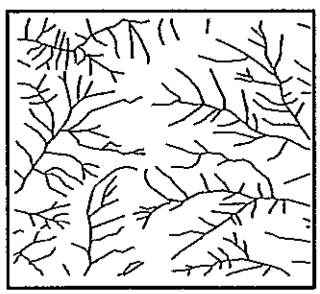
Daniel's Creek
BLM-Medford
12.80 mi. / sq. mile
1000 feet (msl)



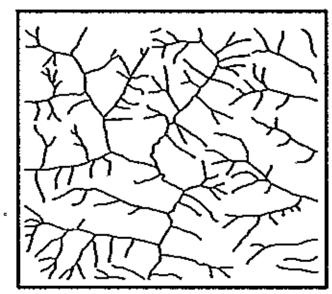
Meacham Corner
BLM-Salem
5.31 mi. / sq. mile
1400 feet (msl)

Resistant sediments

Baldy Mountain
Siuslaw NF
6.94 mi. / sq. mile
1300 feet (msl)

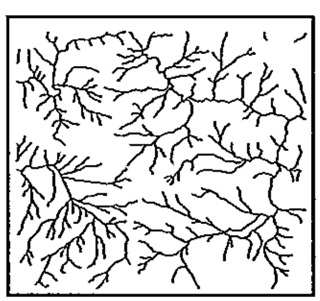


Glenbrook
BLM / Siuslaw NF
5.97 mi. / sq. mile
1230 feet (msl)



Walton
BLM-Eugene
5.48 mi. / sq. mile
900 feet (msl)

Weak rock



Trask Mountain
BLM / Siuslaw NF
6.49 mi. / sq. mile
2200 feet (msl)

North Cascades

Granitic

Tiffany Mountain
Okanogan NF
3.66 mi. / sq. mile
7000 feet (msl)

Intermediate Sediments

Hoodoo Peak
Okanogan NF
5.68 mi. / sq. mile
4900 feet (msl)

Weak Rock

Greenwater
Mt. Baker-Snoqualmie NF
8.93 mi. / sq. mile
2800 feet (msl)

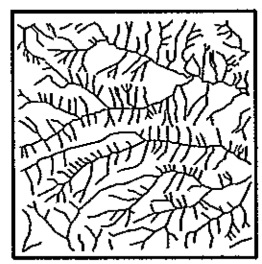
Metamorphic

Liberty Lake
Wenatchee NF
9.58 mi. / sq. mile

Sauk Sandstone

Peshastin
Wenatchee NF
8.45 mi. / sq. mile

Pyroclastics

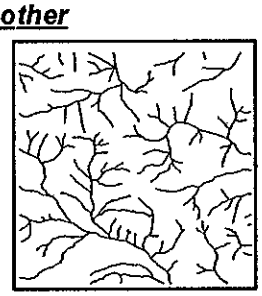


Meeks Table
Wenatchee NF
7.79 mi. / sq. mile

Resistant, other

Pugh Mountain
Mt. Baker-Snoqualmie NF
6.75 mi. / sq. mile
3700 feet (msl)

Bedal
Mt. Baker-Snoqualmie NF
4.71 mi. / sq. mile
2800 feet (msl)

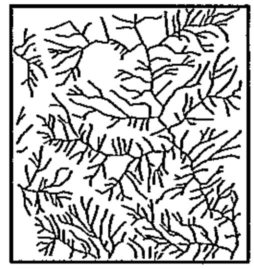


Frost Mountain
Wenatchee NF
4.66 mi. / sq. mile
4600 feet (msl)

Pyramid Mountain
Wenatchee NF
12.42 mi. / sq. mile
6200 feet (msl)

Western Cascades

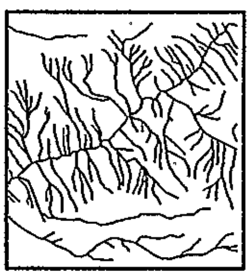
Intermediate Sediments



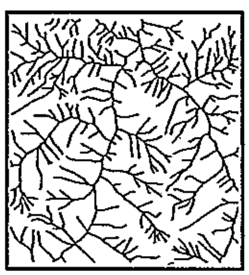
Harrington Creek
BLM - Roseburg
9.21 mi. / sq. mile
2600 feet (msl)

Resistant, other

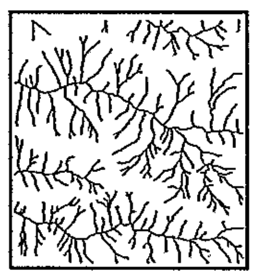
Purcell Mountain
Gifford Pinchot NF
6.92 mi. / sq. mile
3000 feet (msl)



Three Lynx
Mt. Hood NF
6.29 mi. / sq. mile
2900 feet (msl)



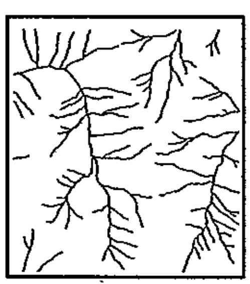
Wanderer's Peak
Mt. Hood NF
7.84 mi. / sq. mile
2800 feet (msl)



Soosap Peak
Mt. Hood NF / BLM
6.42 mi. / sq. mile
2910 feet (msl)

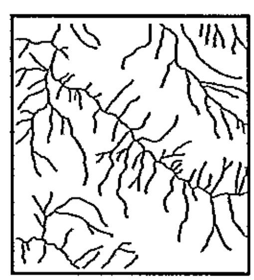
Brown Mountain
Rogue River NF
3.54 mi. / sq. mile
5000 feet (msl)

Garwood Butte
Umpqua NF
2.41 mi. / sq. mile
4800 feet (msl)



Grasshopper Mountain
Willamette NF
4.16 mi. / sq. mile
4480 feet (msl)

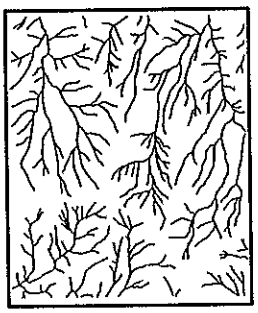
Coffin Mountain
Willamette NF
5.63 mi. / sq. mile
4000 feet (msl)



Gawley Creek
Willamette NF / BLM
4.58 mi. / sq. mile
2600 feet (msl)

Western Cascades

__Weak Rock__

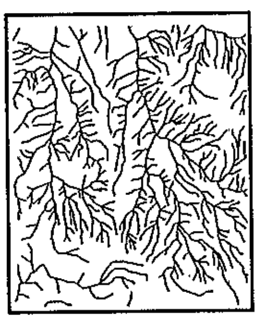


Abbott Butte
Umpqua NF
6.87 mi. / sq. mile
3900 feet (msl)

Buckeye Lake
Umpqua NF
6.55 mi. / sq. mile
3600 feet (msl)

Reynold's Ridge
Umpqua NF
8.27 mi. / sq. mile
2440 feet (msl)

Sinker Mountain
Willamette NF
7.75 mi. / sq. mile
2900 feet (msl)



Jordan
BLM - Salem
9.58 mi. / sq. mile
1200 feet (msl)

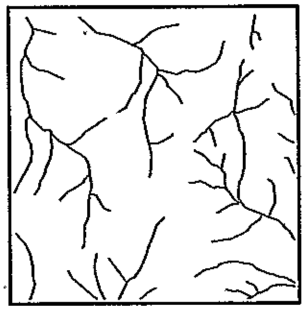
Blue Lake
Gifford Pinchot NF
5.69 mi. / sq. mile
4000 feet (msl)

Smith Creek Butte
Gifford Pinchot NF
11.57 mi. / sq. mile
2200 feet (msl)

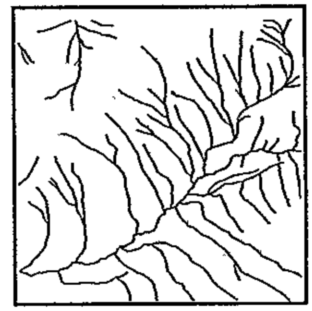
Quartz Creek Butte
Gifford Pinchot NF
6.34 mi. / sq. mile
2300 feet (msl)

High Cascades

Resistant, other

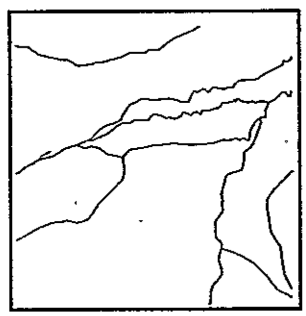


Wolf Peak
Mt. Hood NF
2.66 mi. / sq. mile
4000 feet (msl)



Red Blanket Mountain
Rogue River NF
4.62 mi. / sq. mile
5200 feet (msl)

Garner Mountain
Klamath NF
2.42 mi. / sq. mile
6000 feet (msl)

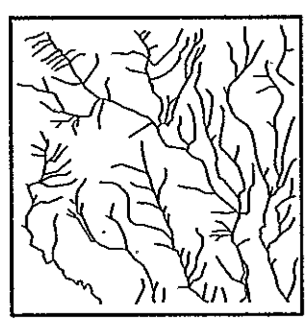


Black Butte
Deschutes NF
1.85 mi. / sq. mile
3160 feet (msl)

Lake of the Woods-North
Winema NF
2.46 mi. / sq. mile
4750 feet (msl)

Unconsolidated deposits

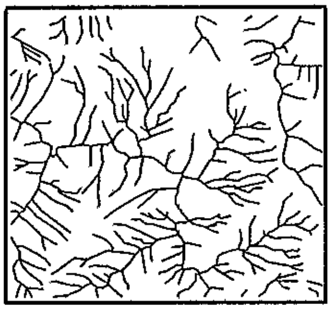
Sun Pass
Winema NF
3.54 mi. / sq. mile
5300 feet (msl)



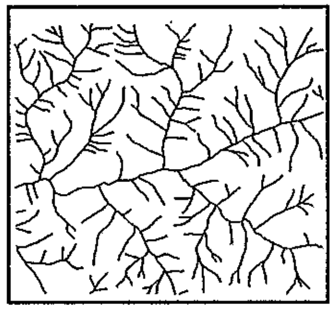
Trout Lake
Gifford Pinchot NF
5.42 mi. / sq. mile
2500 feet (msl)

Franciscan Formation

Intermediate Sediments



Quail Prairie Mountain
Siskiyou NF
6.28 mi. / sq. mile
1840 feet (msl)



McCullough Creek
BLM - Roseburg
6.27 mi. / sq. mile
1850 feet (msl)

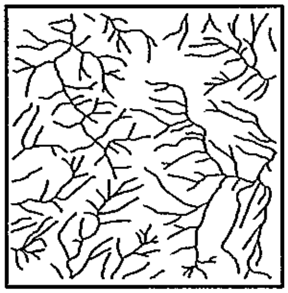
Leech Lake Mountain
Mendicino NF
8.96 mi. / sq. mile
5200 feet (msl)

Weak Rock

Hull Mountain
Mendicino NF
9.04 mi. / sq. mile
5400 feet (msl)

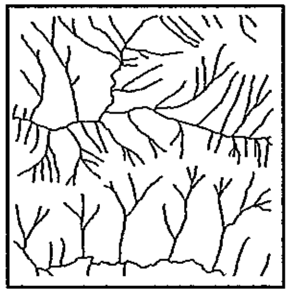
Klamath

Granitic

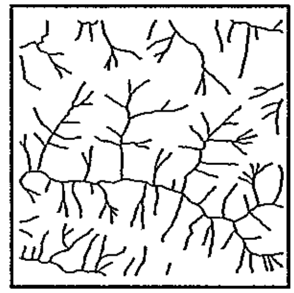


Pony Buck Peak East
Shasta-Trinity NF
6.35 mi. / sq. mile
1400 feet (msl)

Intermediate Sediments



Tish Tang Point
Six Rivers NF
5.13 mi. / sq. mile
2050 feet (msl)

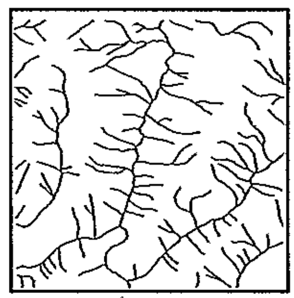


Lonesome Ridge
Six Rivers NF
4.63 mi. / sq. mile
3500 feet (msl)

Resistant, other

Mt. Peavine
Siskiyou NF
9.67 mi. / sq. mile
2400 feet (msl)

Murphy
BLM - Medford
5.10 mi. / sq. mile
2800 feet (msl)



Del Loma
Shasta-Trinity NF
4.77 mi. / sq. mile
2500 feet (msl)

Weak rock

Happy Camp
Klamath NF
6.69mi. / sq. mile
3200 feet (msl)

Onion Mountain
Siskiyou NF
9.76 mi. / sq. mile
feet (msl)

Table V-G-4. Calculation of Intermittent Stream Miles based on Drainage Density

	Forest/BLM Area (ac) **	density factor (km/sq km)	Estimated Area of Lakes/ponds	Miles by stream class I	II	III	Perennial (miles) Fish-bearing	nonfish-bearing	Intermitt. (miles)	Total Stream miles	Note #
DES	1,620,900	1.14	4052	233	170	112	403	112	1,000	1,515	1
GIP	1,371,700	4.44	3429	220	1,620	2,840	1,840	2,840	10,639	15,319	
MBS	1,723,485	4.20	4309	283	524	10,720	807	10,720	6,727	18,254	1
MTH	1,063,450	3.59	2659	400	3,300	4,200	3,700	4,200	1,742	9,642	
OKA	1,706,200	2.88	4266	80	241	603	321	603	11,413	12,337	
OLY	632,324	5.00	1581	336	560	1,277	896	1,277	5,777	7,950	
ROR	632,028	2.52	1580	519	341	568	860	566	2,582	4,008	
SIS	1,092,302	6.30	2731	1,394	1,052	4,044	2,446	4,044	8,087	14,577	2
SIU	631,361	4.31	1578	1,100	100	2,000	1,200	2,000	3,653	6,853	2
UMP	983,889	3.72	2460	343	430	977	773	977	7,447	9,197	
WEN	2,164,180	5.30	5410	805	963	1,795	1,768	1,795	25,245	28,808	
WIL	1,675,407	3.58	4189	421	828	2,001	1,249	2,001	11,825	15,075	
WIN	1,043,547	1.85	2609	60	130	110	190	110	1,000	1,300	1
KLA	1,680,282	3.22	4201				1,195	2,675	9,736		3
SH-T	2,121,547	3.64	5304				1,900	745	16,752		3
SIX	958,470	3.64	2396				850	1,109	6,810		3
MEND	894,339	5.56	2236				319	1,127	11,042		3
	NOTE: for analysis purposes, Ken Wright adjusted total stream length for CA forests										
BLM-Eug	316,590	3.65					640	963	1303		2
BLM-Med	866,323	3.64					531	1617	5781		
BLM-Salem	393,612	3.80					776	820	2165		
BLM-Ros	419,410	3.50					1028	646	2017		
BLM-KFalls	39,413	0.98					23	29	45		
BLM-Coos	329,588	4.23					556	1695	1254		
BLM-Ukiah	16,012	4.45					168	305	324		

Column.. 1: Forest/District area per Forest Plans or C.Novak
2: Total stream density from USGS quad "window" exercise
3: Area of lakes/ponds/wetlands outside of RHCAs... estimated as 0.25% of total Forest area
4: Miles by FS Stream Class per Forest or from 1984 table
5: Miles by FS Stream Class per Forest or from 1984 table
6: Miles by FS Stream Class per Forest or from 1984 table
7: miles of Class I-II from Forests (R6); perennial fish-bearing from R5 and BLM
8: miles of Class III from Forests (R6); perennial nonfish-bearing from R5 and BLM
9: [(col. 1) * (col. 2)] - [(col. 6) + (col. 7)]... adjusted as noted and with correct units

Note 1: estimated by professional judgement
Note 2: estimated from other coastal forests
Note 3: Forest acres per Ken Wright

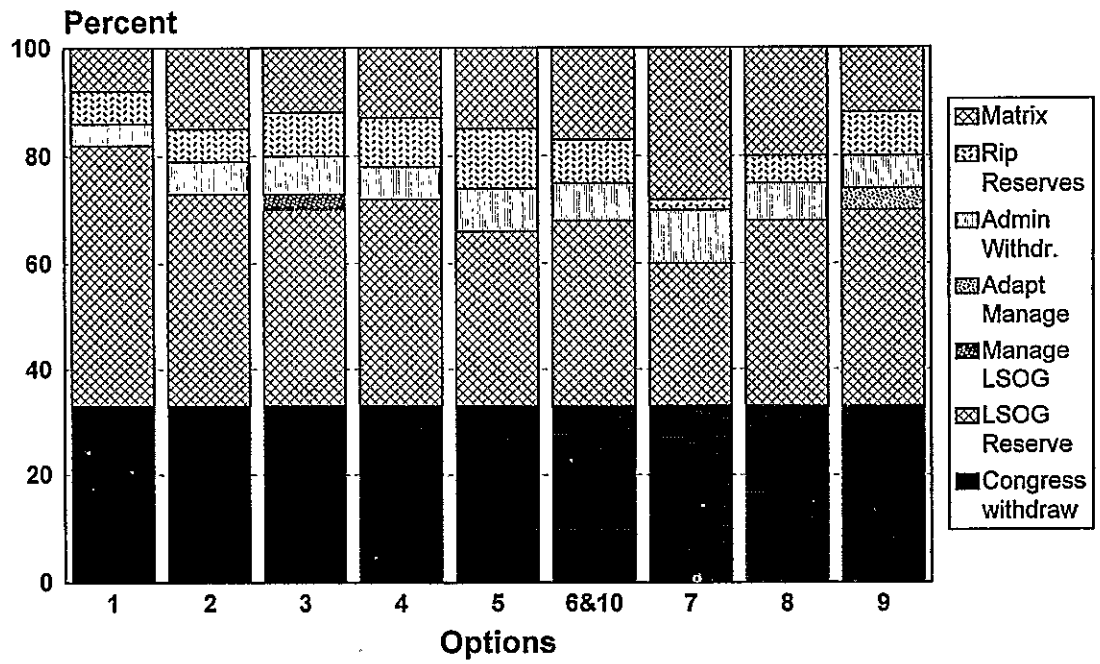


Figure V-H-1. Percent of Tier 1 Key Watersheds by forest allocation under each forest management option.

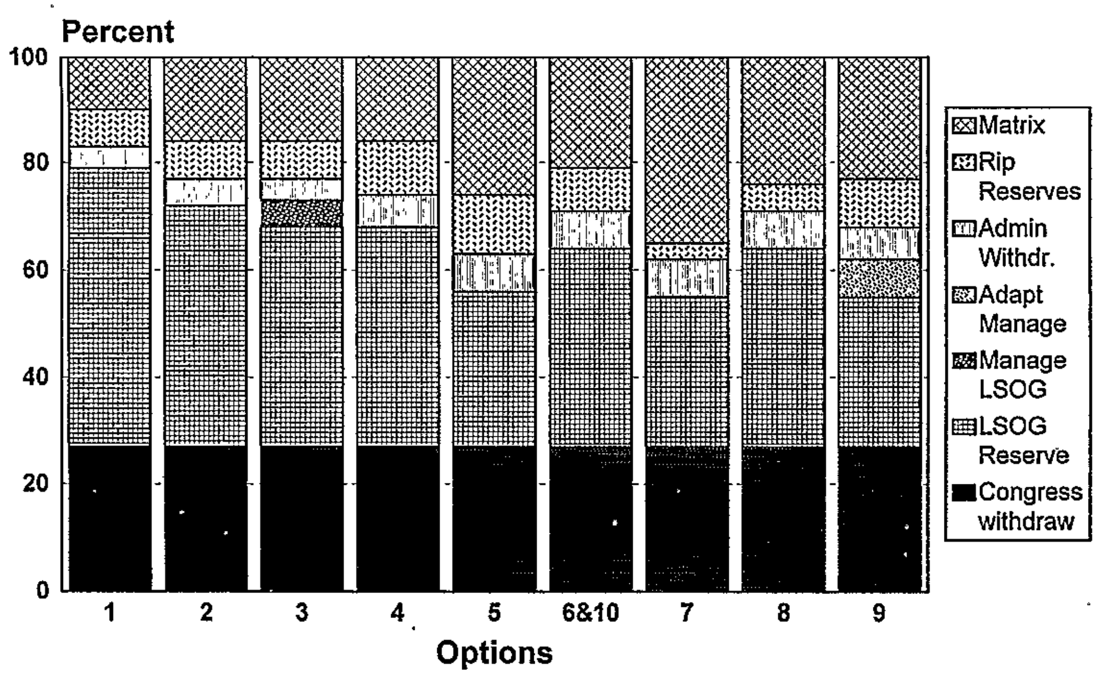


Figure V-H-2. Percent of Tier 2 Key Watersheds by forest allocation under each forest management option.

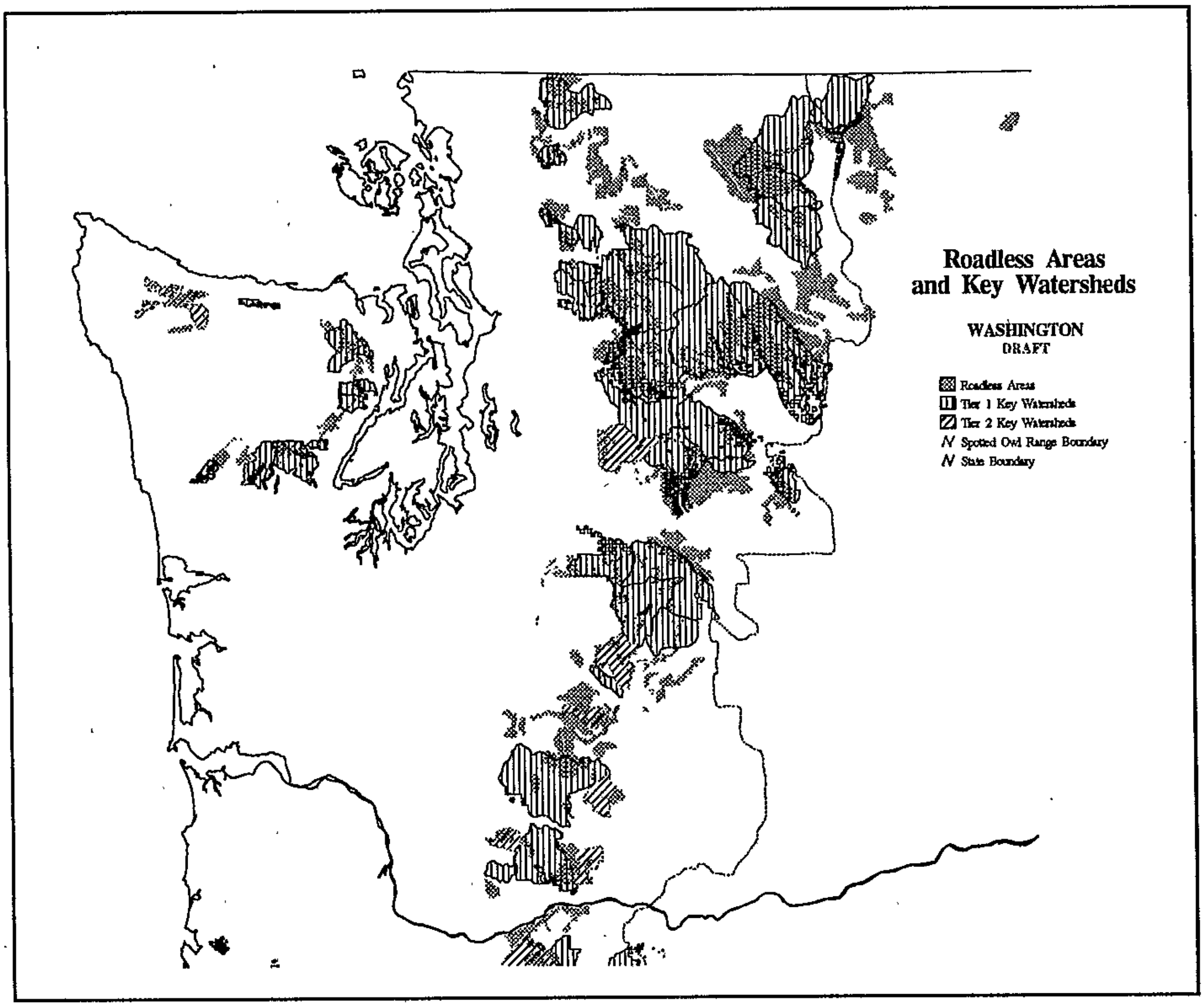


Figure V-H-3. Washington roadless areas and Key Watersheds. Roadless areas shown are those that were inventoried during the Roadless Area Review and Evaluation (RARE II) process and remain in roadless condition.

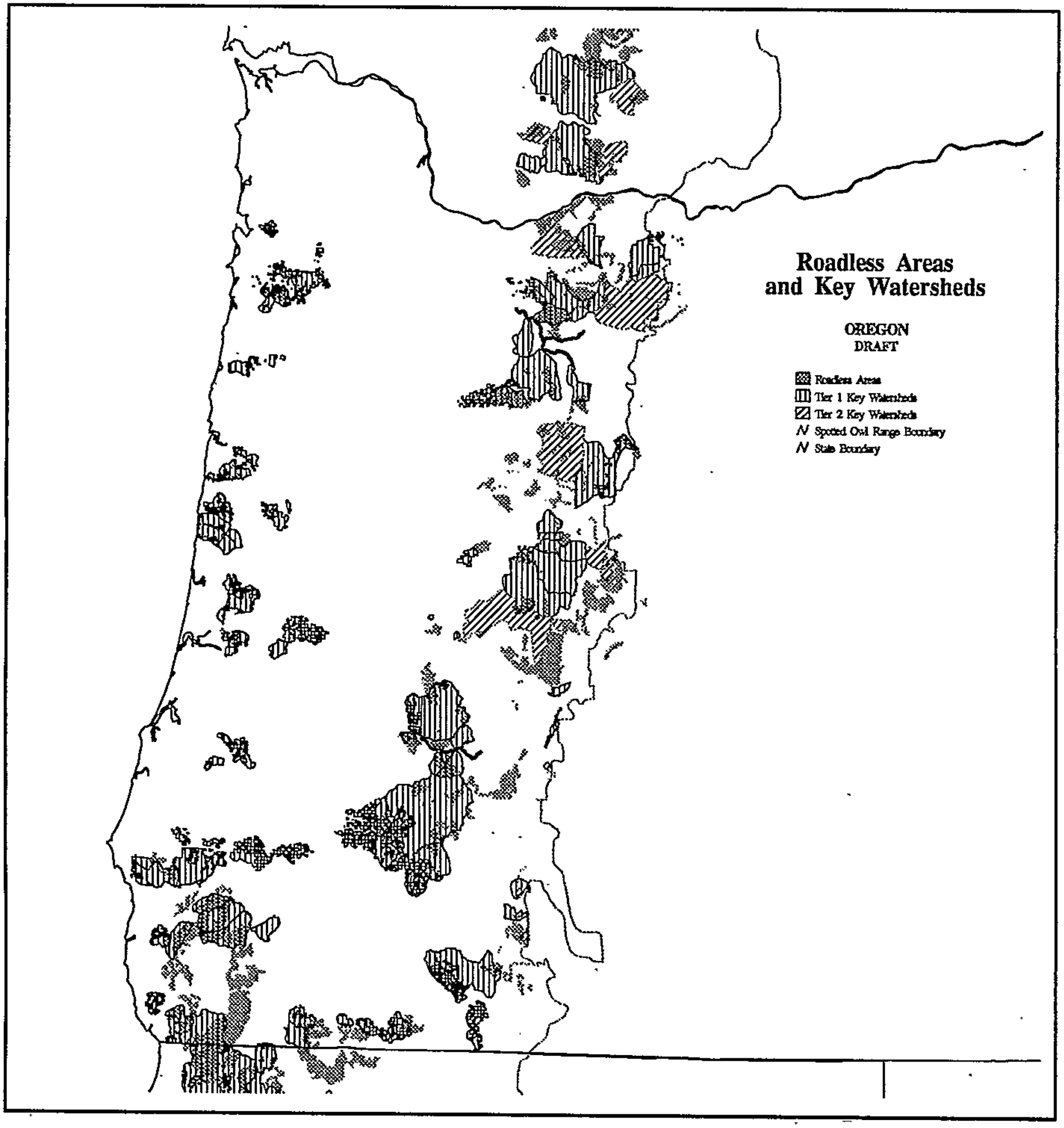


Figure V-H-4. Oregon roadless areas and Key Watersheds. Roadless areas shown are those that were inventoried during the Roadless Area Review and Evaluation (RARE II) process and remain in roadless condition.

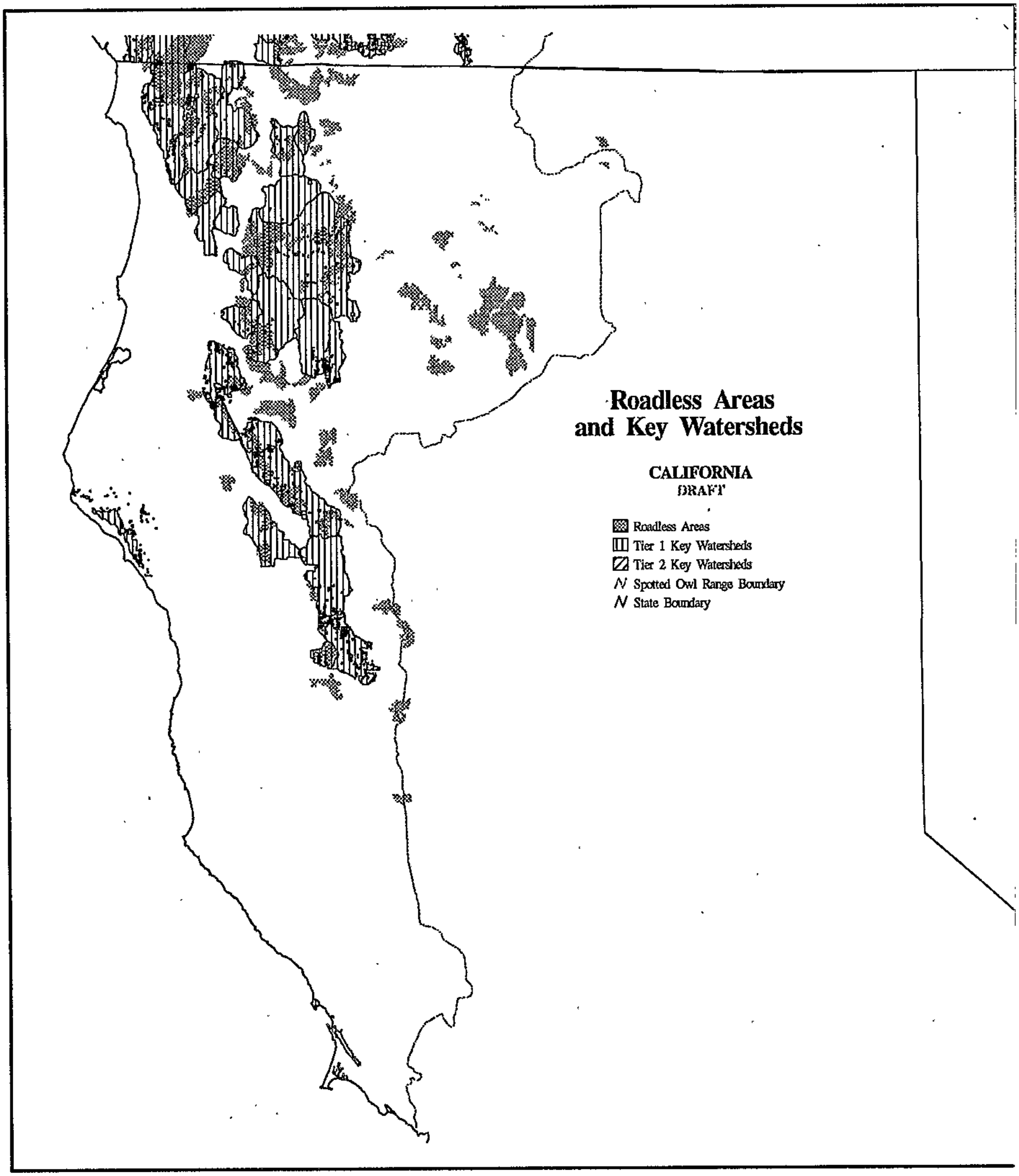


Figure V-H-5. California roadless areas and Key Watersheds. Roadless areas shown are those that were inventoried during the Roadless Area Review and Evaluation (RARE II) process and remain in roadless condition.

Table V-H-1. Key Watersheds.

Watershed Tier	River/Key Watershed		National Forest	BLM District
	WASHINGTON			
	Puyallup R.			
1	WF-23	White R.	Mt. Baker-Snoqualmie	
	Snohomish R.			
1	WF-25	Skykomish R.	Mt. Baker-Snoqualmie	
	Snoqualmie R.			
2	WF-24	M.Fk. Snoqualmie R.	Mt. Baker-Snoqualmie	
	Stillaguamish R.			
1	WF-27	Deer Cr.	Mt. Baker-Snoqualmie	
1	WF-28	N.Fk. Stillaguamish R.	Mt. Baker-Snoqualmie	
1	WF-26	S.Fk. Stillaguamish R.	Mt. Baker-Snoqualmie	
	Skagit R.			
1	WF-29	Sauk R.	Mt. Baker-Snoqualmie	
1	WF-30	Suiattle R.	Mt. Baker-Snoqualmie	
	Nooksack R.			
1	WF-31	S.Fk. Nooksack R.	Mt. Baker-Snoqualmie	
1	WF-32	N.Fk. Nooksack R.	Mt. Baker-Snoqualmie	
	Columbia R.			
1	WF-1	Wind R.	Gifford Pinchot	
2	WF-5	White Salmon R.	Gifford Pinchot	
2	WF-3	Little White Salmon R.	Gifford Pinchot	
	Lewis R.			
1	WF-2	E.Fk. Lewis R.	Gifford Pinchot	
2	WF-4	Siouxon Cr.	Gifford Pinchot	
1	WF-6	Lewis R.	Gifford Pinchot	
	Cowlitz R			
2	WF-8	N.Fk. Cispus R.	Gifford Pinchot	
2	WF-10	Clear Fk. Cowlitz R.	Gifford Pinchot	
2	WF-7	Upper Cispus R.	Gifford Pinchot	
1	WF-9	Packwood Lake & associated streams	Gifford Pinchot	
	Methow R.			
1	WF-20	Twisp R.	Okanogan	
1	WF-21	Early Winters Cr./Upper Methow R.	Okanogan	
1	WF-22	Chewach R.	Okanogan	
	Chelalis R.			
1	WF-33	Wynoochie R.	Olympic	
1	WF-34	Satsop R./Canyon R.	Olympic	
	Quillaute R.			
2	WF-40	Soleduck R.	Olympic	
	Quinault R.			
1	WF-41	Cook Cr./McCalla Cr.	Olympic	
	Strait of Juan de Fuca			
1	WF-38	Dungeness R.	Olympic	
1	WF-39	Elwha R.	Olympic	

Table V-H-1. (Continued)

Watershed Tier	River/Key Watershed		National Forest	BLM District
	Hood Canal			
1	WF-35	Skokomish R.	Olympic	
1	WF-42	Lake Cushman/N.Fk. Skok. tribs	Olympic	
1	WF-36	Duckabush R.	Olympic	
1	WF-37	Dosewallips R.	Olympic	
	Quilcene R.			
2	WF-43	L. Quilcene R.	Olympic	
	Columbia R.			
	Yakima R.			
1	WF-11	Naches R./Little Naches R.	Wenatchee	
1	WF-12	Rattlesnake Cr.	Wenatchee	
1	WF-13	Bumping-American R.	Wenatchee	
1	WF-14	Cle Elum R.	Wenatchee	
	Wenatchee R.			
1	WF-15	Ingalis Cr.	Wenatchee	
1	WF-16	Mission Cr.	Wenatchee	
1	WF-17	Icicle Cr.	Wenatchee	
1	WF-18	Upper Wenatchee R.	Wenatchee	
	Entiat R.			
1	WF-19	Entiat R.	Wenatchee	
	OREGON			
	Pacific Ocean			
1	OF-44	Winchuck R.	Siskiyou	
1	OF-57	Elk R.	Siskiyou	
	Smith R.			
1	OF-45	Baldface Cr./N.Fk. Smith R.		
	Chetco R.			
1	OF-46	Emily Cr.	Siskiyou	
1	OB-47	N.Fk. Chetco R.		Coos Bay
	Rogue R.			
1	OF-48	Taylor Cr.	Siskiyou	
1	OF-49	Quosatana Cr.	Siskiyou	
1	OF-50	Shasta-Costa Cr.	Siskiyou	
	Illinois R.			
1	OF-51	Grayback Cr./Cave Cr.	Siskiyou	
1	OF-52	Upper Sucker Cr.	Siskiyou	
1	OF-53	Upper E.Fk. Illinois R.	Siskiyou	
1	OF-54	Lawson Cr.	Siskiyou	
1	OU-55	Silver Cr.	Siskiyou	Medford
1	OF-56	Indigo Cr.	Siskiyou	
	Sixes R.			
1	OF-58	Dry Cr.	Siskiyou	

Table V-H-1. (Continued)

Watershed Tier	River/Key Watershed		National Forest	BLM District
	Coquille R.			
1	OU-59	S.Fk. Coquille R.	Siskiyou	Coos Bay
1	OB-60	Cherry Cr. (E.Fk. Coquille)		Coos Bay
1	OB-61	N.Fk. Coquille R.		Coos Bay
	Coos R.			
1	OB-62	Tioga Cr.		Coos Bay
	Lower Umpqua R.			
1	OF-63	Franklin Cr.	Siuslaw	
1	OB-64	Paradise Cr.		Coos Bay
	Smith R.			
1	OF-65	Wassen Cr.	Siuslaw	
1	OF-66	N.Fk. Smith R.	Siuslaw	
1	OB-67	Upper Smith R.		Roseburg
	Siuslaw R.			
1	OF-68	N.Fk. Siuslaw R.	Siuslaw	
1	OF-69	W.Fk. Indian Cr.	Siuslaw	
1	OF-70	Sweet Cr.	Siuslaw	
	Pacific Ocean			
1	OF-71	Cummins/Tenmile/Rock/Big Crs.	Siuslaw	
1	OF-72	Yachats R.	Siuslaw	
	Alsea R.			
1	OU-73	Drift Cr. (Alsea)	Siuslaw	Salem
1	OB-74	Tobe Cr.		Salem
1	OB-75	Lobster Cr.		Salem
	Yaquina R.			
1	OF-76	Mill Cr.	Siuslaw	
	Siletz R./Bay			
1	OU-77	Drift Cr. (Siletz)	Siuslaw	Salem
1	OB-78	N.Fk. Siletz R./Warnick Cr.		Salem
	Nestucca R.			
1	OB-79	Nestucca R.	(Siuslaw)	Salem
1	OF-80	Three Rivers	Siuslaw	
1	OF-81	Powder Cr./Niagara Cr.	Siuslaw	
1	OF-82	Limestone Cr./Boulder Cr./Tony Cr.	Siuslaw	
	Tillamook Bay			
1	OB-83	Kilchis R.		Salem
1	OB-84	Little N.Fk. Wilson R.		Salem
	Trask R.			
1	OB-85	M.Fk. Trask R./Elkhorn Cr.		Salem

Table V-H-1. (Continued)

Watershed Tier	River/Key Watershed		National Forest	BLM District
	Umpqua R.			
	S. Umpqua R.			
1	OU-86	S. Umpqua R.	Umpqua	Roseburg
	Cow Cr.			
1	OB-93	W.Fk. Cow Cr.		
1	OB-94	Middle Cr.		
	N. Umpqua R.			
1	OF-87	Calf Cr.	Umpqua	
1	OF-88	Copeland Cr.	Umpqua	
1	OF-89	Boulder Cr.	Umpqua	
1	OU-90	Steamboat Cr. (inc. Canton & Pass Crs.	Umpqua	Roseburg
1	OF-91	Deception Cr./ Wilson Cr.	Umpqua	
1	OF-92	N. Umpqua R. Corridor (Steamboat Cr. to Deer Cr.)	Umpqua	
	Rogue R.			
1	OU-96	Elk Cr.	Rogue River	Medford
1	OU-97	S.Fk./N.Fk. Little Butte Cr.	Rogue River	Medford
	Applegate R.			
1	OF-98	Palmer Cr.	Rogue River	
1	OF-99	Beaver Cr.	Rogue River	
1	OF-100	Yale Cr.	Rogue River	
1	OF-101	Little Applegate R.	Rogue River	
	Klamath R.			
1	OB-102	Jenny Cr.		Medford
2	OF-103	Clover Cr.	Winema	
2	OF-104	Rainbow Cr.	Winema	
2	OF-105	Pelican Butte	Winema	
1	OF-106	Cherry Cr.	Winema	
1	OF-107	Seven Mile Cr.	Winema	
1	OF-108	Evening Cr.	Winema	
	Columbia R.			
	Willamette R.			
	M.Fk. Willamette R.			
1	OF-109	Fern Cr.-Shady Del	Willamette	
2	OF-110	N.Fk. of the M.Fk. Willamette R.	Willamette	
	Santiam R.			
	N. Santiam R.		Willamette	
2	OF-110	Upper N. Santiam R.	Willamette	
1	OU-111	Upper Little N. Santiam R.	Willamette	Salem

Table V-H-1. (Continued)

Watershed Tier	River/Key Watershed		National Forest	BLM District
	Mckenzie R.			
1	OF-112	S. Fk. Mckenzie R.	Willamette	
1	OF-113	Horse Cr.	Willamette	
1	OF-114	Lost Cr./Scott Cr.	Willamette	
1	OF-115	Boulder Cr.	Willamette	
1	OF-116	Upper Mckenzie R.	Willamette	
1	OB-117	Lower McKenzie tribs (Marten, Bear)		Eugene
	Columbia R.			
1	OF-118	Fifteen Mile Cr./Ramsey Cr.	Mt. Hood	
1	OF-119	W.Fk. Hood R.	Mt. Hood	
1	OF-120	Mill Cr./Five Mile Cr./Eight Mile Cr.	Mt. Hood	
	Clackamas R.			
1	OF-121	Clackamas R. Corridor (Big Cliff to Clackamas headwaters)	Mt. Hood	
1	OF-122	Collowash R.	Mt. Hood	
1	OF-123	Fish Cr.	Mt. Hood	
1	OF-124	Oak Grove Fk. Corridor (Clackamas R. to Timothy Lake)	Mt. Hood	
1	OF-125	Roaring R.	Mt. Hood	
1	OU-126	Eagle Cr.	Mt. Hood	Salem
	Sandy R.			
1	OU-127	Salmon R.	Mt. Hood	Salem
2	OF-128	Bull Run R.	Mt. Hood	
	Deschutes R.			
2	OF-129	White R.	Mt. Hood	
1	OF-130	Big Marsh Cr.	Deschutes	
1	OF-131	Odell Cr.	Deschutes	
2	OF-132	Deschutes R. Corridor (Lava Lake to Crane Prairie)	Deschutes	
2	OF-133	Cultus Cr.	Deschutes	
2	OF-134	Deschutes R. Corridor (Dilman Meadows to La Pine Rec. Area)	Deschutes	
2	OF-135	Deschutes R. Corridor (Benham Falls Camp to Dillon Falls)	Deschutes	
2	OF-136	Tumalo Cr.	Deschutes	
2	OF-137	Squaw Cr.	Deschutes	
1	OF-138	Metolius R.	Deschutes	
2	OF-139	Three Creeks Meadows and Creek	Deschutes	
	CALIFORNIA			
	Eel R.			
1	CF-140	Thatcher Cr.	Mendocino	
1	CF-141	Black Butte Cr.	Mendocino	
1	CF-142	M.Fk. Eel R.	Mendocino	

Table V-H-1. (Continued)

Watershed Tier	River/Key Watershed		National Forest	BLM District
	Klamath R.			
	Trinity R.			
1	CF-143	N.Fk. Trinity R.	Shasta-Trinity	
1	CF-144	Canyon Cr.	Shasta-Trinity	
1	CF-145	S.Fk. Trinity R.	Shasta-Trinity	
1	CF-146	New River	Shasta-Trinity	
	Eel R.			
1	CF-147	N.Fk. Eel R.	Six Rivers	
	Mad R.			
1	CF-148	Pilot Cr.	Six Rivers	
	Klamath R.			
1	CF-149	Red Cap Cr.	Six Rivers	
1	CF-150	Bluff Cr.	Six Rivers	
1	CF-151	Blue Cr.	Six Rivers	
1	CF-152	Camp Cr.	Six Rivers	
	Trinity R.			
1	CF-153	Lower S.Fk. Trinity R.	Six Rivers	
1	CF-154	Horse Linto Cr.	Six Rivers	
	Pacific Ocean			
1	CF-155	Smith R.	Six Rivers	
	Klamath R.			
1	CF-156	Salmon R.	Klamath	
1	CF-157	Wooley Cr.	Klamath	
1	CF-158	Elk Cr.	Klamath	
1	CF-159	Dillon Cr.	Klamath	
1	CF-160	Clear Cr.	Klamath	
1	CF-161	Grider Cr.	Klamath	
	Mattole R.			
1	CB-162	Honeydew/Bear Cr.		Ukiah

Table V-H-2. Percentage of Tier 1 Key Watersheds by forest management allocation by option by state and physiographic province.

			OPTION 1				OPTION 2				OPTION 3				
			Percent of key watershed in:				Percent of key watershed in:				Percent of key watershed in:				
State/ Physiographic province	Total acres federal land	Congress Withdrawn Areas	Late Succession Reserves	Admin. Withdrawn Areas	Riparian Reserves	Matrix	Late Succession Reserves	Admin. Withdrawn Areas	Riparian Reserves	Matrix	Late Succession Reserves	Managed Late-Succession Reserves	Admin. Withdrawn Areas	Riparian Reserves	Matrix
Washington															
Eastern Cascades	3,472,400	46	33	7	5	10	27	8	5	15	30	0	7	6	11
Western Cascades	3,721,700	37	47	5	4	6	42	8	4	10	40	1	9	5	8
Western Lowlands	126,300	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Olympic Peninsula	1,518,800	22	61	0	9	8	60	0	8	11	60	0	0	9	9
Total:	8,839,200	40	41	6	5	8	36	7	5	12	36	1	8	6	10
Oregon															
Klamath	2,106,200	8	74	2	7	9	65	3	9	15	61	3	4	10	14
Eastern Cascades	1,557,400	23	55	3	7	12	51	4	5	17	55	0	3	7	12
Western Cascades	4,478,200	23	60	1	7	9	48	2	9	18	37	11	3	12	15
Coast Range	1,396,800	6	79	0	7	7	45	9	7	21	75	0	0	9	10
Willamette Valley	25,600	0	0	0	56	56	0	0	0	0	0	0	0	56	56
Total:	9,564,200	17	66	1	7	9	47	2	7	15	50	6	3	11	14
California															
Coast Range	388,200	18	53	9	7	13	73	0	8	13	45	0	9	10	17
Klamath	4,459,900	41	43	4	5	7	27	9	7	16	24	2	11	10	13
Cascades	1,009,200	0	0	0	0	0	0	0	28	56	0	0	0	0	0
Total:	5,857,300	40	43	5	5	7	39	9	8	17	24	2	11	10	13
Three-State Total:	24,260,700	33	49	4	6	8	40	6	6	15	37	3	7	8	12

Table V-H-2. (Tier 1 Watersheds continued)

State/ Physiographic province	Total acres federal land	Congress Withdrawn Areas	OPTION 4 Percent of key watershed in: Late Succession Reserves*	OPTION 4 Admin. Withdrawn Areas	OPTION 4 Riparian Reserves	OPTION 4 Matrix	OPTION 5 Percent of key watershed in: Late Succession Reserves*	OPTION 5 Admin. Withdrawn Areas	OPTION 5 Riparian Reserves	OPTION 5 Matrix	OPTION 6 & 10** Percent of key watershed in: Late Succession Reserves	OPTION 6 & 10** Admin. Withdrawn Areas	OPTION 6 & 10** Riparian Reserves	OPTION 6 & 10** Matrix
Washington														
Eastern Cascades	3,472,400	46	27	8	6	12	21	12	7	14	22	10	6	17
Western Cascades	3,721,700	37	45	6	5	7	42	8	6	8	40	9	4	10
Western Lowlands	126,300	0	0	0	0	0	0	0	0	0	0	0	0	0
Olympic Peninsula	1,518,800	22	61	0	8	8	61	0	8	8	60	0	8	11
Total:	**8,839,200**	**40**	**37**	**7**	**6**	**10**	**33**	**9**	**6**	**11**	**32**	**9**	**5**	**14**
Oregon														
Klamath	2,106,200	8	66	3	10	13	59	4	13	17	61	4	10	17
Eastern Cascades	1,557,400	23	49	4	9	15	25	17	12	23	44	4	7	21
Western Cascades	4,478,200	23	39	2	16	20	23	4	22	28	37	3	12	26
Coast Range	1,396,800	6	80	0	7	7	80	0	7	7	75	0	7	12
Willamette Valley	25,600	0	0	0	56	56	0	0	56	56	0	0	28	56
Total:	**9,564,200**	**17**	**52**	**2**	**13**	**16**	**40**	**5**	**17**	**22**	**48**	**3**	**10**	**21**
California														
Coast Range	388,200	18	50	11	8	13	50	11	8	13	45	9	7	21
Klamath	4,459,900	41	26	9	11	13	22	10	12	15	24	11	8	17
Cascades	1,009,200	0	0	0	0	0	0	0	0	0	0	0	0	0
Total:	**5,857,300**	**40**	**27**	**9**	**11**	**13**	**23**	**10**	**12**	**15**	**24**	**11**	**8**	**17**
Three-State Total:	**24,260,700**	**33**	**39**	**6**	**9**	**13**	**33**	**8**	**11**	**15**	**35**	**7**	**8**	**17**

* Includes 147,000 acres of managed late-successional areas.

** Table information is the same for Option 6 and Option 10

Table V-H-2. (Tier 1 Watersheds continued)

State/ Physiographic province	Total acres federal land	Congress Withdrawn Areas	OPTION 7 Percent of key watershed in: Late Succession Reserves*	Admin. Withdrawn Areas	Riparian Reserves	Matrix	OPTION 8 Percent of key watershed in: Late Succession Reserves	Admin. Withdrawn Areas	Riparian Reserves	Matrix	OPTION 9 Percent of key watershed in: Late Succession Reserves	Managed Late-Succession Reserves	Admin. Withdrawn Areas	Riparian Reserves	Matrix
Washington															
Eastern Cascades	3,472,400	46	21	12	1	20	22	10	4	19	26	2	7	7	13
Western Cascades	3,721,700	37	38	9	1	15	40	9	3	12	41	3	6	6	8
Western Lowlands	126,300	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Olympic Peninsula	1,518,800	22	50	1	2	25	60	0	6	12	66	12	0	0	0
Total:	**8,839,200**	**40**	**31**	**10**	**1**	**18**	**32**	**9**	**3**	**15**	**35**	**3**	**6**	**6**	**10**
Oregon															
Klamath	2,106,200	8	27	13	4	48	61	4	6	21	55	7	4	12	15
Eastern Cascades	1,557,400	23	25	17	2	33	44	4	5	24	46	0	4	10	17
Western Cascades	4,478,200	23	23	4	4	47	37	3	8	30	46	1	2	12	16
Coast Range	1,396,800	6	69	0	2	22	75	0	5	14	63	20	0	5	6
Willamette Valley	25,600	0	0	0	0	84	0	0	28	84	0	0	0	56	56
Total:	**9,564,200**	**17**	**31**	**7**	**3**	**42**	**48**	**3**	**6**	**25**	**50**	**5**	**2**	**11**	**15**
California															
Coast Range	388,200	18	50	11	1	20	45	9	5	23	50	0	11	8	13
Klamath	4,459,900	41	16	12	2	29	24	11	5	20	25	3	10	10	12
Cascades	1,009,200	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total:	**5,857,300**	**40**	**17**	**12**	**2**	**29**	**24**	**11**	**5**	**20**	**26**	**2**	**10**	**10**	**12**
Three-State Total:	**24,260,700**	**33**	**27**	**10**	**2**	**28**	**35**	**7**	**5**	**20**	**37**	**4**	**6**	**8**	**12**

* Includes 147,000 acres of managed late-successional areas.

Table V-H-3. Percentage of Tier 2 Key Watersheds by allocation by option by state and physiographic province.

			OPTION 1				OPTION 2				OPTION 3				
			Percent of key watershed in:				Percent of key watershed in:				Percent of key watershed in:				
State/ Physiographic province	Total acres federal land	Congress Withdrawn Areas	Late Succession Reserves	Admin. Withdrawn Areas	Riparian Reserves	Matrix	Late Succession Reserves	Admin. Withdrawn Areas	Riparian Reserves	Matrix	Late Succession Reserves	Managed Late-Succession Reserves	Admin. Withdrawn Areas	Riparian Reserves	Matrix
Washington															
Eastern Cascades	3,472,400	16	51	2	16	15	48	3	13	20	48	0	3	13	20
Western Cascades	3,721,700	42	50	3	2	3	46	4	3	5	40	5	5	3	5
Western Lowlands	126,300	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Olympic Peninsula	1,518,800	0	68	1	16	15	66	1	13	19	67	0	1	13	19
Total:	**8,839,200**	**31**	**53**	**3**	**7**	**7**	**49**	**4**	**6**	**10**	**45**	**3**	**4**	**6**	**10**
Oregon															
Klamath	2,106,200	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Eastern Cascades	1,557,400	24	43	6	12	16	41	6	9	20	41	0	6	9	20
Western Cascades	4,478,200	26	56	2	5	10	45	3	6	20	36	8	4	6	20
Coast Range	1,396,800	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Willamette Valley	25,600	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total:	**9,564,200**	**25**	**51**	**4**	**7**	**13**	**43**	**4**	**7**	**20**	**38**	**5**	**5**	**7**	**20**
California															
Coast Range	388,200	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Klamath	4,459,900	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cascades	1,009,200	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total:	**5,857,300**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Three-State Total:	**24,260,700**	**27**	**52**	**3**	**7**	**10**	**45**	**4**	**7**	**16**	**41**	**5**	**5**	**7**	**16**

Table V-H-3. (Tier 2 Watersheds continued)

State/ Physiographic province	Total acres federal land	Congress Withdrawn Areas	OPTION 4 Percent of key watershed in: Late Succession Reserves*	Admin. Withdrawn Areas	Riparian Reserves	Matrix	OPTION 5 Percent of key watershed in: Late Succession Reserves*	Admin. Withdrawn Areas	Riparian Reserves	Matrix	OPTION 6 & 10** Percent of key watershed in: Late Succession Reserves	Admin. Withdrawn Areas	Riparian Reserves	Matrix
Washington														
Eastern Cascades	3,472,400	16	75	0	4	4	71	1	5	7	48	3	13	20
Western Cascades	3,721,700	42	41	4	6	7	22	7	11	17	40	5	5	8
Western Lowlands	126,300	0	0	0	0	0	0	0	0	0	0	0	0	0
Olympic Peninsula	1,518,800	0	67	1	16	16	67	1	13	18	67	1	13	19
Total:	8,839,200	31	51	3	7	7	37	5	10	16	45	4	7	12
Oregon														
Klamath	2,106,200	0	0	0	0	0	0	0	0	0	0	0	0	0
Eastern Cascades	1,557,400	24	27	11	16	22	10	16	15	36	25	13	11	27
Western Cascades	4,478,200	26	39	3	10	21	33	3	8	29	36	4	8	27
Coast Range	1,396,800	0	0	0	0	0	0	0	0	0	0	0	0	0
Willamette Valley	25,600	0	0	0	0	0	0	0	0	0	0	0	0	0
Total:	9,564,200	25	34	6	12	22	24	8	11	32	32	7	9	27
California														
Coast Range	388,200	0	0	0	0	0	0	0	0	0	0	0	0	0
Klamath	4,459,900	0	0	0	0	0	0	0	0	0	0	0	0	0
Cascades	1,009,200	0	0	0	0	0	0	0	0	0	0	0	0	0
Total:	5,857,300	0	0	0	0	0	0	0	0	0	0	0	0	0
Three-State Total:	24,260,700	27	41	5	10	16	29	7	11	26	37	6	8	21

* Includes 147,000 acres of managed late-successional areas.

** Table information is the same for Option 6 and Option 10

Table V-H-3. (Tier 2 Watersheds continued)

State/ Physiographic province	Total acres federal land	Congress Withdrawn Areas	OPTION 7 Percent of key watershed in: Late Succession Reserves*	Admin. Withdrawn Areas	Riparian Reserves	Matrix	OPTION 8 Percent of key watershed in: Late Succession Reserves	Admin. Withdrawn Areas	Riparian Reserves	Matrix	OPTION 9 Percent of key watershed in: Late Succession Reserves	Managed Late-Succession Reserves	Admin. Withdrawn Areas	Riparian Reserves	Matrix
Washington															
Eastern Cascades	3,472,400	16	71	1	1	11	48	3	9	24	8	0	6	28	42
Western Cascades	3,721,700	42	21	8	3	26	40	5	3	10	29	17	4	2	6
Western Lowlands	126,300	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Olympic Peninsula	1,518,800	0	55	1	4	40	67	1	11	21	54	46	0	0	0
Total:	**8,839,200**	**31**	**35**	**6**	**3**	**26**	**45**	**4**	**5**	**14**	**29**	**18**	**4**	**6**	**11**
Oregon															
Klamath	2,106,200	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Eastern Cascades	1,557,400	24	10	16	4	47	25	13	7	31	26	0	12	11	27
Western Cascades	4,478,200	26	33	3	2	35	36	4	4	30	27	0	4	9	33
Coast Range	1,396,800	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Willamette Valley	25,600	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total:	**9,564,200**	**25**	**24**	**8**	**3**	**40**	**32**	**7**	**5**	**30**	**27**	**0**	**7**	**10**	**30**
California															
Coast Range	388,200	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Klamath	4,459,900	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Cascades	1,009,200	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total:	**5,857,300**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**	**0**
Three-State Total:	**24,260,700**	**27**	**28**	**7**	**3**	**35**	**37**	**6**	**5**	**24**	**28**	**7**	**6**	**9**	**23**

* Includes 147,000 acres of managed late-successional areas.

Appendix V-I
Watershed Analysis and its Role in Ecosystem Management

Rationale for a Watershed Basis to Ecosystem Management

In its broadest sense, ecosystem management represents a philosophy of natural resource management that emphasizes sustaining ecological systems and functions while deriving socially-defined benefits. Ecosystems are influenced by both biological and physical changes, so if we are to design land use to sustain ecosystems, we must understand the effects of land-use activities on both the physical and biological environment, and we must understand how these components of the environment interact with each other. In order to employ ecosystem management, we must also develop human institutions for planning and decision-making to maximize beneficial uses, while minimizing environmental impacts.

The concepts of ecosystem management are still in their infancy, but include using science to define landscape states, interpret the intrinsic potential of landscapes to produce desired outputs, and predict the consequences of activities on ecosystems and human communities. Implementing ecosystem management on federal lands must recognize some of these emerging principles, which include:

- **Multivalue:** Societal expectations for forest landscapes, including beneficial uses, goods, services, economic and ecologic values must direct forest management to the extent that they do not conflict with sustaining ecosystems structure and function.

- **Multiscale:** The process must address issues and concerns generated at spatial scales ranging from regions, where conservation policy is formulated, to physiographic provinces, where management activities and strategies are coordinated, to smaller watersheds/landscapes where site-specific activities are planned and implemented. Strategies developed at coarser scales provides context for and guides implementation at finer scales, while information from finer scales provides feedback on assumptions and decisions made at coarser scales.

- **Multiownership:** Planning must include all owners in mixed ownership lands. This includes both inter-agency coordination and public participation in some type of partnership arrangement.

- **Multidisciplinary:** Implementing ecosystem management requires simultaneous consideration of issues traditionally viewed as independent. Wildlife viability, biodiversity, upland silviculture practices, riparian structure and function, hydrologic and geomorphic processes, among others, must be analyzed at a common spatial scale, where linkages among system elements can be evaluated, and redundancies and incompatibilities in management options be addressed.

Ecosystem planning is a multi-scale, hierarchical process designed to incorporate these principles. Central to this process is the concept that watersheds represent a physically and ecologically relevant, and socially acceptable scale for managing forest resources.

There are many reasons to consider watersheds as an appropriate spatial unit for implementing ecosystem management. They include:

Linkage across spatial scales and policy levels: Watersheds link regional conservation strategies, provincial and landscape objectives, and project implementation.

Linkage among physical processes: Many key physical processes are best understood at a watershed basis (e.g. movement of water, sediment, wood, and consequent effects on channel structure and habitat). Many of these processes are linked in time and space and tend to propagate downstream. Understanding these linkages is essential for understanding on- and off-site effects of land use.

Basis for managing key species: Some organisms are strongly tied to watersheds and associated channel networks (e.g. fish, riparian obligates); others that are not (e.g. owls) can be accounted for by including trans-watershed habitat and migration areas. Recognizing watersheds is essential to achieve objectives for organisms whose habitat needs cross ownership boundaries or that use different habitats over their life cycle (e.g. fish). Building watersheds into conservation schemes for species that are not watershed-based allows coordination and flexibility in developing management options that influence all species and may offer opportunities for creative solutions that meet multiple objectives.

Basis for addressing beneficial uses: Watersheds represent real, unchanging, physical boundaries for managing many beneficial uses of forested lands (e.g., municipal water supply, water quality, hydroelectric power, sport fisheries, irrigation). Other uses, such as recreation or timber supply to local communities are less tightly defined by watershed boundaries but watersheds can be aggregated to address these concerns. Watershed based management would allow both management and regulatory agencies to coordinate planning and implementation across multiple ownerships, and efficiently deal with complex and interconnected natural resource problems.

Basis for community involvement in natural resource planning: Watersheds provide a rational and effective spatial scale for citizens to participate in natural resource decision-making. Many of the best examples of community-based resource planning -- the Applegate Project in southern Oregon and the Mattole and Redwood Community Watershed Associations in northern California -- are organized on a watershed basis. Watersheds represent a natural demarcation of geography that encompasses a wide diversity of ownerships, issues, and viewpoints. They have intrinsic appeal for aesthetic, cultural, and historical reasons as well. Furthermore, a watershed basis for planning insures that those communities and individuals most directly affected by decisions have a role in decision making.

Implementing ecosystem management requires matching objectives to the intrinsic capabilities and capacities of landscapes, which requires information on geomorphic, ecologic, and social conditions and processes operating in specific landscapes. *Watershed analysis* is a systematic procedure for characterizing watershed and ecological processes to meet specific management and social objectives. It has been adopted as the basis for a number of recent planning efforts and appears to be the emerging standard for resolving environmental conflicts in the western United States. In this section, we consider how watershed analysis might contribute to ecosystem planning on federal lands.

Scales of Analysis in Ecosystem Planning

Ecosystem planning needs to be conducted at four spatial scales: regional, province/river-basin, watershed and site (fig. V-I-1). The region is defined for the purposes of this report as the Pacific Northwest, which encompasses the entire range of the northern spotted owl. River basins are areas of similar beneficial use or have particular suites of down stream resource concerns. The Klamath, Umpqua, Willamette Rivers and provincial groupings of small coastal watersheds, with common geology, climate and physiography are examples (figs. V-I-2 and V-I-3). Watersheds are sub-basins of 20-200 square miles (fig. V-I-4), and are the scale at which watershed analyses are conducted. Sites are areas of variable size but typically ranging from tens to hundreds of acres, where specific activities, such as timber harvest, watershed restoration, silvicultural treatments, or road construction take place.

At each scale, analyses describe human needs, environmental values, and important watershed and ecosystem functions. Information collected at broader spatial scales guides analysis and development of management options at finer scales. Conversely, information collected at the finer scales provides early warning of likely future problems at the broader scales. By this approach, key issues are dealt with at their appropriate spatial scales.

Interdisciplinary teams will be convened at regional, river basin, and individual watershed levels. The membership of these teams must draw from the best expertise available in public and private institutions. Analyses of each scale will be an interagency effort, drawing on personnel in a variety of agencies, including the Forest Service, Environmental Protection Agency, Bureau of Land Management, National Marine Fisheries Service, and Fish and Wildlife.

Information from the regional scale identifies important beneficial uses, resource values, and economic issues and is used to evaluate how resources in a particular river basin or watershed influence resource values throughout the region. In many cases, regional issues transcend river-basin or watershed boundaries and may constrain management options at these scales. For example, habitat protection for threatened and endangered species may be established as a regional network, based on region-wide habitat conditions or availability of refugia.

Regional scale issues are those that apply across thousands of square miles, and include:

1. Land allocation decisions, e.g. identified reserve systems for species conservation or old-growth forest protection.

2. Standards and guidelines to achieve regional management objectives, e.g. the 50-11-40 rule for management of Matrix lands or riparian standards and guides.

3. Regional programs to support at-risk communities, which may include sustainable levels of commodity outputs.

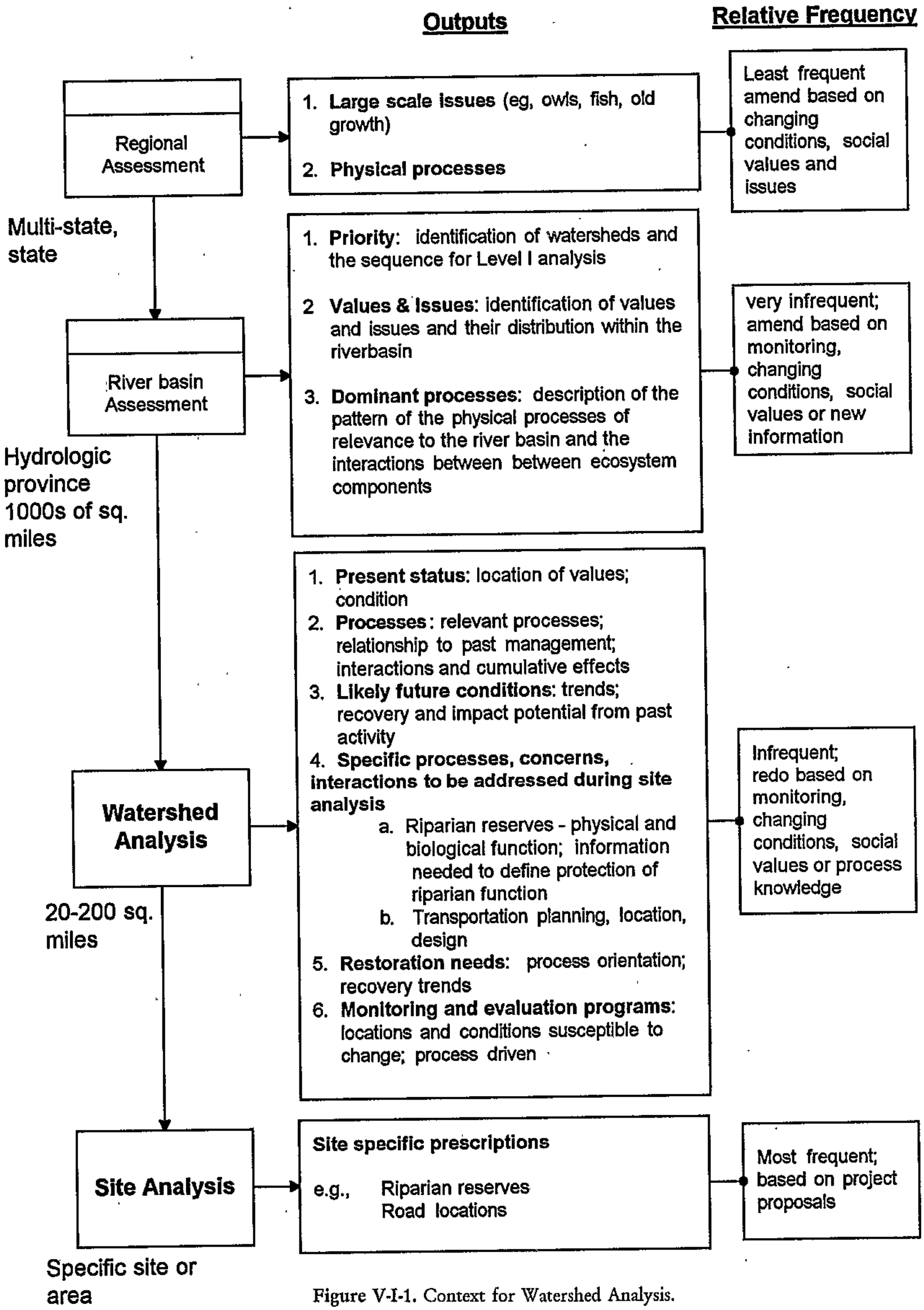


Figure V-I-1. Context for Watershed Analysis.

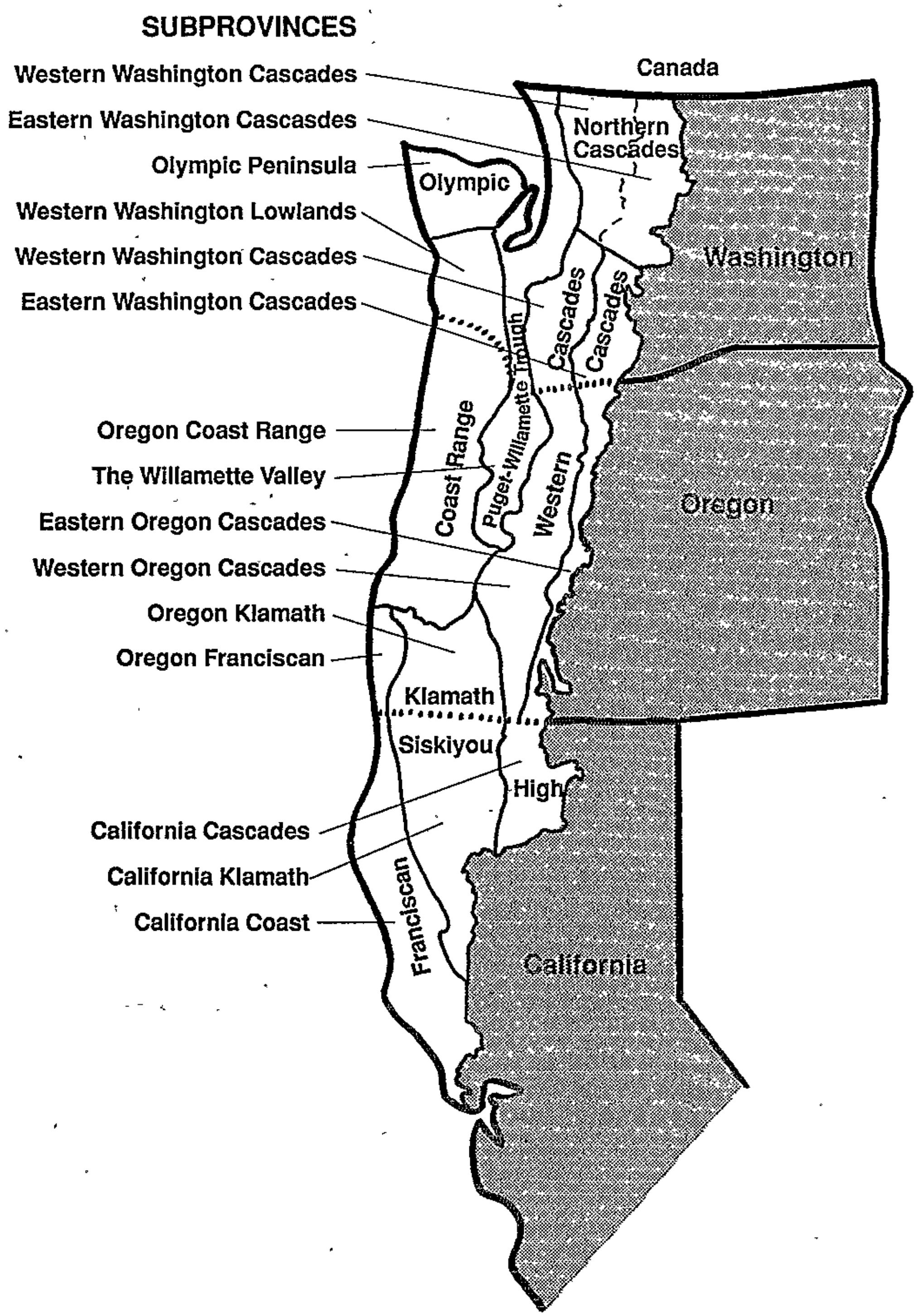


Figure V-I-2. Provinces and subprovinces.

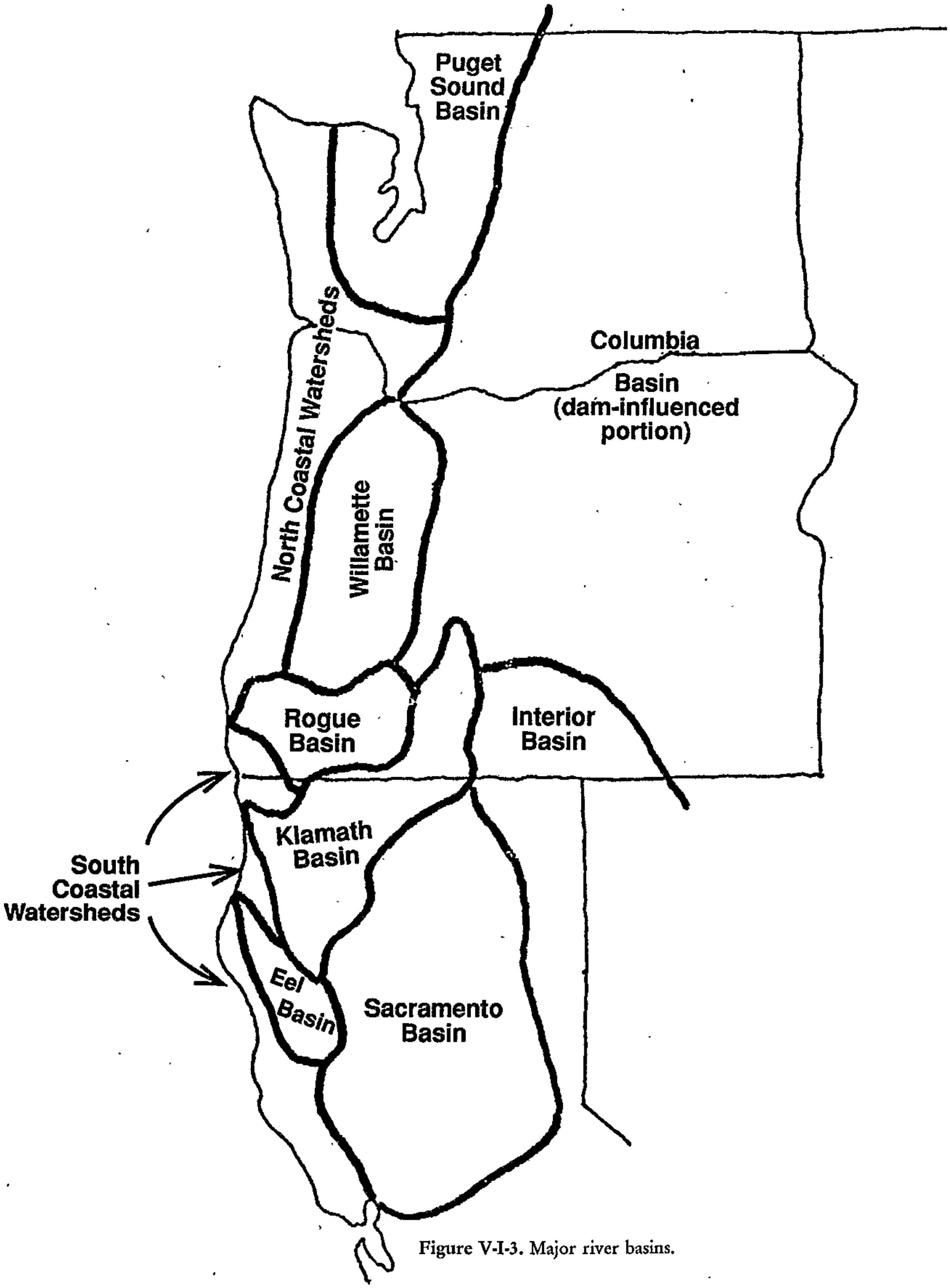


Figure V-I-3. Major river basins.

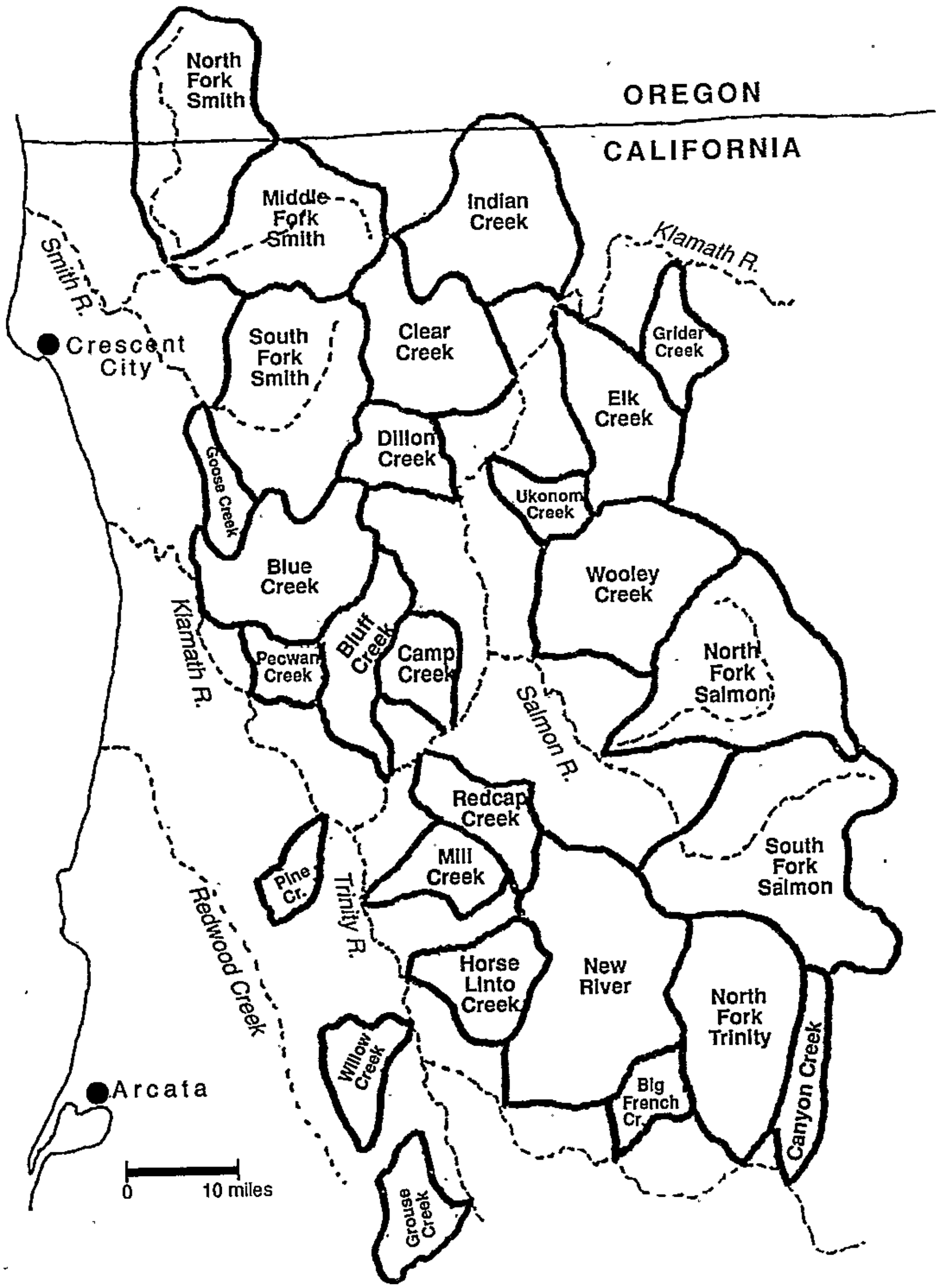


Figure V-I-4. Example of project watersheds in northwest California

At the river basin scale, beneficial uses and ecosystem values for large river basins or physiographic provinces are analyzed. Physical and biological processes that affect those uses and values are identified. Goals of this phase of analysis are to:

1. Identify key resource issues and concerns, for example threatened and endangered species, historic and contemporary resource use, water quality issues, distribution of stocks or communities at risk; identify individuals and groups who can speak for these interests.

2. Identify the context of the river basin with respect to other large basins (intra-basin/regional issues that cross drainage basin boundaries)

3. Identify ownership patterns, agency boundaries and areas of jurisdiction, wilderness, and other special management areas, historical land use patterns.

4. Describe the physiographic province(s)in which the basin lies and identify key physical processes and their spatial distribution at this coarse scale, for example, parts of drainage basin subject to different types of mass movements, rain-on-snow processes etc.

5. Identify overriding ecological issues and areas, for example Key Watersheds, ecological reserves, species distributions.

6. Prioritize watersheds for analysis.

7. Integrate results from individual watershed analyses and evaluate cumulative effects at the province and river basin scales.

8. Provide a general description of physical and biological conditions within the river basin

The results of this analysis will define a minimum set of issues and maps that will guide the more detailed individual watershed analyses.

The most comprehensive analyses are conducted at the watershed scale, discussed below. Assessments of physical and biological processes, conditions, and resources are used to evaluate environmental impacts as well as management opportunities and constraints. Watersheds to be analyzed will be identified from maps developed from regional and river-basin analysis and will be approximately 20-200 square miles in size. Information from watershed analysis is used to design management alternatives to meet objectives that are compatible with watershed and ecosystem function, and to guide site-level planning, the fourth scale of analysis. The preferred alternative identified in the Draft EIS, Elk River, Wild and Scenic River Management Plan is an example of how information obtained through watershed analysis might be used to develop management allocations (fig. V-I-5). Monitoring activities can be planned and initiated at this level.

Finally, at the site-scale of tens to hundreds of acres, individual projects are planned and initiated. These may include timber sales, silvicultural treatments, restoration activities, and so on, and are designed to be compatible with information developed in the watershed-level analyses. Monitoring activities are also planned and initiated at this scale.

In addition to these four spatial scales, ecosystem planning must also consider several temporal scales. Assessments of beneficial uses, values, and impacts must incorporate

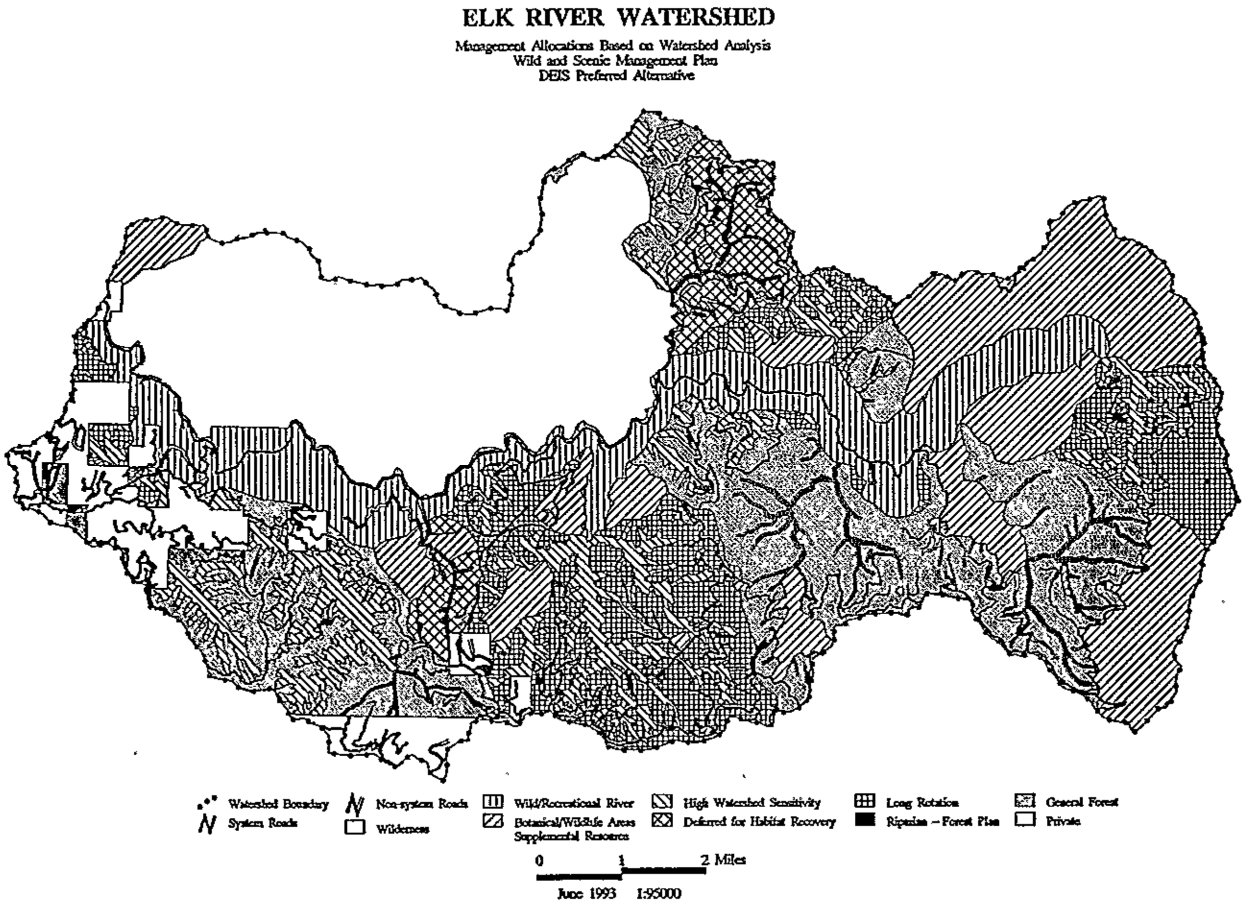


Figure V-I-5. Elk River watershed: management allocations based on watershed analysis.

longer time periods than those usually addressed in the past. At each spatial scale, analysis must:

- Encompass the full range of past impacts;
- Encompass the full range of likely future impacts, including best-guess estimates for mixed-ownership lands;
- Consider time periods long enough to represent rare natural catastrophes such as major floods, fires, windstorms, and droughts (e.g., 100 years). The analysis should also consider the possible effect of potential, but unmeasurable concerns such as global climate change.

Analytical Framework for Watershed Analysis

Watershed analysis develops and integrates information on physical and biological processes and conditions. It also analyzes social values, uses, and perceptions as they apply to a specific landscape. Development of information in each of these areas is guided by a set of analysis modules that describe key processes and components of watershed and ecosystem function as well as human/social values for watershed products, attributes, and amenities. While these modules can be defined independently, considerable overlap exists among modules. A key component of watershed analysis is the opportunity to explore areas of overlap, for example between upland terrestrial ecology and riparian issues or the relation between ecological process and societal expectations for the watershed. Because of their comprehensive nature, watershed analyses are carried out by interdisciplinary teams.

The goals of watershed analysis are:

1. Determine the type, areal extent, frequency, and intensity of watershed processes, including mass movements, fire, peak and low streamflows, surface erosion, and other processes affecting the flow of water, sediment, organic material, or disturbance through a watershed.

2. Using the results from #1, interpret the natural disturbance regime of both riparian zones and uplands and compare with disturbance regime under managed conditions.

3. Identify parts of the landscape, including hillslopes and channels, that are either sensitive to specific disturbance processes or critical to beneficial uses, key stocks or species.

4. Determine the distribution, abundance, life histories, habitat requirements, and limiting factors of critical species identified by the regional or river basin analyses, e.g. fish, owls, other riparian dependent species.

5. Identify beneficial uses, societal concerns and issues, and public perceptions and uses of the watershed.

6. Integrate the information generated to describe physical and biological conditions and into a set of management options, opportunities, and constraints.

7. Establish ecologically and geomorphically appropriate criteria for establishing boundaries of Riparian Habitat Conservation Areas and other special protection areas.

8. Design approaches to evaluate and monitor the reliability of the analysis procedure and the effectiveness of adopted management activities.

9. Identify restoration objectives, strategies and priorities.

Several elements of the proposed procedure allow watershed analysis to be carried out efficiently and relatively rapidly. First, most of the required information already exists (topographic maps, aerial photographs, climatic records, geologic maps, soils maps, land-use history, and resource information). Second, issues that are relevant to a particular management activity or downstream resource can be focused on from the start. This approach allows the nature and precision of the information required to be defined beforehand, and thus avoids collection of information that will have little utility in the analysis. Third, watersheds and areas within watersheds can be stratified according to their susceptibility to disturbance. Representative sites within each stratum can then be evaluated and the results used to characterize responses throughout the stratum. This strategy allows large areas to be assessed quickly.

Watershed analysis is carried out by a Watershed Interdisciplinary Team made up of four to six specialists acquainted with the area. Members of this interagency team have training equivalent to that of Forest Service District specialists (Bachelor's degree with several years' experience), augmented by a training session in watershed analysis. Disciplines represented on the team vary between watersheds, but a team is likely to include a forester/botanist, geomorphologist/geologist/hydrologist, aquatic ecologist/fish biologist, terrestrial ecologist/wildlife biologist. In particular, the geologist or hydrologist must have training in geomorphology. A handbook, described at the end of this section, is being developed that describes techniques and procedures used for watershed analysis.

Application of information from watershed analysis: Watershed analysis reports will organize the information generated into a framework useable by decisionmakers. Reports might include descriptions of:

1. Management strategies to optimize ecologic protection by jointly considering upland and riparian zone functions, for example by extending upland reserves into riparian zones, or by designing riparian zone buffers to meet upland objectives.

2. Management strategies to model land use activities on vegetation patterns interpreted as resulting from natural disturbance regimes (e.g. fire, windthrow, debris flow). This might influence the structure and areal extent of protection areas.

3. Using results from one module to predict effects on resources analyzed under a different module. For example, evaluations of the distribution of seasonally saturated areas might also be used to predict distribution of upland amphibians or other organisms requiring moist habitat.

4. Creative approaches to addressing apparent social conflicts. For example, concerns about visual impacts from timber harvest could be modelled for the watershed and included in timber sale layout and design.

5. Optimizing design of transportation network to jointly meet riparian, upland silviculture, water quality, and recreation objectives.

6. Directly addressing legal requirements posed by National Environmental Policy Act, Environmental Policy Act, National Forest Management Act, Endangered Species Act to consider viability issues, or cumulative effects.

7. Strategies for development of restoration or monitoring programs.

Watershed analyses provide general guidelines and constraints on specific management activities. Site-specific analyses allow development of implementation plans for management activities consistent with management opportunities and constraints identified by the watershed analyses.

Restoration: The goal of watershed restoration is to restore desired conditions and processes. Restoration opportunities and constraints must be evaluated in the context of watershed processes if restoration strategies are to be effective. Watershed analysis provides the foundation upon which to build efficient, effective restoration programs. Without the benefit of watershed analysis, restoration efforts may be largely ineffective. See appendix J for a detailed discussion of restoration.

Monitoring: Monitoring provides the feedback that guides management adaptation. At the narrowest scale of monitoring, the specific management activities prescribed by watershed analysis will be evaluated to determine: (1) if practices are actually implemented as prescribed, and (2) if the prescribed practices are effective. Which attributes are useful to measure depends on the processes active in a watershed and the types of impacts of concern. Consequently, monitoring projects must be guided by the results of watershed analysis.

Monitoring also increases knowledge of watershed processes, cumulative effects, conditions, and trends through time. Watershed analyses are likely to reveal gaps in basic knowledge. For example, predictive models may need to be calibrated for a particular watershed. Thus, monitoring will provide additional information about processes and linkages that are poorly understood.

Research: An active research program is a necessary component of long-term ecosystem planning that incorporates watershed analysis. Watershed analysis requires understanding the linkages between management activities, geomorphic processes, habitat structure and dynamics, and ecosystem response. In reality, our knowledge of these linkages is limited. Obviously, management decisions cannot be forestalled until these linkages are completely understood. Rather, watershed management needs to be based on the best available knowledge. Given the inherent complexity of watershed and ecological processes, and the consequent uncertainty of our knowledge, it is extremely important that our understanding of ecological and geomorphic processes improve through long-term research. Watershed analysis methods must be regularly updated to incorporate this increased understanding.

Handbook for Watershed Analysis on Federal Lands

A handbook is currently being prepared that describes the strategy to be used for watershed analysis on federal lands in the western United States. The handbook will also provide outlines of analytical techniques that may be used. However, the handbook is not intended to be used as a cookbook: it assumes a high level of expertise within each of the disciplines represented on the watershed analysis team. Any analysis problem can be approached using a variety of methods, and professionals on the analysis team are in the best position to decide which methods are most appropriate in a particular area.

Watershed analysis on the scale envisioned involves some difficult problems. Results must be produced quickly, yet the issues, ecosystems, and watershed processes to be evaluated are extremely complicated. The analysis strategy is thus designed to simplify the analysis as much as possible. This is feasible for several reasons:

1. A preliminary diagnosis of issues, impacts, and watershed processes can be used to closely focus the types of analyses required during a watershed analysis.

2. Many land-use decisions can be based on a qualitative description of the distribution and types of conditions in a watershed. Rarely are precise measurements of process rates necessary.

3. Watersheds can be stratified into areas that behave uniformly with respect to particular processes. Thus, understanding obtained from site-specific measurements may logically be extrapolated to other areas within the same strata.

This strategy is presented in the form of a sequence of tasks in the handbook.

Task 1 is the compilation of the background information available for the watershed. This task will be carried out over a two-month period before the analysis actually begins by the agencies responsible for land management in the watershed. The handbook describes minimum data needs and sources to canvas for other useful data. Quick methods for filling in data gaps are also described.

Task 2 uses interviews with local experts and concerned people to provide preliminary information about the issues, impacts, and locations of primary concern in the watershed.

Task 3 provides a preliminary diagnosis of the types of ecosystem and watershed conditions that will need to be evaluated in more detail. Likely impact mechanisms are identified for each issue using existing information. Methods for diagnosis are described by the handbook. Slope stability analysis for Augusta Creek is an example in which likely impact mechanisms are identified (fig. V-I-6). Distribution of areas subject to slope instability was interpreted from information contained within the Willamette National Forest Soil Resource Inventory. Slope data for each mapped unit was extracted from the Willamette National Forest Soil Resource Inventory based on whether hillslope gradients were less than 30 degrees, between 30 and 60 degrees, and greater than 60 degrees. Geologic descriptions from the Willamette National Forest Soil Resource Inventory were used to determine whether underlying bedrock was hard, moderately hard, or soft. A rating Matrix combining these two variables was used to assign a hazard rating of low, moderate, or high slide potential to each mapped unit (fig. V-I-6). Predicted hazard ratings were tested and found to be in excellent agreement with the historical pattern of landslides observed on aerial photographs. This step ensures that field and analysis time will be used efficiently to address the most important processes and issues in the watershed.

Task 4 uses results of Task 3 to stratify the watershed into subareas that can be evaluated as uniform response units for each of the processes or issues of concern. The process of determining debris flow susceptibility for Augusta Creek is an example of how a watershed might be stratified and how this stratification may be used as a basis mapping of Riparian Reserves (fig. V-I-10). To determine the susceptibility of different stream reaches to debris flows, a stream network map was overlaid on the slide potential map (fig. V-I-6). Areas with high slope instability were assumed to be most likely to generate debris flows. First-order channels (headward channels without tributaries) were assigned a debris flow hazard rating equal to the slide potential of the surrounding

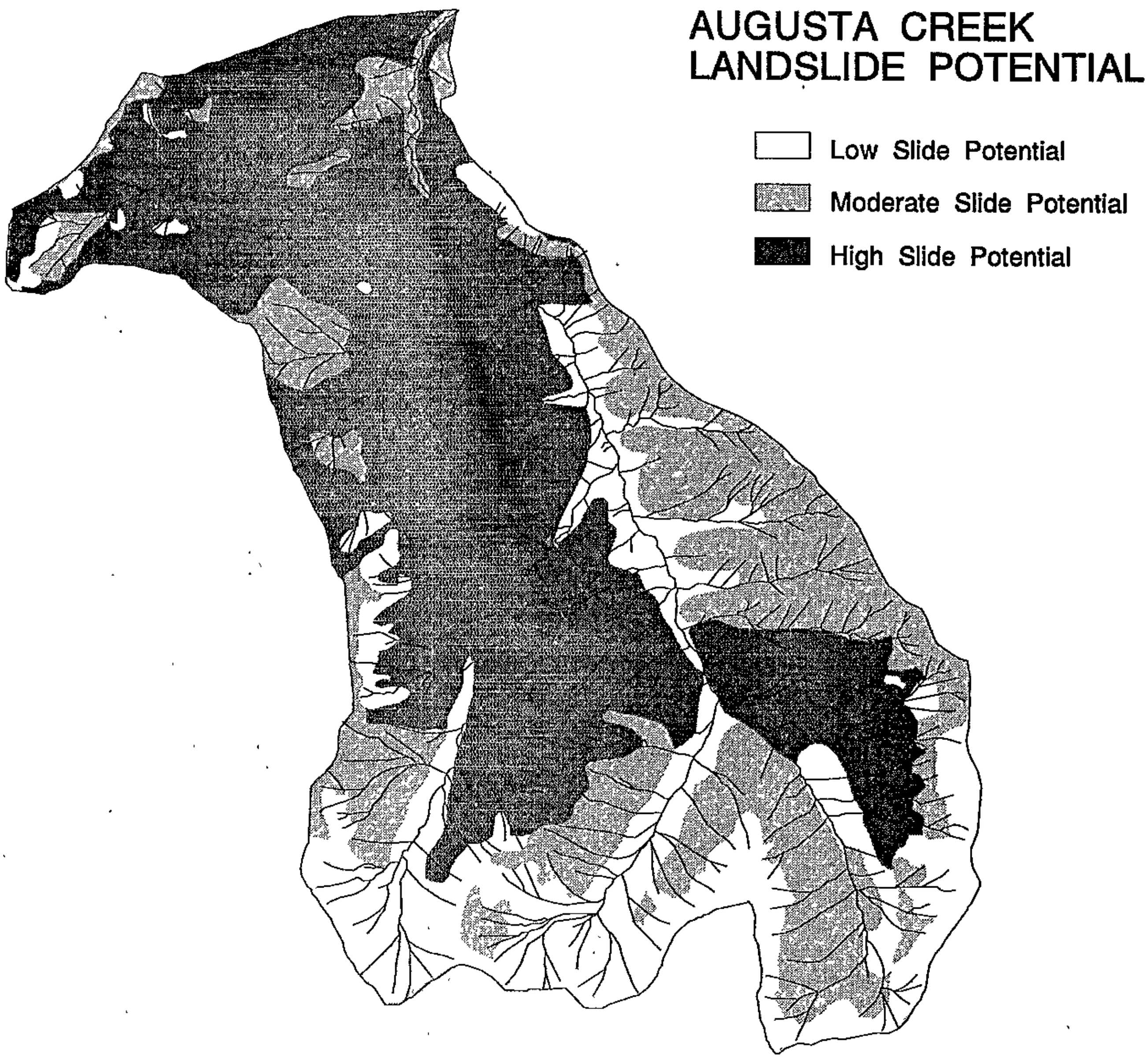


Figure V-I-6. Landslide potential with stream network, Augusta Creek basin, Willamette National Forest.

landscape (fig. V-I-6). Debris flow hazard to higher order channels downstream was assumed to be a function of two factors: channel gradient (fig. V-I-7) and tributary junction angle (fig. V-I-8), based on work by Benda (1985) and others. Debris flow hazard was reduced on class where channel gradient was less than three degrees or tributary junction angle exceeded 70 degrees, to produce a map of debris flow potential (fig. V-I-9). The stratification will vary according to process or issue. The handbook describes methods for stratification, and outlines parameters that may be useful for different types of stratification.

Task 5 identifies existing impacts and altered conditions, their locations, and their immediate causes. This step is primarily field based, and methods that have been found useful for these types of analysis are described by the handbook.

Task 6 describes the pathways of influence between land-use activities and environmental changes. This task is an extension of the fieldwork and analysis of Task 5. The handbook describes the types of information necessary for determining impact causes and for determining the sensitivity of sites and biological communities to change.

Task 7 evaluates the type and location of impacts to be expected in the future due to existing land use. Many changes will not occur until triggered by large storms, or until existing changes are transported downstream to sensitive sites. The handbook describes methods for predicting these future changes.

The handbook presents analytical methods as modules that can easily be revised or replaced as new techniques are validated.

The handbook also outlines the format and content of the Watershed Analysis Report. The first section of the reports will describe conditions and impact mechanisms in the watershed, including:

1. A description of existing conditions in the watershed, including the distribution of important resources, values, and species; and the distribution and severity of environmental changes.

2. A description of impact mechanisms in the watershed and their association with land-use activities.

3. A description of future environmental changes that may occur because of the present distribution of land use.

The second section will specify the watershed processes and ecosystem concerns and interactions that will need to be addressed at a project-planning scale in different parts of the watershed. Specific applications will be described for:

1. Delineation of Riparian Reserves.

2. Restoration planning.

3. Monitoring.

4. Transportation planning.

5. Cumulative effects assessments.

6. General land-use planning.

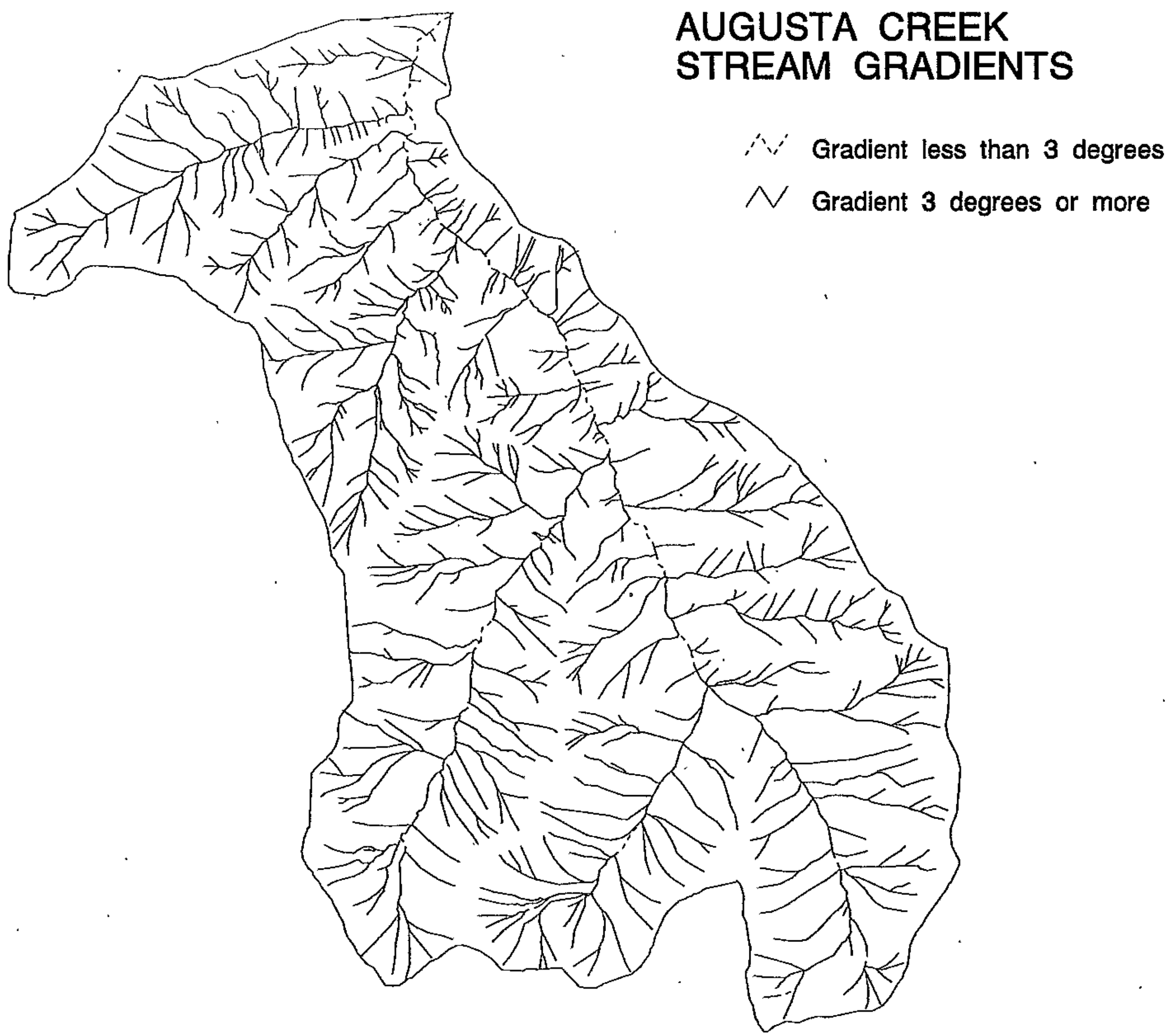


Figure V-I-7. Distribution of stream reaches with channel gradients greater than and less than 3 degrees, Augusta Creek basin, Willamette National Forest.

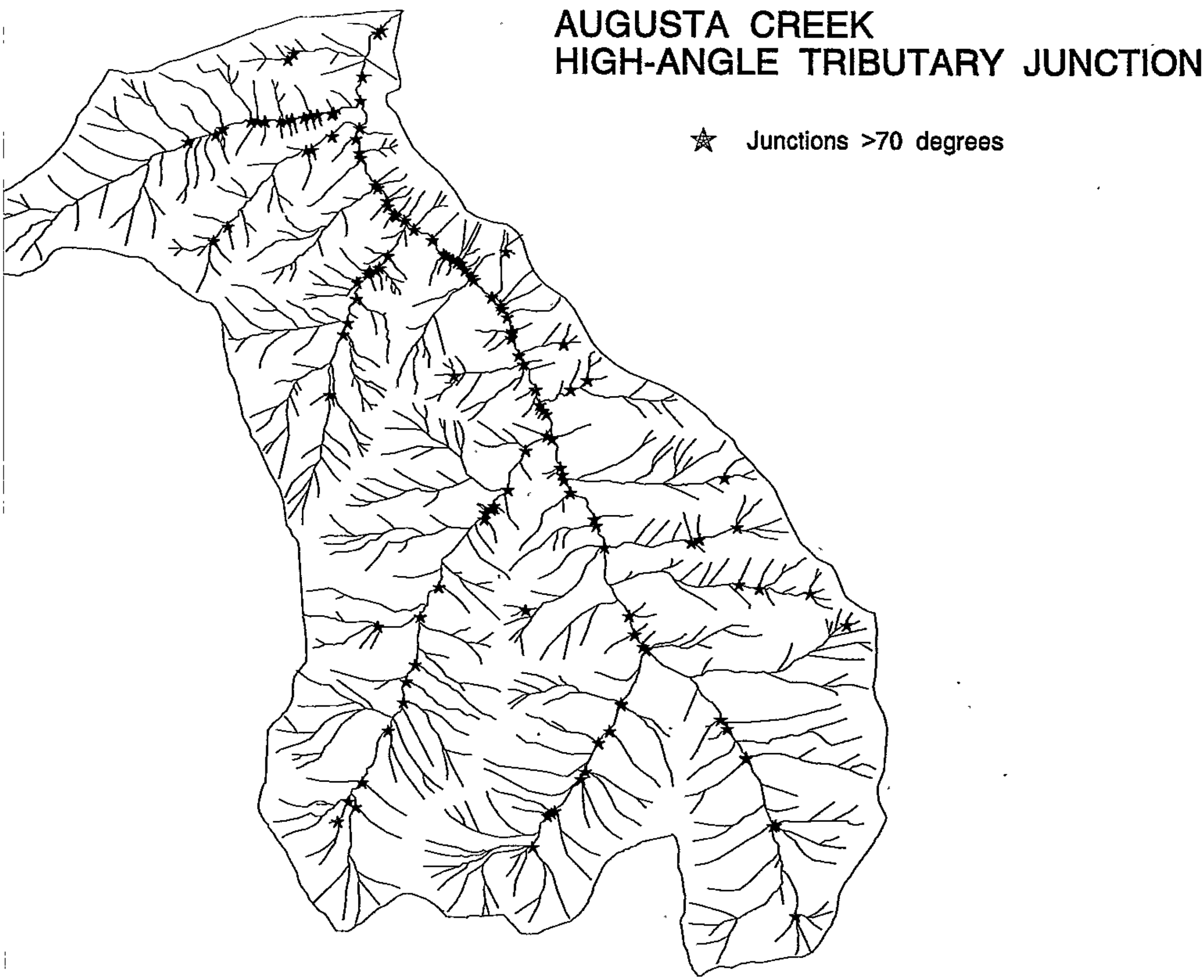


Figure V-I-8. Stream network for Augusta Creek watershed, Willamette National Forest, showing high-angle tributary junctions greater than 70 degrees.

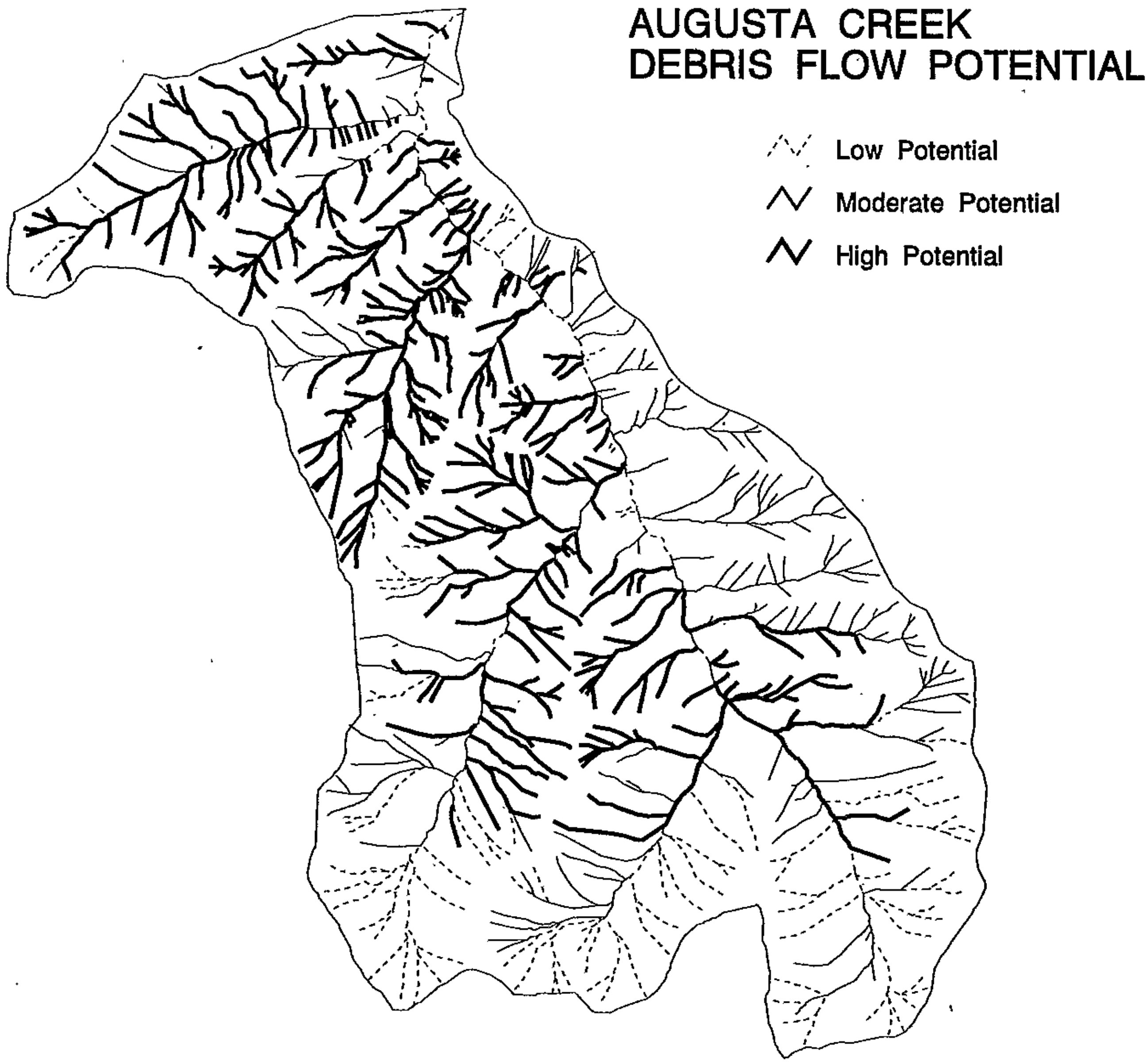


Figure V-I-9. Debris flow potential map for Augusta Creek basin, Willamette National Forest, based on slope stability and potential for debris flow runout from stream gradient and tributary junction analysis.

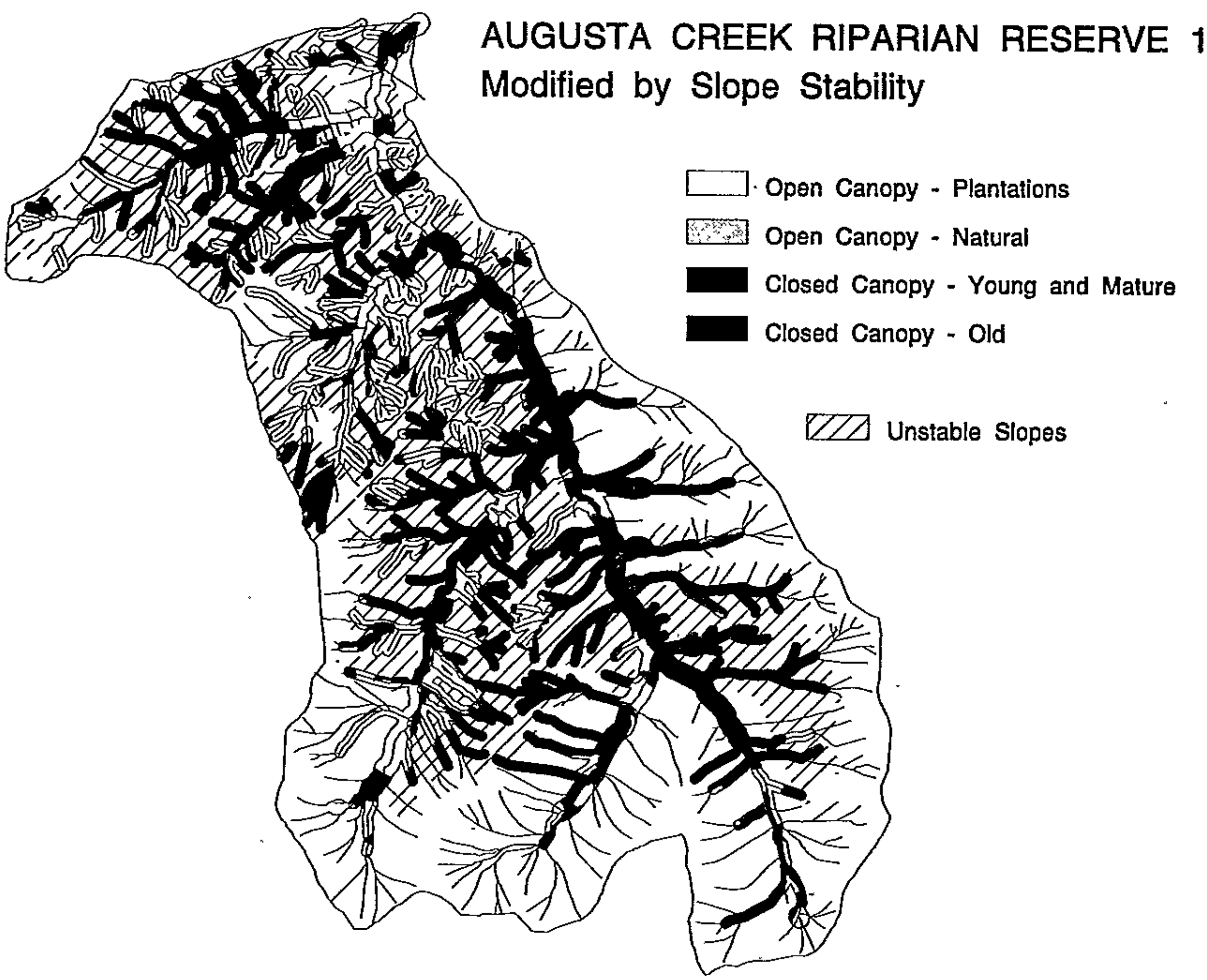


Figure V-I-10. Augusta Creek basin with Riparian Reserve 1 modified by slope stability considerations.

Appendix V-J
Restoration of Watersheds and Riparian Ecosystems

Overview of Restoration

Forest management activities have altered the frequency, intensity, and scale of natural disturbance regimes. Hydrologic disturbance regimes that have been altered include streamflow and sedimentation, water temperature and chemistry, and stream channel/riparian area structural elements.

New land management strategies have been proposed that will attempt to mimic natural disturbance regimes. If successful, processes that degrade watersheds will be reversed. However a time lag will occur between implementing new ecosystem management strategies and the recovery of systems that were degraded under past management. Carefully applied ecosystem restoration treatments can accelerate natural recovery.

Restoration strategies should be comprehensive, addressing both watershed protection and restoration in an integrated program that moves ecosystems toward recovery and resilience.

We advocate an approach to watershed and riparian ecosystem restoration that emphasizes protecting the best habitats that remain (Pacific Rivers Council in press; Reeves and Sedell 1992), found in watersheds termed "refugia" or Key Watersheds, particularly where these support species of special concern (Thomas 1993). Restoring watersheds that are currently degraded is also important in the long-term, to bring all public land ecosystems to full productivity and function.

A refugia (or key watershed) network serves as the anchor or cornerstone for further restoration design and strategy development. Refugia are habitats or environmental factors that convey spatial and temporal resistance and resilience to biotic communities degraded by biophysical disturbances. Landscape features associated with refugia may include localized microhabitats and zones within the channel, unique reaches, riparian vegetation, floodplains, and groundwater. These areas may serve as source areas for recolonization following natural or anthropogenic disturbances (Sedell et al. 1990).

A comprehensive approach to restoration that attempts to embrace the entire ecosystem is most appropriate. While such an approach is conceptually satisfying, in practice it is complex and frequently infeasible. Only certain types of undesirable processes can be feasibly reversed. Some types of restoration that are desirable would require amounts of funding that cannot be reasonably anticipated. Practical restoration must start by determining all ecological restoration needs, then sifting these for the most important processes of concern, "treatability", cost-effectiveness, funding expectations, management situation, and institutional and socio-political considerations to arrive at the best implementable program.

The Role of Watershed Analysis

Watershed analysis is the first step in a watershed restoration program. It is used to determine restoration needs and strategies for watersheds of 20-200 square miles. Watershed analysis identifies physical and biological conditions and processes and where they occur on the landscape. This information is used to assess restoration needs and potentials and guide the detailed inventory of restoration sites.

To develop a comprehensive restoration strategy, it is crucial that all causes of degradation and their interactions be identified during of the watershed analysis. Landscape-level restoration planning should identify mechanisms to reestablish disturbance regimes and related physical, chemical, and biological characteristics that are within the range of natural variability.

We stress that the most successful method of habitat restoration has been watershed protection (Reeves et al. 1991). Any restoration programs and projects should be integrated with comprehensive strategies for watershed protection.

Types of Restoration Treatments

- **Hillslope restoration**

Hillslope restoration consists of activities such as upgrading roads to control and prevent erosion (e.g., larger culverts, outsloping, rocking), decommissioning or obliteration of unneeded roads, controlling erosion on bare, eroding slopes, and improving derelict and degraded lands such as abandoned mines, gullied meadows, and areas where soils have become impoverished.

- **Riparian area restoration**

Riparian restoration consists of activities such as planting and culturing native species of vegetation, thinning and interplanting existing stands of riparian vegetation, controlling streamside landsliding, restoration of riverine wetlands, control of grazing, correction of overdrained and gullied meadows, removal or upgrading of inappropriate recreational developments, and removal or upgrading of roads in riparian areas.

- **Stream channel restoration**

Stream channel restoration consists of activities such as placing large woody material, rocks or artificial structures to catch or improve spawning gravel, improving migratory fish access, creating additional rearing habitat, and reconfiguring stream channels to improve habitat and stream channel dynamics.

Short-Term and Long-Term Restoration

Devising solutions to degraded conditions may involve both short-term and long-term solutions. Only a few problems have good short-term solutions. The nature of solutions depends on the nature of the particular problems in the watershed.

For example, insufficient large woody debris (LWD) in a stream channel has both a short-term solution -- placing/anchoring LWD in streams -- and a long-term solution -- establishing and managing riparian areas to provide sufficient amounts of LWD over the long-term.

Too much sediment has a short-term solution -- upsize culverts, harden crossings, decommission abandoned roads, or otherwise reduce sediment influx to streams -- and a long-term solution -- minimize additional road construction, stringent requirements for future stream crossings, etc.

High stream temperatures has few short-term solutions (e.g., creating thermal refuges using coldwater diversions and pool excavation), and only one long-term solution; establish and manage riparian areas to provide sufficient shade.

If the problem is too little LWD and too much sediment, priority for restoration measures may be to reduce sediment inputs first and place in-stream structures second.

Monitoring

Long-term success of a restoration program depends not only on thorough planning but on post-project monitoring and evaluation. Many short-term treatments are straightforward and present little uncertainty as to their effectiveness. Most long-term solutions carry considerable uncertainties about how well they address long-term restoration objectives, and they must incorporate periodic site-specific and synoptic evaluations.

At a minimum, project monitoring should attempt to answer the following:

1. Are pre-project conditions identified and understood? Is the problem defined correctly?

2. Was the project implemented as planned?

3. Did the project accomplish the desired changes in habitat?

4. Did aquatic and riparian populations respond to the project?

Guidelines for Restoration Projects

Note: These guidelines are given to guide the overall choices of restoration strategies and tactics. Some appropriate restoration projects cannot satisfy all of these,

1. All restoration programs should be preceded by a watershed analysis.

2. Projects should, whenever possible, provide a broad range of benefits to riparian and aquatic ecosystems.

3. Projects should address causes of degradation rather than symptoms.

4. Projects should have a well-defined life span. Expected restoration benefits should be realistically expressed in terms of the life span of the project.

5. Projects, once completed, should be self-sustaining, requiring minimum maintenance or operation.

6. Projects should contribute to the restoration of historic composition and biodiversity of ecosystems, and bring disturbance regimes into the range of natural variability.

7. Projects should restore linkages between refugia and other isolated habitat units.

8. Projects should integrate watershed protection, including adjustment or cessation of management practices that are responsible for degraded habitat conditions.

Recommended major restoration activities

Many restoration opportunities exist. The most important opportunities fall into 3 categories: (1) control and prevention of road erosion and sedimentation; (2) riparian silviculture, and; (3) stream channel improvements.

Control and prevention of road erosion and sedimentation

Federal lands within the range of the northern spotted owl contain approximately 110,000 miles of roads. A substantial proportion of this network, particularly roads built before 1980, constitutes a legacy of current and potential sources of damage to riparian and aquatic habitats, mostly through sedimentation. Without an active program of identifying and correcting problems, damage to aquatic habitats will continue for decades.

On public lands in the range of the northern spotted owl, road networks in upland areas are the most important source of accelerated delivery of sediment to anadromous fish habitats (Swanson et al. 1987). Road-related landsliding, surface erosion and stream channel diversions often deliver very large quantities of sediment to streams, both chronically and catastrophically during large storms. Many older roads with poor locations and inadequate drainage control and maintenance pose very high risks.

Roads modify natural hillslope drainage networks and accelerate erosion processes. These changes can alter physical processes in streams, leading to changes in streamflow regimes, sediment transport and storage, channel bank and bed configurations, substrate composition, and stability of slopes adjacent to streams. These changes can have significant biological consequences, that affect virtually all components of stream ecosystems (Furniss et al. 1991).

NOTE: Agency capacity to conduct road maintenance has recently declined greatly, as funds for maintenance and timber-purchaser-conducted maintenance have been drastically reduced. This is resulting in progressive degradation of road drainage structures and function causing erosion rates and potentials to increase: This will worsen unless additional funding for road maintenance is provided and/or road mileage is drastically reduced through decommissioning. If we do not maintain or remove the roads, mother nature will remove them, with serious consequences to aquatic habitats.

Applying erosion prevention and control treatments to high-risk roads can drastically reduce risks for future habitat damage. Many treatments have well-established effectiveness and are cost-effective. In watersheds that contain high quality habitat and have only limited road networks, large amounts of habitat can be secured with small expenditures to apply "storm-proofing" and "decommissioning" measures to roads (Harr and Nichols 1993).

Road treatments to protect and restore aquatic habitats fall into two broad categories:

1. Road decommissioning: includes closing and stabilizing of a road to eliminate potential for storm damage and preclude the need for maintenance, and;

2. Road upgrading: includes erosion control and prevention work on roads that will remain open.

Table V-J-1 gives the road functions that can damage riparian and aquatic habitats and some of the restoration solutions that can be applied.

Inventory of Roads to Determine Upgrading and Decommissioning Needs

Standards and Guidelines proposed in Appendix H require inventory of all roads and stream crossings, and improvement or obliteration of those that pose a substantial risk to riparian resources:

> "Determine the influence of each road on the Aquatic Conservation Strategy Objectives through Watershed Analysis."

We estimate that a field inventory of all roads, not including other elements of watershed analysis, will require approximately 170 person-years to complete, at a cost of approximately $8 million. Methods for conducting these inventories are being prepared for inclusion in a Watershed Analysis Handbook.

Road decommissioning and upgrading are discussed in detail below.

Decommissioning of Unnecessary, Unstable, or Poorly Located Roads

Unneeded roads and roads that are currently or potentially damaging to riparian and aquatic resources should be removed or restored to control ongoing erosion and eliminate the potential for catastrophic failure. Most of these problems are associated with older roads that were located in sensitive terrain and roads that have been essentially abandoned but are not adequately configured for long-term drainage. These roads are "loaded guns," waiting for the next large storm to fail and damage streams. Harr and Nichols (1993) found that, during the a major runoff event, roads that were "decommissioned" by removing unstable fills and stream crossings suffered almost no erosion, while nearby roads that were scheduled for but had not yet received decommissioning were extensively eroded and caused severe stream damage.

Decommissioning means removing those elements of a road that reroute hillslope drainage and present slope stability hazards. Another term for this is for "hydrologic obliteration." This treatment may be applied to unneeded roads and to roads that present high hazards to habitats that cannot be eliminated through road upgrading. Road decommissioning includes:

- Removal of culverts.
- Decompaction of the road surface (ripping).
- Outsloping.
- Waterbarring.
- Removal of unstable or potentially unstable fills.

Table V-J-1. Road functions that can damage riparian and aquatic habitats and some of the restoration solutions that can be applied.

Type of problem Erosion Sedimentation	Location of problem	Decommissioning solution	Upgrading solution
Mass failure	fillslopes	•Pull unstable sidecast and place in stable location •Control drainage to prevent saturation of residual fills	•Replace unstable fills with stable configuration •Control drainage to prevent saturation of fills •Relocate road section to avoid oversteepened and unstable geomorphic features
	cutbanks	•Buttress cuts with pulled fill material •Obliterate inboard ditch to prevent undercutting of cutbank	•Outslope roads to eliminate cutslope undermining by ditch and ditch transport of cutslope-derived sediments
Surface erosion	fillslopes	•Pull steep fills and sidecast. •Protect surface with mulch and revegetate •Control drainage to prevent concentrated runoff	•Protect surface with mulch and revegetate •Outslope road to disperse runoff and limit surface-derived sediment transport
	cutbanks	•Mulch and revegetate if feasible	•Mulch and revegetate if feasible
	road surface	•Decompact, outslope, mulch and revegetate	•Rock surface, outslope road to disperse runoff and sediment, •Install rolling dips or other cross-drain structures
Fluvial erosion	ditch	•Remove ditch or cross drain very	
	ditch relief culvert outlets	•Remove culverts and establish frequent cross-drainage, or thoroughly disperse drainage	•Install more frequent relief culverts •Add energy dissipation or downspouts
Stream crossing failure	stream crossings and inboard ditches	•Remove stream crossings •Backslope fills to stable angle •Mulch and revegetate fills	•Upgrade stream crossing structure to accommodate the 100-year or greater stormflows •Install trash racks •Install debris handling structures (drop inlet, etc.) •Modify inlet configuration •Harden crossing to resist failure or contribute minimal damage upon failure
Diversion of streams at stream crossings	stream crossings	•Remove stream crossings •Backslope fills to stable angle •Mulch and revegetate fills	•Install crossdrain (waterbar, rolling dip) just downgrade from crossing; •Install "failure dip" on crossing fill
Peak flow augmentation	general	•Remove inboard ditch •Decompact road •Outslope road •Place excavated fills against cutbanks to approximate normal hillslope drainage	•Outslope road to avoid rapid routing of surface runoff, intercepted interflow •Employ frequent ditch relief cross-drains to prevent large accumulations of discharge
Fish Migration Blockage	stream crossings	•Remove stream crossings	•Replace impassable structures •Modify culvert to provide conditions for passage
Stream Channel		•Pull road fills back, remove from	•Relocate road to remove encroaching
Human access leading to:			
poaching		•Remove road	•Control access during critical periods
inappropriate recreational uses		•Remove access through road decommissioning	•Restrict access (gating during critical periods, fencing, etc.) •Education •Enforcement
spill hazards	stream crossings and ditches	•Remove access through road decommissioning	•Enforcement •Remove inboard ditch (outslope) •Adequate spill contingency planning and response

Decommissioning differs from full site restoration that attempts to recontour slopes with nearly complete removal of road (Spreiter 1991). With decommissioning, most of the roadbed is left in place, facilitating inexpensive reconstruction should the need arise (fire, management emphasis change, etc.), but hydrologic risks are greatly reduced.

In some cases, full site restoration may be appropriate, such as in highly visual sensitivity areas, or as part of a complete ecosystem restoration treatment. We expect, however, that decommissioning will be more appropriate and cost-effective in most cases where the protection of aquatic habitats is the primary objective.

We believe the decommissioning of unneeded, neglected, and high-impact roads to be the most urgent and significant restoration need on public lands in the range of the Northern spotted owl, based on the magnitude of ongoing and potential effects to aquatic ecosystems.

Upgrading or "Storm-Proofing" Roads that will Continue to be Needed for Land Management

Road upgrading is done on roads that will remain open to control the ongoing erosion and sedimentation, reduce the risk of future erosion and sedimentation, and correct road-related barriers to fish migration.

Preventing chronic erosion and reducing the risks of catastrophic storm-related erosion is feasible and cost-effective for many roads. "Storm-proofing" roads to reduce or eliminate the risk of severe road-related erosion during large storms is particularly important because catastrophic road-related erosion from large storms has been the most significant source of management-related aquatic habitat damage observed in many watersheds.

Control of chronic erosion and sedimentation

Many techniques are available for reducing chronic erosion and sedimentation from roads. Techniques must be tailored to the specific erosional processes that are active. Types of techniques include:

- Conversion of inslope/ditch roads to outslope roads (usually with backup surface drainage control such as rolling dips).
- Relieving inboard ditchlines more frequently to prevent critical amounts of drainage water discharge.
- Rocking road surfaces to armor against road surface erosion and maintain design drainage configuration against traffic impacts, especially where roads must remain open during wet periods.
- Mulching and revegetating bare, erosion-prone surfaces such as cuts and fills, wherever derived sediments have access to the stream system.
- Site-specific drainage solutions applied wherever erosive concentrations of road drainage or streamflow are causing sediment delivery to streams.
- Adopting maintenance techniques that are specifically designed and conducted to control erosion and sedimentation.

Reducing risks of catastrophic damage resulting from large storms

Certain types of road features can lead to high risks of catastrophic erosion and sedimentation, such as undersized stream crossing structures, stream crossings with stream diversion potential, unstable fills, and road drainage routing that can trigger landslides. Types of remedial techniques include:

- Correcting stream diversion potential at stream crossings, such that if a crossing fails or overtops, streamflow is not diverted down the road or ditchline.
- Upgrading stream crossings to pass at least the 100-year streamflow, plus associated bedload and debris; using a variety of techniques such as larger culverts, trash racks, drop inlets, inlet configuration changes, hardening crossing fills, and controlling sediment and debris loading upstream of the crossing.
- Removing and reconfiguring unstable fills.
- Relocating road sections that pose high risks of landsliding during large storms.
- Converting inslope/ditch roads to outslope roads.
- Rerouting of road drainage to stable receiving areas.

Estimated Magnitude of Road Decommissioning and Upgrading

Prior to site-specific inventory of roads, the magnitude of opportunities is unknown. Little inventory has been conducted to determine current road restoration needs. Decisions on what restoration or upgrading treatments might be applied depends on many factors, including the severity of ongoing or potential effects, transportation needs, the value and sensitivity of downstream uses, social expectations, the "treatability" of the problems, the costs of treatment, and a variety of other factors. Thus, the magnitude of the need for road decommissioning and upgrading is unknown at this time.

However, we can make some estimates of the miles of road that might be involved if we make some assumptions. We stress that these are rough estimates for short-term planning purposes only, and that the actual magnitude of opportunities will require intensive inventories, is likely to differ from these estimates.

Total road mileage:

Total inventoried road miles (5/93) on public lands in the range of the northern spotted owl[a]	87,554
Estimated actual road miles on public lands in the range of the northern spotted owl[a]	109,400[b]
Total miles of FS Level 1 (closed but not decommissioned)	11,500
Total miles of FS Level 2 (high-clearance vehicles only)	43,000
Total miles of FS Level 1 and Level 2	54,500
BLM miles in equivalent Levels 1 & 2 estimated at	15,500
Total miles, FS and BLM equivalent Levels 1 & 2	70,000

[a] northern spotted owl
[b] Estimated actual mileage. Substantial mileage of roads are not included in current transportation databases, as they are not considered to be part of the transportation "system," but they exist. Based on discussions with Forest Engineers, we estimate that the magnitude of uninventoried road miles is about 25% of the inventoried road miles.

Approximately 20% of total road mileage is in roads that are maintained for full public use; that is, maintenance level 3,4 & 5, which are constructed and maintained such that a sedan can travel safely.

Three approaches to estimation of the amount of road to be treated are given.

Approach 1. Assume that 20 percent of high-clearance vehicle and closed roads (in Maintenance Levels 1 and 2 and BLM equivalents) are unneeded, are causing significant damage to aquatic habitat, and are to be decommissioned. Further assume that of the 80 percent of the road network in maintenance Levels 1 and 2 that is not decommissioned, 50 percent needs upgrading:

Mileage to treat	
Miles to be decommissioned	14,000
Miles to be upgraded	28,000

Approach 2. Assume only roads in key watersheds are to be treated.

Assume that one-third of the roads in key watersheds need to be decommissioned, one-third need to be upgraded, and one-third do not need any treatment.

Miles to treat	
Approximate mileage of roads in key watersheds	23,000 (inventoried)
	29,000 (est. actual)
Miles to be decommissioned	9,600
Miles to be upgraded	9,600

Approach 3. Avoid catastrophic damage by treating only the roads that present the greatest risks. Assume that five percent of roads fall into this category, and that half of these will be decommissioned and half upgraded.

Mileage to treat	
Mileage to be decommissioned	2,700
Mileage to be upgrade	2,700

Riparian Silviculture: Planting, Thinning, and other Vegetation Management in Riparian Areas

Large areas of riparian land can benefit from establishing and managing of vegetation. Planting trees and brush on eroding streamside landslides improves riparian and aquatic habitats (Furniss 1989). Beschta et al. (1991) determined that the restoration of vegetation adapted to riparian environments and the natural succession of riparian plant communities is necessary to recreate sustainable salmonid habitat and should be the focal point for fish habitat improvement programs.

Multiple benefits to ecosystems accrue from riparian revegetation, including:

(1) Topsoil enriched and increased long-term ecosystem productivity; (2) control and prevention of erosion; (3) improved biological diversity: (4) enhanced ecosystem resilience to disturbance; (5) accelerated plant succession on recently disturbed areas, leading to more favorable plant cover and more "mature" ecosystems; (6) improved wildlife habitat; (7) Improved aesthetics; and, (8) employment.

Types of riparian silviculture projects include:

- Planting on streamside landslides.
- Planting on flood deposit "high-bars" near streams and rivers.
- Planting on disturbed areas such as skid trails, landings, hot-burned streamside areas, degraded meadows, and cable corridors.
- Interplanting conifers such as Douglas-fir and ponderosa pine among even-aged riparian hardwoods (such as alder and willow).
- Thinning to promote growth and vigor of riparian trees.
- Aerial seeding of inaccessible areas, such as landslide surfaces and riparian areas.

Estimated Magnitude of Riparian Silviculture

Comprehensive inventories of opportunities for riparian silviculture have not been conducted on most Forests and BLM Districts. However, we can make rough order-of-magnitude estimates of the land areas that might benefit from riparian silviculture treatments for short-term planning purposes. Intensive inventories are needed to accurately define the nature, magnitude and locations of areas where riparian silviculture can produce cost-effective benefits.

Total length of stream on public lands in the range of the northern spott 218,506 miles
Assuming streamside landslides, eroding areas, plantable/thinnable riparian vegetation and other riparian restoration opportunities occupy 10 percent of stream length and are 100 feet wide:
Area of riparian lands to treat . . . . 264,856 acres
Assume that only 40% of these are "treatable" (plantable, accessible, operable):
Total treatable area . . . . 105,942 acres

Stream Channel Improvements

In the past 10 years, large programs of in-stream fish habitat modification have been undertaken on both National Forest and Bureau of Land Management lands. Many projects proceeded with inadequate planning and post-project evaluation. Consequently, in-stream habitat modification programs have recently been criticized as ineffective (Beschta et al. 1991; Frissell and Nawa 1992).

In-stream restoration activities that are based on accurately interpreting watershed, stream, and biological processes and deficiencies can be an important component of an overall program of restoring fish habitats. In-stream restoration measures are inherently short-term and must be accompanied by watershed-wide restoration and protection to achieve long-term restoration. It is important to note that short-term solutions, while not complete, may be crucial as part of a program to recover anadromous fish stocks, while long-term restoration measures have time to become effective.

There are numerous examples of how such activities have improved fish habitats (House et al. 1991, Crispin et al. in press). Special emphasis should be afforded to careful planning, monitoring and evaluation of all in-stream habitat modification projects (Reeves et al., 1991).

Magnitude of in-stream habitat modification potential may be broadly estimated as follows:
Miles of fish-bearing streams within the range of the northern spotted owl . . 24,439
Estimated proportion of fish-baring stream miles that have habitat modification opportunities = 5%
Estimated miles of stream having habitat modification opportunities .1,250

Coordinated Action with Private Landowners

In recent years including private landowners in watershed restoration programs has met with considerable success in many areas. For many watersheds, participation of private landowners is essential to achieving restoration goals. Both the Forest Service and the Bureau of Land Management have actively encouraged field personnel to establish partnerships and cooperative projects.

Models for collaborative planning and project implementation have demonstrated methods to bring various agencies, institutions, owners, and citizens into comprehensive restoration programs that have far more potential for successful outcomes than single-party programs.

Such collaborative efforts usually require an agency to initiate the idea and promote its development. Federal land-management agencies are ideally suited for this role but must invest funds and time, and take risks that for some initiatives collaboration might not be successful.

Grants for restoration work, such as provided by Section 319(h) of the Clean Waters Act, can provide incentive to landowners to participate. Agencies can facilitate the securing of such grants, which can help to facilitate broader cooperation.

Involvement of owners, users, regulators, and managers in restoration holds excellent prospects for long-term success of both restoration and protection goals. We recommend continued emphasis and encouragement of this approach in mixed-ownership watersheds.

Elements of a 10-year Forest Ecosystem Restoration Program

1. Establish a program for providing adapted native revegetation stock for restoration work (years 1- 10).

Securing reliable supplies of native, adapted revegetation plant materials for restoration work requires 2-3 years and involves identification of suitable species, seed collection, and growing. Waiting for full identification of restoration work is usually infeasible because of the time needed for seed collection and grow-out of the plants. Species, seed zones, and numbers of plants will be necessarily somewhat speculative. The alternative is either to not have suitable plant materials or to defer restoration treatments for 2 years or more after they are fully designed. This step should commence immediately.

2. Assemble a regional interagency restoration advisory team (year 1) to:

- Develop watershed analysis methods for restoration.
- Conduct initial prioritization of watersheds for pre-restoration watershed analysis.

- Develop ecological restoration priorities.

- Developed regional technical criteria for evaluating restoration treatments.

- Provide resources to assist restorationists (expertise, analysis tools, information exchange).

- Keep emergency restoration contingency plans current.

- Facilitate rapid team assembly to plan for disasters, such as fire and flood.

3. Reconnaissance assessment for all lands (year 1)

Conduct a reconnaissance-level assessment of all public lands in the northern spotted owl range using aerial photos, local knowledge and cursory field survey to identify major problem areas and high-priority watersheds for detailed assessments and watershed analysis.

4. Establish Criteria to prioritize watersheds for watershed analysis (year 1) and specific work sites and develop scheduling of restoration work (years 1 & 2), based on:

- The immediacy of biological and physical restoration at the 20-200 square mile watershed scale.

- The "treatability" of the kinds of watershed problems that occur. Use risk-cost analysis to broadly estimate the efficacy of treatment for the categories of problems and restoration solutions.

- Biological resources, especially listed species and species considered to be "at-risk".

- Refugia for anadromous fish and their specific restoration needs.

- The degree to which restoration treatments could contribute to long-term productivity, diversity and resilience of riparian and aquatic ecosystems.

5. Prioritize watersheds for watershed analysis based on these criteria (year 1)

The Interagency Team should establish the priority watersheds for restoration. Initial priorities should focus on Tier 1 Key Watersheds, and on other areas that may exhibit characteristics of refugia as described by Sedell et al. (1990). That is, watersheds that have good to very good fish habitat, or where good habitats can be readily restored.

6. Conduct watershed analysis on selected watersheds (years 1 and 2)

We estimate the cost for watershed analysis to vary between $0.25./acre to $1.50/acre, depending on the size of the watershed and the quality of the existing information base.

7. Conduct public scoping on potential restoration work (year 2).

8. Conduct watershed analysis for restoration, including restoration objectives and detailed work activity descriptions (years 2 & 3).

Watershed analysis will identify watershed disturbance processes and where they occur on the landscape; current conditions of hillslopes and channels; status of aquatic communities, limiting factors for riparian ecosystems, inventory of past land use practices, and where opportunities exist for effective restoration.

Watershed analysis will identify objectives for restoration activities. The objectives establish the framework for restoration work, including cost-effectiveness (or cost-risk) thresholds for deciding which treatments are worthwhile, what measures are needed, where they are to be carried out, which techniques need to be used, what sequence of actions should be planned, and how the work is to be accomplished.

9. Prepare NEPA documents (years 2&3)

10. Implement restoration work (years 2-10)

11. Monitor, evaluate and document work (year 4-10)

Appendix V-K
Current State Forest Practice Regulations for Riparian Protection

California

The width of the Watercourse and Lake Protection Zone is determined by slope steepness and water class. Rules are provided for all activities within the Watercourse and Lake Protection Zone. Timber harvest is allowed with appropriate equipment. Up to 50 percent of the overstory and 50 percent of the understory may be removed in the protection zone. Of the 50 percent overstory, at least 25 percent must be coniferous, but exceptions can be made. Exceptions for higher levels of removal are given. Existing roads in all buffers can be utilized, but in general no new roads are allowed in Class I or II zones. Specifications appear in the rules for roadbuilding, use of heavy equipment, prescribed burning, and other common silvicultural practices.

Water class characteristics or key indicator beneficial use for Watercourse and Lake Protection Zone:

Class I-1) Domestic water supplies, including springs on site and/or within 100 feet downstream of the operations area and/or

2) Fish always present or seasonally present onsite includes habitat to sustain fish migration and spawning.

Class II-1) Fish always or seasonally present downstream and/or

2) Aquatic habitat for non-fish species

Class III- No aquatic life present, watercourse showing evidence being capable of sediment transport. Class I and II waters under normal high water flow conditions after completion of timber operations.

Class IV- Man made water courses, usually downstream, established domestic, agricultural, hydro-electric supply or other beneficial uses.

Stream and riparian protection; California Forest Practice Rules

Stream Class	Watercourse and Lake Protection Zone widths		
Class I	Slope Class	< 30	75 feet
	Slope Class	30-50	100 feet
	Slope Class	> 50	150 feet
Class II	Slope Class	< 30	50 feet
	Slope Class	30-50	75 feet
	Slope Class	> 50	100 feet
Class III & IV	No minimum protection		

Washington

Under the Washington State Forest Practices Rules and Regulations Washington has designated five water categories determined by water usage and water quality. Riparian

Management Zones are measured horizontally from the ordinary high water mark of Type 1, 2, and 3 waters and must extend to the line where vegetation changes from wetland to upland plant community or to a line required to leave sufficient shade. The widths of the riparian management zones currently being implemented in Washington are designed to, on the average, recruit 70 percent of historic large woody debris.

Watershed analysis is required on certain sensitive watersheds.

Stream and riparian protection, Washington State Forest Practices Rules and Regulations

Stream type	Riparian management area
Fish bearing streams	25-100 ft
Non-fish bearing perennial streams	No minimum protection
Intermittent/ephemeral streams	No minimum protection

Watershed analysis is a Best Management Practice designed to assess selected biological and physical parameters of the environment within a watershed administration unit. The watershed analysis also provides information needed to regulate cumulative impacts of forest practices on fish, water, and capital improvements on state land and its subdivisions. Level I assessments are low intensity evaluations of a watershed administration unit to identify areas of resource sensitivity and to determine whether a more sensitive level 2 Assessment is needed.

Oregon

Requirements are set for the average width of Riparian Management Areas for streams, estuaries, lakes and wetlands. The measurement is the average width over the length of stream where the operation occurs. The absolute width may vary depending on topography, vegetative cover, needs of the harvesting plan, and aquatic and wildlife habitat needs. Riparian Management Areas must be managed for protection of riparian values along Class I streams. The Riparian Management Area width on each side of the stream shall average 3 times the stream width, but shall not be less than 25 feet or greater than 100 feet. In Riparian Management Areas adjacent to Class I waters, an average of 75 percent of the pre-operational shade must be maintained over the aquatic area; at least 50 percent of the pre-operational tree canopy must be maintained; and conifers must be retained in the half of the Riparian Management Area closest to the water (or an average of 25 feet of the water whichever is greater).

Class I Waters - fishery and domestic use
Class II SP Waters - Class II waters that have a special impact on Class I waters.
Class II Waters are not Class I but have a defined channel or bed

Stream and riparian protection,; Oregon Forest Practices Purpose Act

Stream type	Riparian Management Area
Class I	25-100 feet depending on width of stream
Class II SP	25-100 feet with exceptions; shade protection only
Class II waters	No minimum projections

VI

Economic Evaluation of Options

Chapter VI

Economic Evaluation of Options

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Chapter VI Contributors

Economic Assessment Group

The economic assessment was conducted with the assistance of a variety of resource economic specialists. Coordination activities were handled by Brian Greber. Assessment design and authorship is attributable to Brian Greber, Richard Haynes, and Cindy Swanson.

A number of special background reports were prepared by contractors. William Schlosser and Keith Blatner prepared a detailed assessment of special forest products. Hans Radtke and Shannon Davis prepared detailed assessments of coastal fisheries and tourism industries. John Loomis assisted in the preparation of forest recreation and tourism reports.

Don Flora and Susan LeVan provided assistance in addressing issues pertinent to the region's forest products industry. Darius Adams provided assistance in conducting National Forest product market assessments.

The assessment of regional economic impacts was conducted with a great deal of assistance from Richard Phillips. Additional assistance was provided by Paul Warner and Bret Bertolin.

Graphical work was conducted by Kay Pennell, Sandi Arbogast, and Martin Raphael.

Timber Sale Assessment Group

Norm Johnson coordinated assessment of sustainable timber harvest and short-term sales on federal land with the assistance of numerous Forest Service and Bureau of Land Management employees. Sarah Crim led the Forest Service Region 6 effort to assess sustainable harvest levels with the help of Bill Connelly, Jim Merzenich, Allen Ager, and analysts throughout the region. Klaus Barber led the Region 5 effort with the help of Ken Wright and numerous analysts. Mike Howell led the Bureau of Land Management effort with the assistance of Cris Cadwell and other analysts.

John Nunan and Tom Ortman led the sales assessment for the Forest Service with the help of Molly Egan, Region 6 Regional Office timber staff, and timber staffs of the National Forests. Randy Gould led the sales effort for Bureau of Land Management with the assistance of many Bureau personnel.

Chapter VI

ECONOMIC EVALUATION OF OPTIONS

Introduction

The Forest Ecosystem Management Assessment Team was charged by the Administration through the Secretaries of Agriculture and Interior with developing options for managing the federal forests of the Pacific Northwest that are within the range of the northern spotted owl. This report summarizes the economic analysis of the proposals brought forth by the Team.

Principal Economic Concerns

Several fundamental economic questions arise when discussing the management of the federal forests of the Pacific Northwest. Several of these were highlighted in the letter of charge to the Forest Ecosystem Management Assessment Team, which was instructed to:

> ...address a range of alternatives in a way that allows us to distinguish the different costs and benefits of various approaches (including marginal cost/benefit assessments), and in so doing at least the following should be considered:
>
> - Timber sales, short and long term.
> - Production of other commodities.
> - Effects on public uses and values including scenic quality, recreation, subsistence, and tourism.

- Effects on environmental and ecological values, including air and water quality, including habitat conservation, sustainability, threatened and endangered species, biodiversity, and long-term productivity.

- Jobs attributable to timber harvesting and timber processing, and to the extent feasible, jobs attributable to other commodity production, fish habitat protection, and public uses of the forests, as well as jobs attributable to investment and restoration associated with each alternative.

- Economic and social effects on local communities, and effects on revenues to counties and the national treasury.

- Economic and social policies associated with the protection and use of forest resources that might aid in the transitions of the region's industries and communities.

- Economic and social benefits from the ecological services you consider.

- Regional, national, and international effects as they relate to timber supply, wood product prices, and other key economic and social variables.

This chapter summarizes the economic assessment of these considerations as they relate to the management of the federal forests in the range of the northern spotted owl. All of the cost and benefit issues listed in the charge were addressed by the economic assessment group. (The most extensive treatment of "environmental and ecological values" is within the biological assessments.) The economic assessment does not take the form of a traditional, benefit-cost analysis; instead, it is constructed to answer the primary policy questions posed to the Team.

Scope

The assessment focused on federal forests in Oregon, Washington, and California that are within the current range of the northern spotted owl. The federal forests included in the analysis are listed in table VI-1. For regional economic assessments, the "impact region" is defined as the central and western Oregon and Washington counties and northern California counties that are directly impacted by the management of these forests (fig. VI-1).

In other parts of the report we will refer to the Pacific Northwest generally (but not always defined) as the states of Washington and Oregon. We will also refer to the Pacific Northwest-westside which is the western parts of the two states (sometimes called the Douglas-fir subregion) and the Pacific Northwest-eastside which is the eastern parts of the two states (sometimes called the Ponderosa Pine subregion). Finally, we will refer to California sometimes as the Pacific Southwest.

Review of Options

Ten different ecosystem management options were considered for partial or full analysis within the biological assessment and are discussed in detail in those chapters. The land allocation and land management implications of the ten options are discussed in the

Table VI-1. Federal lands included in the analysis.

Agency	Administrative unit
Forest Service - National Forest	Region 6 (Washington)
	Gifford Pinchot
	Mt. Baker-Snoqualmie
	Okanogan (owl portion only)
	Olympic
	Wenatchee
	Region 6 (Oregon)
	Deschutes (owl portion only)
	Mt. Hood
	Rogue River
	Siskiyou
	Siuslaw
	Umpqua
	Willamette
	Winema (owl portion only)
	Region 5 (California)
	Klamath
	Mendocino
	Shasta-Trinity
	Six Rivers
Bureau of Land Management - Districts	Oregon
	Coos Bay
	Eugene
	Lakeview
	Medford
	Roseburg
	Salem
	California
	Ukiah

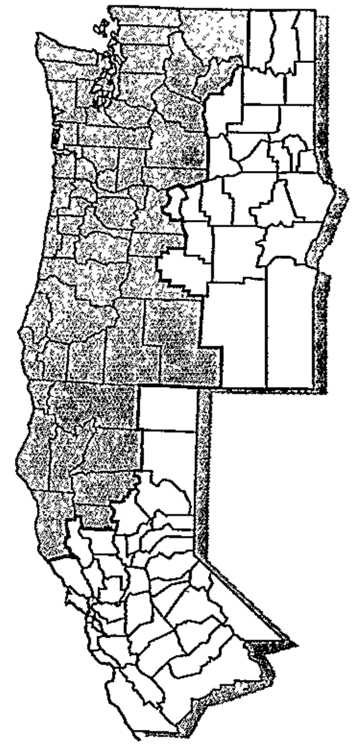

Figure VI-1. Geographic area encompassed in the impact region.

assessment of timber management (Johnson et al. 1993, a report prepared for the Team). The key characteristics of the ten options are displayed in table III-2.

Outlook for Federal Timber Harvests

Sustainable Harvest Levels

In this analysis, we assumed that the federal forests in the owl region will be managed under a nondeclining yield mandate -- meaning that the planned harvest level in future decades cannot be less than the current decade's planned harvest level. The decadal harvest levels were estimated for each National Forest or Bureau of Land Management District using a variety of techniques including linear programming (FORPLAN), simulation (TRIM-plus), and data-base manipulation. These planning models estimate the acres treated and resource yields given land allocation patterns, management standards, and managerial constraints. Johnson, K.N., S. Crim, K. Barber, and M. Howell in an analysis written for this report, includes further details on the assumptions, techniques, and results.

The probable levels of federal timber sales for the owl region for the first decade under the rules for each option are summarized in table VI-2 and figure VI-2. In their analysis, Johnson et al. use the term "probable sales quantity" to describe these results rather than "allowable sale quantity" as they worked with agency personnel to estimate the likely sale level (probable sale level) under the rules for each option rather than the maximum sale level (allowable sale quantity) under the rules as has often been done in the past especially on the National Forests. Thus, they attempted to estimate sale levels likely to be achieved as opposed to estimating ceiling or upper limit estimates.

Some of the management rules and procedures for the different options make it difficult to fully determine the actual sale level that will result. As an example, many of the options call for further watershed assessment in certain Key Watersheds before timber harvest can occur there. Johnson et al. made estimates of likely timber sales that will result using a set of interim rules in those watersheds, but it is problematic as to what level of timber sales will be mandated after assessment. In addition, many options call for designation of "activity centers" for marbled murrelets and other species, as they are found, within which timber harvests will be prohibited or restricted. No allowance for these findings was made beyond sites that are already known. Finally, Option 9 includes the designation of Adaptive Management Areas across the owl region. In general, Johnson et al. assumed that such designation would not reduce the sales level that would otherwise occur under the option, but the actual level of sales that will occur in these areas remains somewhat uncertain.

Probable sale estimates do not include additional volume that might be obtained under some options from thinning, salvage and other treatments within reserves. An additional volume of up to 0-150 million board feet/year might be obtained from these activities depending on the option.

Figure VI-2 also summarizes "other wood," which includes cull volume and small salvage operations that are not counted in the normal allowable sales calculations. Historically, this has accounted for about 10 percent of the total harvest off of federal lands in the impact region. In the future, "other wood" is estimated at 10 percent of probable sales

Table VI-2. Historic federal harvests and probable annual average timber sales in the first decade by option.[a]

Administrative Unit	Average Harvest 1980-89	Average Harvest 1990-92	Option[c] 1	2	3	4	5	6	7	8	9	10
National Forests- Owl Forests			million board feet, scribner									
Region 6 - Owl Forests												
Western Washington	824	404	22	69	75	67	119	87	186	133	131	94
Eastern Washington	195	124	11	31	33	30	26	37	47	65	47	52
Western Oregon	1902	897	68	207	239	284	392	300	716	473	429	357
Eastern Oregon	127	100	15	45	45	37	49	47	65	53	59	52
Total	3048	1525	116	352	391	418	585	471	1015	723	666	555
Region 5 - Owl Forests												
Total	561	291	20	127	132	106	146	141	242	246	152	220
Bureau of Land Management - Owl Forests												
Western Oregon/Calif.	880	568	41	134	142	146	177	158	406	298	260	200
Eastern Oregon	35	5	0	3	3	3	6	4	7	6	6	4
Total	915	573	41	37	145	149	183	162	413	304	266	204
Total Owl Forests	4524	2389	177	616	668	673	915	774	1669	1274	1084	979
National Forests- Non-Owl Forests[b]												
Region 6 - Non-Owl Forests												
Eastern Washington	134	138	102	102	102	102	102	102	102	102	102	102
Eastern Oregon	942	831	422	422	422	422	422	422	422	422	422	422
Total Non-Owl Forests	1076	969	524	524	524	524	524	524	524	524	524	524

[a]Probable sale levels should be within 10 percent of the final results and include no "other wood" estimates. Historic numbers are "gross" volumes and thus include historic levels of "other wood. Historic numbers for 1990-92 are estimates.
[b]Non-owl forests have not been subjected to rigorous analysis for the various alternatives and appear only for regional price projections. Fate of the eastside forests is highly uncertain at the present time.
[c]Volumes for Options 1, 3, and 10 are approximated on the basis of analysis on the other seven options.

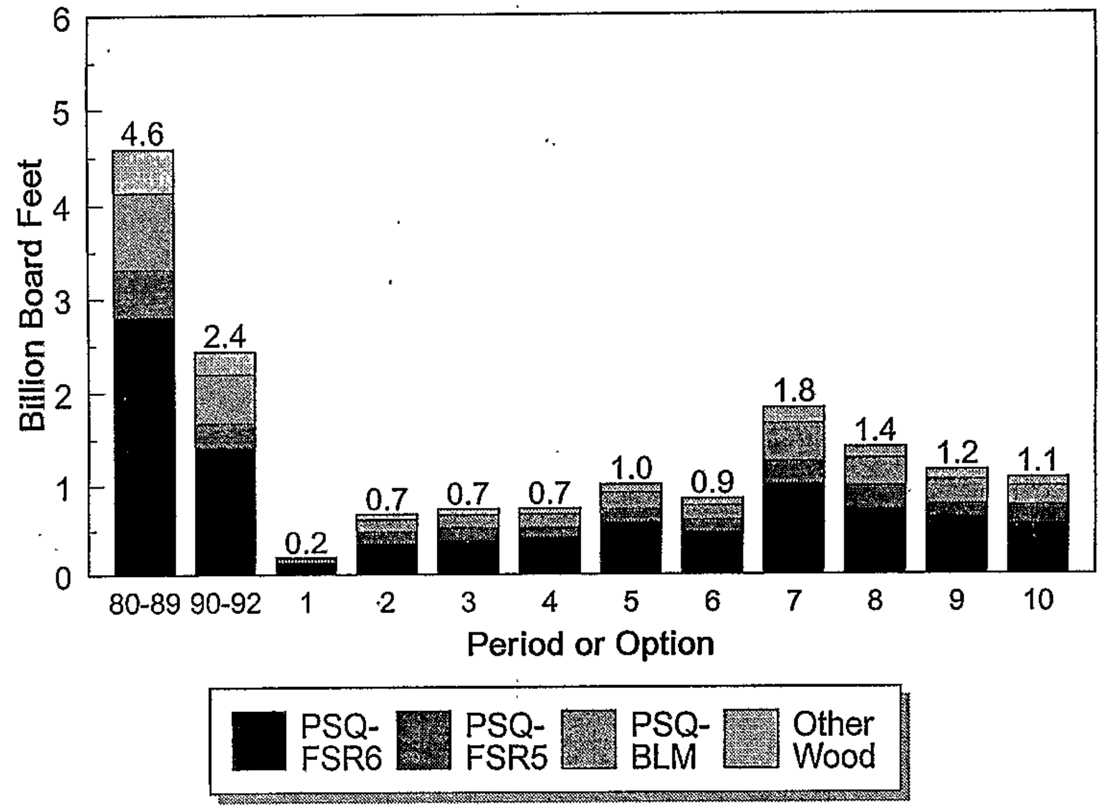

Figure VI-2. First decade probable timber sales levels (PSQ) for options and historic harvest levels.

levels under each option. However, future removals of "other wood" are uncertain, due to changes in forest management practices, e.g., retention of snags and large woody debris.

The average annual value of harvest in the region was over $650 million per year in 1990-1992 (stumpage prices from Warren 1992). This represents the market value of the trees prior to harvesting. Log values to the mill in this period would be over $1 billion per year -- actual product values would be substantially higher (logging and transportation costs are assumed to be approximately $140 per 1,000 board feet from Adams et al. [1988] updated to 1990-1992).

Short-term Harvest Outlook

The short-term harvest is problematic and may differ from the calculated sustainable level due to required surveys, assessments and time required to distill proposals into new timber sales programs. The sales levels specified in the last section reflect the average annual sales levels that might be forthcoming on average in the decade ahead. Prior to being able to implement the active sales program it must be realized that:

- Coastal harvests will be restricted until the completion of marbled murrelet surveys (which may take 3 years or more to complete).

- Harvests in many watersheds will be restricted until comprehensive watershed analyses are conducted (these may take several years).

- The sales that have been laid out in the current sales program are often in areas that have been set aside in various options.

It takes many months or years to prepare timber sales. Sale planning and design by an interdisciplinary team, completion of protocols for the location of threatened and endangered species (such as the northern spotted owl and marbled murrelet), and National Environmental Protection Act compliance all take significant amounts of time. In addition, the added rules for management in many of the options of this report add to the complexity of sale design.

Given the time needed to prepare new sales, Johnson et al. (1993) concentrated their sale assessment on sales that were prepared in the last few years or are near completion in preparation. The results from their timber sale analysis for the portions of the National Forests of Regions 5 and 6 within the northern spotted owl region are summarized in table VI-3.

Four kinds of sales were considered:

1. Sales sold and awarded (category 1). By and large, these sales are available for harvest except in the near zone of the marbled murrelet where discussions with U.S. Fish and Wildlife Service continue. They make up most of the "volume under contract" in other displays in this report.

2. Sales prepared but not sold that have been enjoined by the decisions of Judge Dwyer (category 2). By and large, these sales would have been the basis of the U.S. Forest Service fiscal year 1992 sale program if Judge Dwyer had lifted the injunction on sales in the habitat of the northern spotted owl.

3. Sales prepared but not yet sold that are not enjoined by the decisions of Judge Dwyer (categories 3 and 4). By and large these sales occur in non-owl habitat or in owl habitat but are not degrading to it. Category 3 sales would be sold by September 30 and category 4 sales by December 31. We have lumped them together for this discussion.

4. Sales sold and not awarded (category 5). These sales have been bought by the purchaser but have not yet been formerly awarded to him. They make up the remainder of the volume reported as "under contract" in other displays in this report.

In table VI-3, each category of sales was classified according to three hierarchial criteria. First, the sales were classified as to whether or not they are within the near zone of the marbled murrelet. Given this determination, sales were further classified as to whether they were inside or outside the reserve system of the option (here option 9). Finally, the sales were further classified as to whether they were inside or outside tier 1 watersheds. As an example, 361.8 million board feet of enjoined sales (category 2) lie inside the near zone of the marbled murrelet. Of this volume, 198.8 million board feet lies in reserves of Option 9 and 163 million lies outside of these reserves. Of the volume in the reserves of Option 9 in the near zone of the marbled murrelet (198.8 million), 63.0 million lies inside tier 1 watersheds and 135.8 lies outside.

Table VI-3. Sale estimates by sale category and Option 9 allocations for National Forests within the owl region.

Land Allocation Classes	Category 1 (Sold & Awarded) Total Vol	Category 1 (Sold & Awarded) Net of RR[a]	Category 2 (Enjoined) Total Vol	Category 2 (Enjoined) Net of RR[a]	Category 3 & 4[c] (Not Enjoined) Total Vol	Category 3 & 4[c] (Not Enjoined) Net of RR[a]	Category 5 (Sold & Not Awarded) Total Vol	Category 5 (Sold & Not Awarded) Net of RR[a]
	Millions of Board Feet							
Total Sales[b]	1808.1	1413.8	1199.2	874.7	475.7	414.2	85.1	58.9
I. Inside Murrelet Near Zone	411.6	244.2	361.8	205.3	63.3	49.3	13.8	4.8
A. Inside Reserves	209.4	109.3	198.8	102.4	13.8	9.8	13.8	4.8
1. Inside Tier 1 Watersheds	133.6	59.2	63.0	32.0	9.3	6.5	9.5	2.8
2. Outside Tier 1 Watersheds	75.8	50.1	135.8	70.4	4.5	3.3	4.3	2.0
B. Outside Reserves	202.2	134.9	163.0	102.9	49.5	39.5	0	0
1. Inside Tier 1 Watersheds	66.0	47.3	48.6	38.1	25.7	21.6	0	0
2. Outside Tier 1 Watersheds	136.2	87.6	114.4	64.8	23.8	17.9	0	0
II. Outside Murrelet Near Zone	1396.5	1169.6	837.4	669.4	412.4	364.9	71.3	54.1
A. Inside Reserves	453.5	372.3	214.5	161.9	77.7	65.0	42.3	30.8
1. Inside Tier 1 Watersheds	190.3	150.2	93.0	67.0	24.4	16.6	21.3	13.7
2. Outside Tier 1 Watersheds	263.2	222.1	121.5	94.9	53.3	48.4	21.0	17.1
B. Outside Reserves	943.0	797.3	622.9	507.5	334.7	299.9	29.0	23.3
1. Inside Tier 1 Watersheds	152.8	119.4	109.2	84.1	45.1	37.5	0	0
2. Outside Tier 1 Watersheds[d]	790.2	667.9	513.7	423.4	289.6	262.4	29.0	23.3

[a] Time needed to do sale redesign to exclude RR (Riparian Reserve) volume is not known at this time.
[b] This does not include three other possible encumbrances: Critical Habitat for the northern spotted owl, Roadless Area designations, and tier 2 watersheds.
[c] Category 4 sales are not mapped. Assumed their total volume (55.3 million board feet) is available outside of all Option 9 allocations.
[d] Some sales will be split between categories. Sales volumes entirely outside the Reserves and Tier 1 Watersheds might be 10 percent less than these results.

The volume in the intersection of each sale category and sale classification is further classified in terms of total volume and volume "net of Riparian Reserve" where Riparian Reserve represents the riparian buffers of Option 9. Thus, the total volume in category 1 sales within the near zone of the marbled murrelet equals 411.6 million board feet while the volume net of riparian habitat conservation areas equal 244.2 million.

A quick scan of these tables reveals that approximately 35 percent of category 1 (667.9/1808.2) and 2 (423.4/1199.2) sale volume lies in less controversial areas -- outside the near zone of the marbled murrelet, the reserve system, tier 1 watersheds, and the Riparian Reserve system. On the other hand, slightly more than half of category 3 and 4 sale volume (262.4/475.7) occurs in these less controversial areas.

In addition, sales were classified in the analysis as to whether they fell into U.S. Fish and Wildlife Service critical habitat for the northern spotted owl and whether they fell into roadless areas. As an example, over one-third of the sale volume of enjoined sales (category 2) in reserves is also in critical habitat and approximately 10 percent of the total enjoined sale volume falls into roadless areas. See Johnson, et al. for more details.

Finally, sales were classified by stand age. Over half of category 1 and 2 sales were from stands over 200 years of age and over 90 percent from stands over 80 years of age. In contrast, category 3 and 4 sales had relatively little volume coming from stands over 200 years of age. See Johnson et al. for more details.

In summary, drawing on timber sales that have already been prepared to provide short-term volume may prove difficult because of their location in the near zone of the marbled murrelet, reserves, tier 1 watersheds, Riparian Reserves, roadless areas, and U.S. Fish and Wildlife Service critical habitat for the northern spotted owl. Of the 1.7 billion board feet in sales not yet sold that are at or near completion in sale preparation (categories 2, 3, and 4), approximately 0.6 billion (slightly more than one-third) lies outside potentially controversial areas in Option 9. And close to half of this 0.6 billion board feet would come from stands over 200 years of age. Even this 0.6 billion board feed may be delayed for some time while sales are redesigned to come into compliance with the rules (especially the Riparian Reserve rules) for the option that is selected. Similar results can be expected in most other options.

An analysis of Bureau of Land Management timber sales produces similar results although less of its potential sale volume is over 200 years of age. On Bureau of Land Management land, preparation of close to 0.1 billion board feet in categories 2, 3, and 4 outside of these potentially controversial areas is near completion.

The agencies may be able to prepare some additional sales in fiscal year 1994 beyond those listed here. Recent new sale preparation has focused on sales in non-owl habitat or sales in owl habitat that did not degrade it. More of these sales might be ready before the end of fiscal year 1994. It must be pointed out though, that the majority of the category 3 and 4 sales considered above will be sold before the end of this fiscal year. Thus, the new sales would replace, to some degree the depletion of these sales. Still some sale volume outside of potentially noncontroversial areas might be forthcoming in fiscal year 1994 to add to the 0.6 + 0.1 = 0.7 billion listed above. It would be surprising, though, if total new sales outside of potentially controversial areas rose much above 1 billion in fiscal year 1994.

Beyond fiscal year 1994, the picture brightens somewhat assuming the agency is given clear rules for project design and an efficient process for dealing with sales in owl habitat. Starting now with the fiscal year 1995 program would give enough lead time (almost 2 years) to prepare substantial amounts of new volume. One dark cloud on the horizon, however, is the continued reduction in force that is rapidly depleting the ranks of timber sale preparers. Unless this reduction is slowed and (in some cases) reversed, the manpower may not exist to prepare a future sales program of significant size.

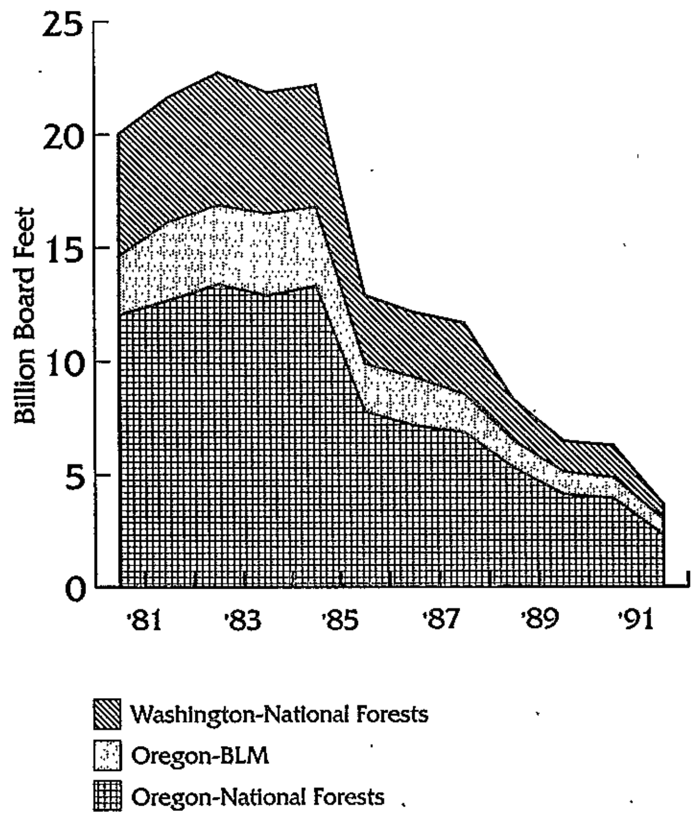

Figure VI-3. Historic federal timber sales volume under contract in Oregon and Washington.

Summary

Estimated sales levels under all of the options are below program levels of the 1980's as well as below the harvest levels of 1990-1992, when most new federal sales were enjoined. In 1990-1992, harvests were being taken from sales under contract from the 1980's (fig. VI-3). The sales levels implied by the new options will not permit even that level of harvests to be realized in the future. In the next 1-3 years the outlook is for sales levels to be substantially less than the potential decadal average sales.

Outlook for Other Commodity Production

A vast array of other resources are associated with the federal forest lands in the impact region. The work of the Forest Ecosystem Management Assessment Team did not deal explicitly with the management of the federal lands for commodities other than timber. In this section we briefly discuss these other commodities as they are important to local economics.

Minerals

The federal lands in the region are known to include substantial mineral resources. The 1992 analysis of critical habitat designation for the northern spotted owl (Schamberger et al. 1992) provided preliminary assessments of the potential impacts of limiting mining activities within the lands designated as being critical habitat for the northern spotted owl.

Ten known mineral resource deposits were located within critical habitat (seven of these were in Jackson and Josephine Counties in Oregon). These minerals include lime, limestone, silicas, copper, zinc, gold, silver, and chrome. Of the ten known deposits, one is currently being mined, three others could be profitably mined at 1990 prices, and four more could be profitably mined given a doubling of mineral prices. The mineral resources from the currently profitable mines are estimated to have a value of $344 million. This value includes the one active operation and the potential contributions from initiating the other operations, and it is uncertain as to the eventual restrictions that would be put upon these reserves. It is also uncertain at this time how additional land-use restrictions underlying the additional land allocations in the options specified by this working group could further restrict mineral activities in the region.

In addition to known reserves with some currently ongoing activity and potential near-term activity, the U.S. Geological Survey identified three mineral terranes in southwestern Oregon and the "copper porphyry" terrane that corresponds roughly to the Cascade mountain range in Washington, Oregon, and northern California as being mineral terranes with substantial potential for yielding future discovery of deposits. The copper porphyry terrane, in particular, appears to hold great potential for revealing future mineral deposits that might be within the bounds of important forest habitat. This terrane contains silver, gold, molybdenum, and copper and holds the potential for production of hundreds of millions of dollars worth of minerals.

In the longer term, it is likely that new mineral deposit discoveries will lead to further activities in mining and mineral processing in the region. The level of expansion in these industries may be limited to some degree by the proposals made by the Forest Ecosystem Management Assessment Team.

Range

Federal lands of the West are often leased for grazing. This use of federal lands for grazing in Oregon, Washington, and northern California is far more typical east of the Cascades than in the range of the northern spotted owl. The Bureau of Land Management lands in the owl region have historically provided about 23,000 animal unit months while national forests in the owl region of Washington, Oregon, and California have provided about 213,000 animal unit months (information from the Bureau of Land Management State Director's Office and from the U.S. Forest Service Regions 5 and 6 offices). This contrasts to 510,000 animal unit months on the remainder of the National Forests in Region 6.

In light of the proposals made by the Forest Ecosystem Management Assessment Team, it is likely that modification of grazing practices would occur, particularly within the riparian protection areas. These modifications would likely have consequences for individuals, but the overall economic consequences of restrictions would likely be overwhelmed by other economic considerations in the region. In addition, the consequences to the industry would be minimized by the relatively minor share of range production represented on the federal lands within the impact region.

Special Forest Products

A great deal of interest exists in the role that nontraditional or "special" forest products might play in the region. Currently, five major segments are in the industry: (1) floral greens, (2) Christmas ornamentals, (3) wild edible mushrooms, (4) other edibles and medicinals, and (5) Pacific yew. These products appear to have a significant amount of economic value. However, their eventual contribution is clouded by below-market pricing by public owners and a lack of recordkeeping.

In a report prepared for the Team, Schlosser and Blatner (1993) summarized many of the key aspects of the special forest products markets in the Pacific Northwest (Washington, Oregon, Idaho, and Montana). The major market segments are floral greens, Christmas ornamentals, and edible mushrooms; Pacific Yew appears to have less of a future in light of the development of synthetic taxol. In 1989 in western Oregon, Washington and southwestern British Columbia, approximately 27 million bunches of floral greens, 4,000 tons of moss, 15,000 thousand tons of Christmas bows, 1,000 tons of holly, and 7 million cones were harvested from the forests in the region with a value of over $42 million (table VI-4). In 1992, preliminary estimates of mushroom harvests totaled 1.1 million tons, with a value over $11 million (table VI-5) paid to the harvesters. These are the values of the sales of these products, not the receipts to the government, as these products are rarely marketed by the federal government. Instead, permits are often issued for nominal fees.

The eastside of the Cascades is an important component of the total harvest and critical to the economic viability of the wild edible mushroom industry. The harvest begins in northern California and proceeds into eastern Washington and eastern Oregon and Idaho during the late spring and moves to the westside in the fall. Buyers located throughout the region often buy throughout this larger regional area. In this analysis we only estimated the westside component of the industry.

The western hemlock zone of the region appears to hold the greatest potential for supporting special forest products activity. Also, the mountain hemlock zone is productive for the high-valued beargrass. These forest types are well represented within the impact region.

Schlosser and Blatner (1993) highlight that silvicultural prescriptions can aid in enhancing the production of special forest products. Most of the floral greens prefer management regimes that maintain the forest in mid- to late-seral stages and maintain semiclosed canopies. Thus, the value of these products can be enhanced through maintenance of stands in this condition. Christmas ornamentals are less sensitive to stand structure, and information is not yet available on management associations of other special products.

Commercial Fisheries

While commercial fisheries production is not a direct output of the forest, it is influenced by the quality of the stream habitat that lies within the forested areas.

Table VI-4. Harvest of floral greens and Christmas ornamentals in western Oregon, western Washington, and southwestern British Columbia in 1989.

	Species	Volume		Value in 1989
				(thousand $)
Floral Greens				
	Evergreen Huckleberry	2,278,454	Bunches	$1,481
	Evergreen Huckleberry Tips	289,521	Bunches	107
	Red Evergreen Huckleberry	173,692	Bunches	113
	Salal	8,490,100	Bunches	7,641
	Salal Tips	10,878,589	Bunches	5,439
	Dwarf Oregon-grape	99,141	Bunches	59
	Beargrass	12,781,823	Bunches	11,504
	Sword Fern	2,463,092	Bunches	1,527
	Scotch-Broom	345,698	Bunches	138
	Moss	3,963	Tons	2,061
Christmas Ornamentals				
	Noble Fir Boughs	9,310	Tons	6,703
	Douglas-fir Boughs	1,317	Tons	263
	Western Red Cedar Boughs	2,375	Tons	1,092
	Western White Pine Boughs	995	Tons	458
	Lodgepole Pine Boughs	272	Tons	99
	Subalpine Fir Boughs	900	Tons	576
	Western Juniper Boughs	283	Tons	142
	Incense Cedar Boughs	176	Tons	133
	Other Boughs		N/A	59
	Cones	7.2	Million	253
	Holly	954	Tons	2,672
Total				42,520

Source: Schlosser and Blatner (1993).

Table VI-5. Preliminary estimates of harvest of edible mushrooms in western Oregon and western Washington in 1992.

Species	Volume	Value in 1992
	(tons)	(thousand $)
Chanterelles	637	4,019
Matsuke	396	6,261
Boletes	29	259
Spreading Hedgehog	20	144
Morels	11	91
Cauliflower	3	23
Other	36	625
Total	1,135	11,422

Source: Based upon interpretations of preliminary data in Schlosser and Blatner (1993).

Fisheries-related industries represent a significant proportion of the coastal economy of the Pacific Northwest. The principal commercial species categories in the region are salmon, tuna, groundfish, crab, shrimp, and others. In addition, clams and oyster values in Washington surpassed landed fish values in the state (oyster and clam values totaled $60 million in 1989, $54 million in 1990, and $48 million in 1991) (Radtke and Davis 1993a, report prepared for the Team). While salmon represents the species most directly impacted by forestry activities, it is important to look at all of the species landed to see how the industry has adapted to changing conditions.

The volume and value of commercial seafood landed in Pacific Northwest ports fell substantially from 1989 to 1991 (table VI-6). The most significant decline was in salmon catch. A variety of factors contributed to this, including depressed fish prices, unfavorable ocean conditions, and increasing competition from other consumers of this resource. The decline in salmon catch continued into 1992 for Oregon and northern California. The catch of groundfish increased substantially in Oregon in 1992 and resulted in a substantial increase in the volume of catch (257 million pounds in 1992 as opposed to 150 million pounds in 1991), but the dollar value of the catch did not increase markedly ($74 million in Oregon in 1992 as compared to $62 million in Oregon in 1991). This is due to a changing mix in the catch and reductions in prices (Radtke and Davis 1993a).

These short-term changes cannot be necessarily be extrapolated to long-term projections. The seafood catch in the early 1980's, for example, declined greatly with bad economic conditions coupled with El Nino conditions. However, there is evidence of a longer term trend in the Pacific Northwest fishing industry -- a trend that has seen a shift from salmon and tuna production toward groundfish and shrimp. This species substitution has allowed the industry to maintain its viability. Three factors, however, currently pose difficulties for the coastal fisheries: (1) the recession in world seafood prices, (2) continued reductions in salmon availability, and (3) the loss of a large share of the groundfish (particularly Pacific whiting) to offshore processors. The continuation of the loss of volume to offshore processors could result in large reductions in onshore groundfish processing in 1993 (Radtke and Davis 1993a).

The focus upon landings at ports in Washington, Oregon, and northern California may understate the importance of Pacific Northwest salmon stocks. Alaska and British Columbia operations dominate the salmon fisheries market and harvest more than 20 times the value of the salmon in the lower three states.

Options proposed by the Forest Ecosystem Management Assessment Team likely would not influence the immediate future of commercial fisheries operations. However, improved watershed and fisheries management policies may aid fish stocks in the longer term.

Summary

The options proposed likely will provide some short-term benefits to the special forest products sector, due to maintenance of forest conditions conducive to the production of some of the special forest products. At the same time, some short-term costs in forage (and livestock) production may be incurred due to range restrictions. Potential restrictions on mineral extraction need further investigation to discern whether the

Table VI-6. Estimated pounds and value of seafood landed at Washington, Oregon and California ports 1989-1992.

Year / Species	Poundage: Washington	Oregon	Northern California	Total	Value: Total
	thousand pounds				thousand $
1989					
Salmon	8,112	11,724	1,878	21,714	25,812
Tuna, Albacore	405	1,080	202	1,687	1,309
Groundfish	22,096	82,510	52,228	156,834	46,375
Crab	17,667	11,676	4,728	34,071	37,822
Shrimp, Pink	15,895	49,129	13,323	78,347	28,611
Other	5,707	9,504	23,060	38,271	13,797
Total	69,882	165,623	95,419	330,924	153,726
1990					
Salmon	5,216	5,412	966	11,594	18,832
Tuna, Albacore	1,108	2,079	222	3,409	2,767
Groundfish	16,642	79,177	47,564	143,383	41,962
Crab	9,137	9,510	9,246	27,893	27,513
Shrimp, Pink	13,549	31,883	8,693	54,125	26,566
Other	4,890	11,011	14,113	30,014	13,920
Total	50,542	139,072	80,804	270,418	131,560
1991					
Salmon	6,715	5,344	624	12,683	13,006
Tuna, Albacore	606	1,259	105	1,970	1,536
Groundfish	16,740	110,817	44,092	171,649	48,075
Crab	4,337	4,924	3,199	12,460	19,051
Shrimp, Pink	9,944	21,711	10,363	42,018	23,398
Other	5,166	5,976	13,070	24,212	15,430
Total	43,567	150,031	71,453	264,992	120,496
1992					
Salmon	N/A	2,364	23	N/A	N/A
Tuna, Albacore	N/A	3,886	618	N/A	N/A
Groundfish	N/A	186,318	39,632	N/A	N/A
Crab	N/A	11,928	7,510	N/A	N/A
Shrimp, Pink	N/A	48,033	18,680	N/A	N/A
Other	N/A	4,454	10,769	N/A	N/A
Total	N/A	256,982	77,239	N/A	N/A

Source: Radtke and Davis (1993a).

current or future production operations may be limited. In the longer term, improved watershed protection may aid fish stocks if coupled with appropriate fisheries management.

Outlook for Noncommodity Production

In addition to commodity products (i.e., those that are marketed) several noncommodity outputs are associated with forest management. While these outputs may not have direct economic value as expressed through market prices, they are valued by society and can lead to tangible economic returns through tourism and recreation expenditures and through increasing the attractiveness of the region to new firms.

Recreation

Forest-based recreation in 1990 totaled 135 million visits in 1990 (table VI-7; Swanson and Loomis 1993, a report prepared for the Team). Estimates of willingness to pay suggest that forest visitors placed a value of over $1.6 billion upon these visits (over and above their actual expenditures of $2.8 billion). The recreation visits can also be portrayed as a function of land classifications used by the federal agencies -- thus permitting the assessment of the acreage allocation within plans. This system is known as the recreation opportunity spectrum and classifies the land base by broad categories of recreation potential, i.e., primitive, semiprimitive nonmotorized, semiprimitive motorized, roaded natural, and roaded modified rural. Currently, the use and total value levels are highest for the more developed, motorized forms of recreation (table VI-8). Use is a function of supply and demand considerations, and there is evidence that there is an excess supply of these more developed, motorized forms of recreation (table VI-9).

Table VI-9 contrasts the implicit recreation opportunity spectrum outcomes in the year 2000 given the two "extreme" options considered by the Forest Ecosystem Management Assessment Team, as well as the implications of retiring roads within the acres classed as semiprimitive motorized or roaded natural so that they may be moved to a nonroaded condition -- thus contributing toward this unmet demand. This latter category is denoted by "Option 1 with Recreation Emphasis." Forests of the region thus appear to be providing less of the primitive and semiprimitive nonmotorized opportunities than is desired by forest recreationists.

While land attributes can be useful for describing some aspects of recreation value, they are not sufficient for describing hunting and fishing opportunities and values. Table VI-7 indicates that Pacific Northwest fishing represents one of the highest valued recreation opportunities in the region. Sport fisheries activities are dominated by trout, salmon, and steelhead fishing and 77 percent of the fishing days were in pursuit of these species (Radtke and Davis (1993a). Forested watersheds can have marked impacts on the habitat for these fish species. Radtke and Davis (1993a) show that, while it is not attributable solely to forest conditions, Pacific Northwest salmon fishing catch rates and angler days have declined greatly from the late 1970's. The economic implications of these changes are addressed in later sections of this report.

Table VI-7. Recreation visits and values in 1990 for Bureau of Land Management and National Forest lands in the range of the northern spotted owl by activity.

Recreation activity	Visits	Value/ visit	Expenditures/ visit	Annual value	Annual expenditures
	thous.	—— $/visit ——		—— thousand $'s ——	
Off-road vehicle use	2,074	10.39	21.91	21,548	45,439
Motorized Sightseeing & exploring)	74,954	4.00	21.91	299,818	1,642,251
Hiking, biking, horsebacking, other nonmotorized visits	10,803	35.86	8.53	213,429	92,150
Camping	11,527	11.00	27.17	126,796	313,185
Hunting	2,604	39.08	20.69	101,757	53,873
Non-consumptive wildlife viewing	4,576	26.06	22.44	119,253	102,687
Picnicking, photography, nature study, interpretive visits, and other day-use	14,703	20.00	13.50	294,055	198,487
Fishing	5,842	42.92	30.65	291,646	179,066
Boating, canoeing, and rafting	1,922	6.00	22.73	11,534	43,696
Swimming, wading, and other water-based visits	2,172	3.00	4.56	6,515	9,903
Winter sports other than snowmobiling	2,224	33.69	22.41	74,922	49,837
Snowmobiling	1,203	33.69	22.41	40,539	26,966
Total	134,604			1,601,812	2,757,540

Source: Swanson and Loomis (1993).

Table VI-8. Recreation visits and values in 1990 for Bureau of Land Management and National Forest lands in the range of the northern spotted owl by Recreation Opportunity Spectrum setting category.

	Recreation Opportunity Spectrum setting category					
	Primitive	Semiprimitive nonmotorized	Semiprimitive motorized	Roaded natural	Roaded modified rural	Total
Acres (thousands)	3,856	1,608	1,578	8,686	7,615	23,342
Visits (thousands)	3,901	3,938	11,593	79,697	33,681	132,810
Annual Value (thous $)	116,226	77,271	123,092	797,699	356,494	1,470,782
Value/Acre ($/acre)	30.14	48.06	78.01	91.84	46.82	63.01
Visits per acre	1.01	2.45	7.35	9.18	4.42	5.69

Source: Swanson and Loomis (1993).

Table VI-9. Recreation acreage needs and values assessment in the year 2000 for Bureau of Land Management and National Forest lands in the range of the northern spotted owl by Recreation Opportunity Spectrum setting category under Options 1 and 7.

	Recreation Opportunity Spectrum setting category					
	Primitive	Semiprimitive Nonmotorized	Semiprimitive Motorized	Roaded Natural	Roaded Modified Rural	Total
Projected Needs in the Year 2000						
Acres (thousands)	5,859	7,610	1,821	3,315	4,748	23,342
Value/acre ($)	30.14	48.06	78.01	91.84	46.82	N/A
Option 7 Allocations in the Year 2000						
Acres Allocated (thousands)	3,934	811	2,211	7,344	9,045	23,342
Acres Contributing to Needs (thousands)	3,934	811	1,821	3,315	4,738	
Deficit (Surplus) (thousand acres)	1,925	6,798	(394)	(4,029)	(4,307)	
Recreation Value (thousand $'s)	118,568	38,988	142,027	304,409	221,842	825,834
Option 1 Allocations in the Year 2000						
Acres Allocated (thousands)	3,960	975	2,876	7,004	8,543	23,342
Acres Contributing to Needs (thousands)	3,960	975	1,821	3,315	4,748	
Surplus (Deficit) (thousand acres)	1,899	6,635	(1,055)	(3,689)	(3,795)	
Recreation Value (thousand $'s)	119,357	46,836	142,027	304,409	221,842	834;470
Option 1 Allocations in the Year 2000 with Recreation Emphasis Allocation Acres						
Acres Allocated (thousands)	3,960	2,553	1,898	6,404	8,543	23,342
Acres Contributing to Needs (thousands)	3,960	2,553	1,821	3,315	4,748	
Surplus (Deficit) (thousand acres)	1,899	5,057	(77)	(3,089)	(3,795)	
Recreation Value (thousand $'s)	119,357	122,669	142,027	304,409	221,842	910,304

Source: Swanson and Loomis (1993) background report.

Scenic Quality, Water Quality, Air Quality, and Other "Public Goods"

The aquatic assessment from the Forest Ecosystem Management Assessment Team addresses the relationship between the alternatives and water quality. Roadside and streamside visual considerations have been designed into forest plans in the region. The recreational assessment has highlighted how recreation values are influenced by landscape attributes, and one can infer some of the scenic values implicit in land management alternatives. The relationship between air quality and the alternatives is difficult to infer. More detailed air quality analysis should be undertaken in Forest, District, or Physiographic Province level planning.

Beyond these relationships lie two prevailing economic questions. First, how do these environmental qualities influence the quality of life within the Pacific Northwest and therefore its attractiveness for new businesses and residents? Second, how does the public at large value the existence of a "quality environment"?

The Pacific Northwest has seen greater than the U.S. average employment growth since 1985 (Mitchell and Sommers 1993). Many contend that this economic growth has been fueled by the quality of life in the region, and that environmental quality is a component of this quality of life. Maintenance of a quality environment has become a critical component of the region's economic development. There is no way to judge, however, the relationship between the options specified and the future economic contributions of the forest from a quality of life standpoint.

Swanson and Loomis (1993) highlight that all Americans place a high value on maintenance of viable ecosystems, even when those systems are far removed from their homes. This implies that direct commodity production and forest use information does not fully account for how society values or assigns costs of particular management actions.

Summary

Economic contributions from the forests of the region extend beyond the commodities yielded. The noncommodity outputs of the forest have true economic values and can provide a basis for economic development both through tourism-related activities and quality of life considerations. Assessment of recreation values, recreation needs, and land allocations suggest that land management strategies can be crafted that enhance the values provided by the forest. The range of options analyzed by this Team indicate little variation in recreation opportunity yields, but when coupled with activities such as watershed restoration, which call for elimination of roads in many watersheds, the options may lead to improved recreational opportunities.

Outlook for Nonfederal Timber Harvests

The change in availability of federal timber will likely impact regional forest product prices and lead to changes in harvest activities from private and other public timber owners in the region. To assess the impacts of changes in federal harvests on regional timber prices and harvests from nonfederal sources, the timber market was simulated using the Timber Assessment Market Model (Adams and Haynes 1980). Simulations were done for harvest levels of 0.5, 1.0, 1.5, and 2.5 billion board feet from the federal forests in the analysis region. These levels spanned the range of harvests in the 10 options. Results are presented for entire half-states for Washington and Oregon, since this is the basis for analysis within the Timber Assessment Market Model. Later sections attempt to disaggregate these projections for implications for the owl region.

In the four simulations, no changes were assumed in the state forestry regulations of private timberlands. If the states enact extensive changes in forest practice act regulations, then these results may overstate the potential expense of private timberland owners. In addition, no changes in the rate and types of forest management were assumed.

Timber Prices

Reductions of federal timber availability in the region do spur price increases for timber (table VI-10). All simulations show large price increases from the level prevailing in the regional market in 1990. These price signals serve to motivate other landowners to harvest timber in the near-term and invest in timber management in the longer term.

Harvest Levels

The reductions in federal harvests tend to spur some supply responses on the part of private owners in the region (table VI-11). The level of the supply response is short lived and tempered by the age distribution of the timber on private lands (fig. VI-4; see also Greber et al. 1991 and Adams et al. 1992). The impact occurs in the early years of the simulations -- by the year 2000 the harvests drop below the levels of the 1980's.

Table VI-12 puts together the public and private timber harvest outlook to show which regions are prone to be most impacted by changing harvest levels. The state of Washington demonstrates some resilience to the changes in federal harvests. Federal harvests represent a much smaller proportion of Washington's harvest than in the other states. The responses by the other landowners allow the state of Washington to maintain harvests at a level somewhat higher than the level of 1990-1992 -- although some 11 to 12 percent less than the level of the 1980's. Most all of the aggregate harvest reduction in Washington is in the western region of the state.

Oregon harvests are apt to be declining given all options considered -- and these reductions will be substantial when compared to the 1980's. Options 1 through 6 and 8 through 10 (which all entailed harvests well under 1.5 billion board feet on the owl forests) all will yield decreases on the westside as well as the eastside. Eastern Oregon is confronted with substantial reductions on federal and nonfederal lands (see tables VI-2 and VI-12). California similarly sees substantial reductions under all options due to reductions on both federal and nonfederal lands (tables VI-2 and VI-12). These reductions in nonfederal harvests are consistent with findings in Haynes et al. (1993).

Table VI-10. Historic and projected prices for timber by geographic region for simulations.

Region/ Year	Harvest level from federal forests in the owl region: 500	1000	1500	2500[a]
	dollars per thousand board feet, scribner (1992 dollars)			
Pacific Northwest Westside				
1990	240	240	240	240
1995	347	333	319	281
2000	303	296	298	284
2010	379	363	341	319
2040	333	312	348	327
Pacific Northwest Eastside				
1990	124	124	124	124
1995	220	206	197	198
2000	260	244	244	221
2010	277	262	266	260
2040	288	270	276	262
Pacific Southwest				
1990	124	124	124	124
1995	227	223	219	212
2000	215	210	202	191
2010	224	221	223	216
2040	180	189	152	180

Source: Timber Assessment Market Model simulations.

[a]Harvest levels in million board feet.

Table VI-11. Historic harvest levels and projects first decade average timber harvests on nonfederal lands by geographic region for options (whole state for Oregon and Washington).

Region	Average 1980-1989	Average[a] 1990-1992	Harvest level from federal forests in the owl region: 500	1000	1500	2500
	million board feet, scribner					
Washington						
Western	4126	3775	4253	4193	4157	4008
Eastern	822	752	848	822	810	803
Total	4949	4528	5101	5015	4967	4811
Oregon						
Western	3023	2855	3569	3519	3489	3364
Eastern	604	688	488	465	455	449
Total	3627	3543	4057	3984	3944	3813
California Owl Region	1640	1783	1361	1327	1287	1219

Source: Timber Assessment Market Model simulations.

[a]California history actually 1990-1991 Oregon and Washington estimated for 1992.

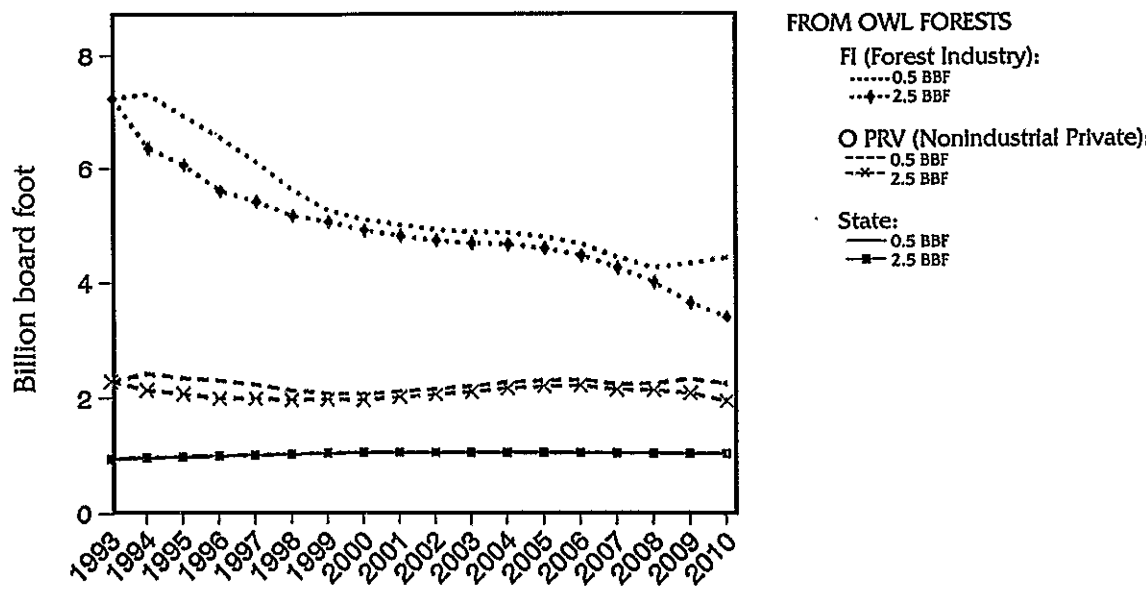

Figure VI-4. Projected harvest levels from nonfederal owners in the Pacific Northwest (FI = forest industry, O PRV = nonindustrial private), given 0.5 billion board feet of harvests from federal owl forests and 2.5 billion board feet of harvests from federal owl forests. Source: Timber Assessment Market Model simulations.

Table VI-12. First decade average timber harvests from all lands by geographic region for alternatives and historic harvest levels (whole state estimate for Washington and Oregon).

Region	Average 1980-1989	Average[a] 1990-1992	Harvest level from federal forests in the owl region			
			500	1000	1500	2500
	million board feet, scribner					
Washington						
Western	4950	4179	4299	4292	4315	4303
Eastern[b]	1151	1014	972	983	1002	1038
Total	6101	5193	5271	5275	5317	5341
Oregon						
Western[a]	5805	4320	3837	4062	4323	4821
Eastern[b]	1708	1624	880	917	951	992
Total	7513	5944	4717	4979	5274	5813
California Owl Region	2201	2074	1436	1477	1512	1594

[a]Western Oregon includes a small amount of northern California Bureau of Land Management harvest.
[b]Non-owl forests have not been subjected to rigorous analysis for the various alternatives and appear only for regional price projections. Fate of the eastside forests is highly uncertain at the present time.

Export Levels

Historically, a significant portion of the nonfederal timber harvest was exported (fig. VI-5). Export logs are, in fact, the second most important forest product in the region in terms of volume and value. While some view these exports as a drain on the manufacturing industries, others view them as a vital part of the economy of the region.

In addition to federal timber sales reductions promoting changes in nonfederal harvest levels, these sales reductions may result in increased domestic competition for the export logs. The combined effects of higher domestic prices, changing wood quality, and increased exportation of milled products has led many to conclude that there will be significant reductions in log exports from the region. Relative to 1988, studies have shown that by the year 2000 the reduction in export levels could range from 30 to 57 percent when looking at some of the recent proposals for federal land management and conservation of the northern spotted owl (Adams and Haynes 1989; Cardellichio et al. 1989; Perez-Garcia 1991). In the short term (1 to 2 years) estimates are that these federal management changes would yield a 25 percent reduction in log exports. From 1988 to 1990-1992, log exports in the region did fall from 3.7 to 2.5 billion board feet (a 32 percent reduction). It would thus appear that this recent level of exports may be reasonable to assume for continuation into the decade ahead -- barring any change in nonfederal log export policies.

Summary

The state impacts from federal harvest reductions will vary. Federal harvests reductions will not be buffered to any great extent by increases in nonfederal harvest levels in Oregon and California but will be in Washington. Recent Washington harvests have been at levels that can be expected into the future, but under the scenarios considered, future reductions are evident in Oregon and California.

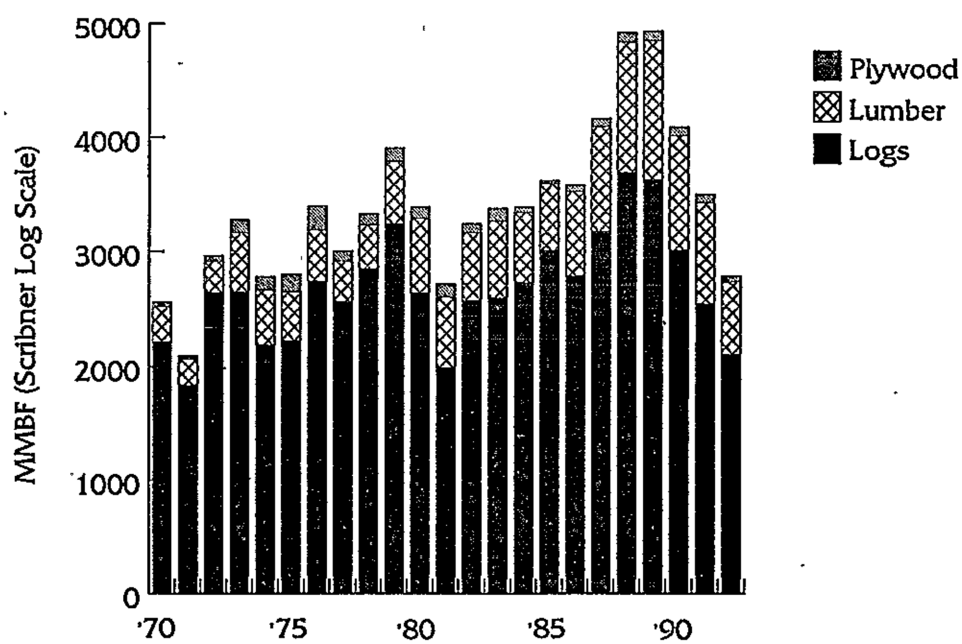

Figure VI-5. Forest products exports from the impact region.

Logs could also be redirected from the log export market to the domestic markets. Market forces, however, have already caused a reduction in log exports to the level that appears to be reasonable to expect in the decade ahead.

Outlook For Regional Employment

Discussions of employment outlooks for each of the individual natural resource sectors focus upon employment directly within those sectors. We recognize that there are "indirect" and "induced" effects caused by changes in industrial purchases and household expenditures within a region. These other impacts will be reviewed within the section entitled "Overall Economic Outlook for the Region."

Timber-Based Employment

Timber-based employment in 1991 stood at approximately 120,000 employees (fig. VI-6). This figure represents wage and salary employees (i.e., employees covered by unemployment insurance) and does not include self-employed personnel, who represent approximately 10 percent additional employment. The wage and salary employees are divided among sectors as follows: 17,000 in logging, 32,000 in sawmilling, 13,000 in veneer and plywood manufacturing, 25,000 in secondary wood products, 6,000 in miscellaneous solid wood products, and 27,000 in pulp and paper. This aggregate level of employment is down from the post 1980's recession high of 140,000 employees. It is estimated that 1992 employment had dropped to 116,000 employees.

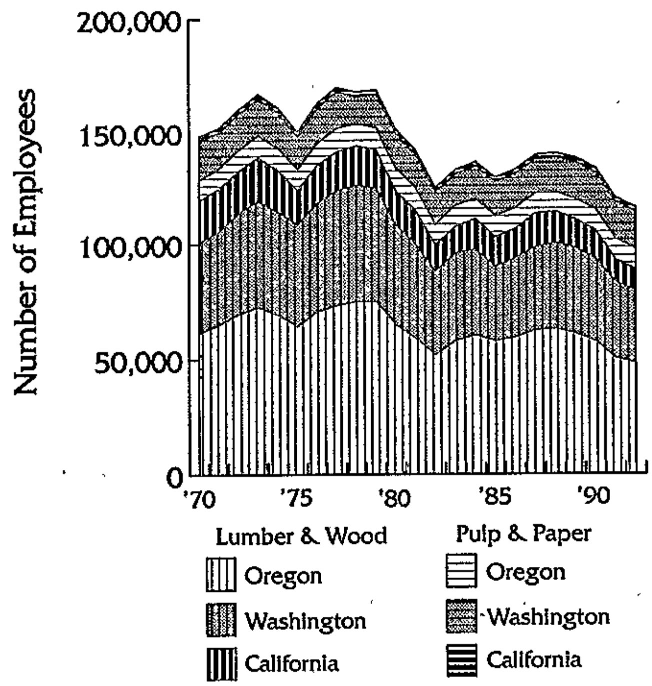

Figure VI-6. Wage and salary employment in the impact region by state and sector 1970-1992. Timber industries include solid wood products (SIC 24, inclusive of mobile home manufacturing) and pulp and paper processing (SIC 26, inclusive of paper converting).

The role of timber in the regional economy has changed over the past 25 years. In 1985-1989, timber-based employment represented approximately 5.1 percent of regional employment (table VI-13). This percentage is down from 9.5 percent in the early 1970's due largely to the diversification within the region's economy that was spurred by growth in the nonmanufacturing sectors. Subregional differences are, however, substantial. To discuss subregional differences, we have adopted the survey units used by the U.S. Forest Service for conducting periodic surveys of forest product industries (fig. VI-7). The Pacific Northwest is still fairly timber dependent outside the influences of the Portland and Seattle metropolitan areas. Table VI-13 shows that while the Puget sound area (containing Seattle) and the northwestern Oregon area (containing Portland) are not well characterized as timber dependent, the remainder of the owl impact region still depends, in a major way on timber -- although less so than 20 years ago.

Using U.S. Forest Service economic data bases and the agency's standard input-output model and methodology (commonly referred to as the IMPLAN model), we estimated that every million board feet change in timber harvests would impact approximately 7.79 solid wood products industry jobs (table VI-14). In addition, historic wood utilization indicated 1.29 pulp and paper industry jobs could be linked to each million board feet of timber harvested. These job estimates are based upon 1989-1990 average harvests and 1990 employment levels. The harvests are distributed by percentages according to 1988 mill survey statistics (Howard and Ward 1991a, 1991b; Larsen 1992).

Table VI-13. Timber industries and total employment by sub-region[a].

State/region	1970-1974 Average			1985-1989 Average		
	Employment		Timber as % of total	Employment		Timber as % of total
	Total	timber		Total	timber	
	-- thousands --		- percent-	-- thousands --		- percent-
Washington - Owl Region						
Olympic Peninsula	83.7	16.6	19.84	127.9	13.2	10.32
Puget Sound	702.7	23.4	3.33	1205.3	21.6	1.79
Lower Columbia	65.0	16.0	24.58	101.0	13.0	12.88
Central	72.2	3.4	4.75	118.7	3.7	3.10
Total	923.6	59.4	6.43	1552.9	51.5	3.31
Oregon - Owl Region						
Northwest	411.8	16.9	4.12	690.9	19.9	2.88
West-Central	103.2	24.6	23.87	176.3	19.7	11.18
Southwest	76.8	23.7	30.83	121.9	21.3	13.31
Central	33.8	7.1	21.14	59.5	8.5	14.22
Total	625.6	72.4	11.57	1048.3	69.4	6.62
California - Owl Region						
Total	67.4	21.0	31.23	106.5	16.3	15.26
All States - Owl Region						
Total	1616.6	152.8	9.45	2707.7	137.2	5.07

Source: Greber (1992).

[a]Does not include self-employed individuals. Add approximately 10% to estimate total employment in timber industries. Timber industries include solid wood products (SIC 24, inclusive of mobile home manufacturing) and pulp and paper processing (SIC 26, inclusive of paper converting).

Table VI-14. Average timber industries employment impacted per million board feet of timber harvest processed by sub-region -- (inclusive of self-employed individuals).

State/Region	Solid wood products[a]	Pulp and paper[b]	Total
	jobs per million board feet, scribner		
Washington - Owl Region			
Olympic Peninsula	4.37	1.01	5.38
Puget Sound	9.67	1.74	11.41
Lower Columbia	5.94	5.58	11.52
Central	10.28	0.00	10.28
Oregon - Owl Region			
Northwest	9.16	2.19	11.35
West-Central	9.11	0.66	9.77
Southwest	9.07	0.37	9.44
Central	16.38	0.00	16.38
California - Owl Region			
Total	5.77	0.63	6.40
All States - Owl Region			
Total	7.79	1.29	9.08
All States - Owl Region by Sector			
Logging	1.62		
Sawmilling	3.08		
Veneer & Plywood	1.33		
Millwork	0.82		
Other Wood Products	0.95		
Pulp		0.17	
Paper Processing		1.11	

[a]Solid wood products is defined as SIC 24, except that mobile homes and prefabricated wood buildings are omitted from the statistics.
[b]Paper converting is not included in the statistics.

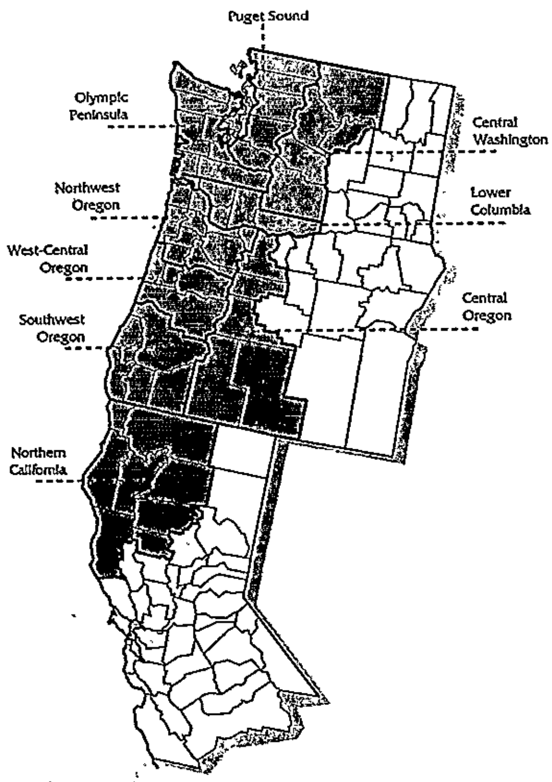

Figure VI-7. Subregional areas for timber industry assessment.

The timber volume processed by region and by option are displayed in table VI-15. These are based upon the harvest levels summarized in table VI-2 and interpolation of the data appearing in table VI-11. Within the half-state region, the harvests are distributed by percentages according to 1988 mill survey statistics (Howard and Ward 1991a, 1991b; Larsen 1992). The resulting projected employment in timber industries is portrayed in table VI-16 (employment is based upon harvests multiplied by IMPLAN based jobs/million board feet). Table VI-16 compares the projected employment levels to employment in 1990 and estimated employment in 1992.

The projections assume no change in pulp and paper employment. This is not to suggest that there will not be impacts upon the pulp and paper sector, only to suggest that the industry will respond to supply-induced changes in ways different from the solid wood products sector. Of the 28,000 total employees in the pulp and paper sector, less than 3,000 are in the pulp sector, while 16,000 are in paper processing and 9,000 are in paper-converting (e.g., envelope and bag manufacturing). The paper-converting sector utilizes paper from the national and global market, and there is a weak direct relationship between forestry activities and this portion of the pulp and paper market. The paper market has already begun to respond to changing market conditions by installing increased paper recycling capacity that can buffer it from changes within the pulp processing sector. In addition, a vast supply of open-market pulp is available on the global market. The pulp sector is apt to be the most impacted of the pulp and paper sectors by the changes in forestry activity, but utilization of alternative species and improved pulp recovery processes can allow these industries to maintain installed

Table VI-15. Historic and projected volume processed per year in next decade from all owners, by subregion and option -- owl region only.

State/Region	Average 1980-89	Average 1990-92	Option 1	2	3	4	5	6	7	8	9	10
	million board feet, scribner											
Washington - Owl Region												
Olympic Peninsula		1914	1970	1978	1977	1974	1980	1975	1967	1971	1977	1966
Puget Sound		1320	1415	1423	1423	1420	1418	1423	1416	1429	1419	1424
Lower Columbia		982	894	910	911	911	924	914	931	922	925	912
Central		353	313	333	335	332	336	337	345	358	335	348
Total	5661	4569	4592	4644	4646	4637	4658	4649	4659	4680	4656	4650
Oregon - Owl Region												
Northwest		1442	1401	1446	1452	1462	1492	1464	1602	1505	1493	1471
West-Central		1519	1184	1240	1253	1262	1311	1279	1419	1368	1353	1316
Southwest		1515	1110	1263	1278	1296	1351	1309	1635	1464	1432	1358
Central		875	459	489	489	486	492	489	511	490	506	487
Total	6972	5351	4154	4438	4472	4506	4646	4541	5167	4827	4784	4632
California - Owl Region Total	2216	2261	1379	1463	1464	1440	1462	1464	1486	1527	1447	1520
All States - Owl Region Total	14849	12181	10125	10545	10582	10583	10766	10654	11312	11034	10887	10802

Table VI-16. Historic and projected employment in timber industries in next decade, by subregion and option.

State/Region	Actual 1990	Estimated 1992	Option 1	2	3	4	5	6	7	8	9	10
	thousand jobs											
Washington - Owl Region												
Olympic Peninsula	13.9		12.0	12.1	12.1	12.0	12.1	12.0	12.0	12.0	12.1	12.0
Puget Sound	25.7		20.9	21.0	21.0	21.0	20.9	21.0	20.9	21.1	21.0	21.0
Lower Columbia	14.1		12.7	12.8	12.8	12.8	12.9	12.8	12.9	12.9	12.9	12.8
Central	4.2		4.0	4.2	4.3	4.2	4.3	4.3	4.4	4.5	4.3	4.4
Total	57.9	51.3	49.7	50.1	50.1	50.0	50.2	50.1	50.3	50.5	50.2	50.2
Oregon - Owl Region												
Northwest	21.9		20.4	20.8	20.9	21.0	21.3	21.0	22.3	21.4	21.3	21.1
West-Central	20.9		14.3	14.8	14.9	15.0	15.4	15.1	16.4	16.0	15.9	15.5
Southwest	21.4		11.0	12.3	12.5	12.6	13.1	12.8	15.7	14.2	13.9	13.2
Central	8.9		7.5	8.0	8.0	7.9	8.1	8.0	8.4	8.0	8.2	8.0
Total	73.1	62.8	53.2	56.0	56.3	56.6	57.9	56.9	62.8	59.5	59.3	57.7
California - Owl Region Total	13.9	11.3	10.0	10.5	10.5	10.4	10.5	10.5	10.6	10.9	10.3	10.8
All States - Owl Region Total	144.9	125.4	112.9	116.6	116.9	117.0	118.6	117.5	123.7	120.9	119.8	118.7

[a]Includes self employed in all solid wood products and pulp and paper sectors (SIC24 and SIC26). Wage and salary employment is approximately 7.5 percent less than total employment.

capacities. However, capital investment is apt to be required, and the current market for pulp is plagued by weak prices (memo from S. Levan, U.S. Forest Service, Madison, Wisconsin, 1993, available from the Team). There is also a large quantity of chips exported from the region – some of these will likely be re-directed to domestic pulp mills.

Similarly, mobile home construction (which is typically included with the timber industry employment statistics) is assumed to maintain historic employment levels. Employment in this sector is included in the projections in table VI-16 at its 1990 level.

These job ratios have not been adjusted for future changes in technology. Greber (1993) notes that technology can increase jobs per unit of input when the focus is upon raw materials saving and product-improving technological change. Because raw material is apt to be viewed as the limiting resource, technology in the decade ahead will likely focus on raw materials savings as opposed to labor savings.

The job ratios in table VI-14 vary significantly by subregion. These vary on the basis of the types of species processed, the types of mills in the subregions, the amount of secondary manufacturing, and the level of exports from the region. For example, the jobs per million board feet are much higher than average in central Oregon, where there is a significant amount of secondary wood products manufacturing that is tied to the species processed in the subregion. The Olympic Peninsula, on the other hand, shows lower jobs per million board feet due to the amount of logs shipped into the region that are exported and the lack of secondary manufacturing activity.

Relative to 1992, these projections imply a range of job displacement ranging from 1,700 to 12,500 jobs. However, compared to 1990 employment levels, these projections imply a range of job displacement from 21,200 to 32,000 jobs. The majority of the job impacts are in Oregon and are concentrated in southwestern Oregon.

Recreation/Tourism-Based Employment

In the 14 coastal counties in the region in 1990, tourism directly supported wages totaling an estimated $348 million (Radtke and Davis 1993b, by a report prepared for the Team). Assuming an average annual wage of $15,000 - $20,000 per full-time equivalent worker, this would suggest that approximately 17,000 to 23,000 full-time equivalent workers were directly supported by the tourism industry in the coastal counties. Actual numbers employed in the industry are likely much higher, because the work tends to be seasonal and often part time. It is, nonetheless, a large and important part of the coastal economy. In the near term, the alternatives proposed will likely not radically change the nature of coastal tourism, but in future decades, restoration of salmon and trout runs could have marked impacts on coastal recreation activities.

Many thousands more are supported by the inland recreation industry as well. The Bureau of Land Management alone estimates that 900 recreation and tourism jobs were directly attributable to their proposed land management plans (see the Bureau of Land Management Resource Management Plans, 1992). Based upon expenditure data summarized in table VI-7 and a ratio of $0.41 of recreation/tourism income for every dollar of recreation expenditures (from Radtke and Davis 1993), we estimate that a total of 50,000 to 80,000 full-time equivalent jobs may be directly attributable to forest-based recreation activities on Bureau of Land Management and National Forest lands combined. Of these jobs, it is estimated that 4,000 to 5,000 are related to jobs created by fishing opportunities. The land allocation patterns inherent in the plans do appear to provide more of the recreation opportunities that are currently supply limiting. Thus, there should be some gains to recreation and tourism in the inland communities. The extent of these gains, however, is currently uncertain.

Commercial Fisheries Employment

Radtke and Jensen (1988) estimated that there were 177,000 full-time equivalent employees supported by the harvesting and processing of 4.8 billion pounds of fish in Washington, Oregon, California, and Alaska. This would imply 0.037 jobs per thousand pounds of fish landed. This figure includes direct, indirect, and induced effects. If we assume that approximately half of these jobs are directly involved in the harvesting and processing of fish, then in 1991 fish landed in Washington, Oregon, and northern California would have supported approximately 5,000 full-time equivalent workers in the fisheries industry.

Similarly, Radtke and Davis (1993) showed that in 1992, 15,108 economy-wide jobs in Oregon would have been supported by $141,528,000 worth of fish landing. In addition, they show that fish harvesting and processing income represented 38 percent of the total income (direct, indirect, and induced) supported by this level of fish landing. If we assume that this means that 38 percent of the 15,108 jobs were directly involved in fish harvest and processing, then we have an estimate of 0.041 jobs per $1,000 of fish landings. Using this with 1991 fish landings in Washington, Oregon, and northern California would suggest approximately 5,000 full-time equivalent workers in the fisheries industry.

Of these 5,000 jobs, less than 10 percent would appear to be directly related to the commercial salmon industry. This low percentage reflects a combination of growth in the importance of other species and the current low levels of salmon catch.

Other Natural Resource Based Employment

State-wide in Washington in the late 1980's, approximately 12,000 people were employed in mining and mineral processing. In Oregon, this number stood at 6,700 (note many of these jobs are in the eastern reaches of the state, outside the owl impact region, and some are on private lands). Northern California statistics are not available. Many of the minerals processed in the region came from federal lands.

The 1992 assessment of northern spotted owl critical habitat designation estimated that four of the 10 mineral deposits within critical habitat could be profitably mined at prevailing mineral prices and that approximately 300 jobs would be associated with this mining and mineral processing activity (Schamberger et al. 1992). It should be noted that this employment level includes the one active operation and the potential contributions from initiating the other operations, and it is uncertain as to the eventual restrictions that would be put upon these reserves. It is also unknown whether other recommendations of this working group could have further implications on known mineral deposits in the region. The vast mineral terranes in the region also hold the potential for thousands of additional jobs in the region as new deposits are discovered; again, implications for future development are unknown at the current time.

In addition to known reserves with some currently ongoing activity and potential near-term activity, the U.S. Geological Survey identified three mineral terranes in southwestern Oregon and the "copper porphyry" terrain that corresponds roughly to the Cascade mountain range in Washington, Oregon, and northern California as being mineral terranes with substantial potential for yielding future discovery of deposits. The copper porphyry terrane, in particular, appears to hold great potential for revealing future mineral deposits that might be within the bounds of important forest habitat. This terrane contains silver, gold, molybdenum, and copper, and holds the potential for production of hundreds of millions of dollars worth of minerals and creation of several thousand mining and mineral processing jobs.

Jobs directly attributable to range activities are quite low. The Klamath Falls District of the Bureau of Land Management uses 1 job per 1,000 animal unit month's directly involved in cattle production activities (USDI Bureau of Land Management 1992) while the Umatilla National Forest uses 0.30 jobs per thousand animal unit months (Haynes et al. 1992). Extrapolating these to the owl region would imply that 69 to 236 livestock jobs would be attributable to range activities. The actual level of reductions in employment in the ranching sector that would be associated with any particular option is unknown at this time.

The floral greens, Christmas ornamentals, and mushroom segments of the special forest products markets produced over $70 million in harvests in 1992 and provided some harvesting employment opportunities for an estimated 28,000 to 30,000 individuals in the region. As many as one-half of these individuals are involved with the harvesting or processing of two or more of the special products -- a situation that is enhanced by the sequential nature of the seasons (i.e., Christmas ornamentals in late fall and early winter, edible mushrooms in spring, and floral greens in all but the spring seasons). Schlosser and Blatner (1993) note, however, that most harvesting and processing jobs are not full time and are seasonal, low paying, and without benefits. Thus, these numbers cannot be compared directly with other employment statistics in this report. There does, however, appear to be further economic potential in the development of industries involved with the processing and marketing of these special forest products. The possible extent of such developments is unknown.

Service Employment in Forestry

Employment impacts discussed within the timber-based employment section of this report focused only on the logging and wood processing jobs in the region. An estimated 6,000 jobs are also involved with forestry services. These people have traditionally been involved with reforestation and timber stand improvement activities. Two factors will be at work influencing the future employment in the forestry services sector: (1) many fewer acres will be harvested and thus the need for reforestation, fertilization, precommercial thinning, and other timber stand improvement work will greatly diminish the need for forestry services workers and (2) proposals from the Forest Ecosystem Management Assessment Team call for a number of assessments and recommend some forest restoration work. Included in the latter category are wildlife surveys for the marbled murrelet and the northern spotted owl, as well as watershed assessments throughout the region. These activities as well as some recommendations for watershed restoration and forest stand improvement will likely help offset some of the declines in the forestry services sector -- and potentially increase employment in the sector.

A review of the Bureau of Land Management draft Resource Management Plans (Greber et al. 1992) showed that the assumed impact on the forestry services sector ranged from approximately 0.3 to 0.6 jobs per million board feet change in timber harvest. Applying these job figures to a 2 billion board foot decline in timber harvests in the region would suggest the displacement of 600 to 1,200 forestry services workers.

Changes in management activities in the remaining timber base (e.g., application of pruning and other cultural practices) could help mitigate some of these job declines. Oliver (1993) estimates that an active pruning program in Washington's federal forests could add 43 jobs per year to the forestry services sector over the next decade. Assuming that approximately one fifth of the region's pruning activities lie in Washington, an active pruning program could add back 200 or more jobs per year over the next decade -- and promote the yield of higher quality, higher valued wood in future decades. Similarly, U.S. Forest Service estimates indicate that 600 jobs could be supported over the next 3 years from an aggressive pruning/timber stand improvement program in Washington and Oregon (memo from Lamar Beasley, U.S. Forest Service, Washington, D.C., 1993). These estimates are thus consistent in magnitude and differ primarily in timing.

Aggressive reforestation activities similarly could support an additional 500 jobs on U.S. Forest Service lands over 3 years and an estimated 200 jobs in 1993 from Bureau of Land Management lands (Beasley memo, 1993; memo from Darwin Priebe, Bureau of Land Management State Office, Portland, 1993).

Northern spotted owl inventory and monitoring are estimated to cost $6.1 million per year (Martin Raphael, U.S. Forest Service, personal communication, 1993). Most of this cost is labor related. Assuming a total cost (with overhead) of $30,000 per job, this translates into 200 jobs per year. Murrelet surveys are estimated to require approximately 200 employees for 5 months per year for the next 2-3 years (weather depending) (Grant Gunderson, U.S. Forest Service, personal communication, 1993).

Watershed restoration activities are receiving increasing attention in the region. U.S. Forest Service estimates of stream and watershed restoration activities indicate the potential for 2,500 jobs in Oregon and Washington over the next 3 years. Additional jobs would likely be possible on Bureau of Land Management lands. Finally, the U.S. Forest Service identifies approximately 3,800 other jobs in Oregon and Washington that are related to other ecosystem restoration activities (Beasley memo, 1993).

The silvicultural activities, surveys, assessments, and restoration work could thus add up to more than 7,000 jobs per year over the next 3 years. The net result, when coupled with forestry services job losses, would be increases in forestry services jobs by approximately 6,000 jobs. Program costs, however, would be substantial, as the estimated budget requirements would be in excess of $250 million per year. These costs, however, should be viewed as a requisite component of forest health in the region and not as simply as source of jobs.

Overall Economic Outlook for the Region

The options proposed by the Forest Ecosystem Management Assessment Team will have the most impact upon the timber industry sector. In addition to the workers displaced in this sector, there will be "indirect effects" caused from changing business expenditures in the region and "induced effects" caused by changing personal expenditures in the region. These ripple effects tend to increase the ramifications of job gains or losses in communities or regions. Table VI-17 summarizes the region-wide direct, indirect, and induced effects stemming from a 1 million board foot change in timber harvest as estimated using the U.S. Forest Service input-output model (IMPLAN). This table shows the impacts only for the solid wood products sector because this was the sector assumed to be impacted by the harvest changes. These numbers show that there is roughly one job impacted outside the timber industries for every job impacted within the timber industries.

While the IMPLAN coefficients are useful for showing a snapshot of the current makeup of an economy, they do not capture the dynamics in an economy and thus do not distinguish between actual job losses and lost opportunities in the economy, e.g., the industries affected by the indirect effects may reposition themselves to serve other markets and current workers may not be displaced, but future growth in the sector may be dampened.

To demonstrate the dynamics in the economy, the state economist in Oregon and the economic forecast council in Washington performed customized forecasts using their respective state economic and revenue forecasting models (Oregon Office of Economic Analysis 1993 and Economic and Revenue Forecast Council 1993). The results of these runs show that while differing harvest levels dampen expansion in the state-wide economies, there is still growth in the regional economies (table VI-18). These state-wide forecasts, however, mask the sub-regional differences where the rural communities are contracting while metropolitan areas are expanding. The new job holders in the region thus do not necessarily correspond to the job losers in the region.

Summary

Timber-based employment is apt to be declining under all options considered. The sub-regions that are characterized as heavily timber dependent are apt to see the most severe impacts. Forestry services appear to also be faced with job declines, but these may be offset largely through monitoring, inventory, and restoration activities.

Some employment gains do appear possible in recreation, tourism, and special forest products. It may, however, be difficult to absorb displaced loggers and millworkers into these fields due both to skill considerations and geographic locations.

In the longer run, the options may provide some boost to commercial fisheries, but in light of the size of this industry and current issues regarding potential overcapacity (Radtke and Davis 1993) these gains may not be substantial. The longer term implications for mineral activities in the region need to be resolved. These activities may bear longer term costs or benefits of great significance to the region and to the nation.

While the net impact of the options is apt to be displacement of natural resource based jobs, the economy of the region as a whole appears to be poised for continued growth. The job loss issue thus becomes more of a distributional nature, with rural communities declining as more developed areas expand.

Table VI-17. Direct, indirect, and induced effects per million board feet of timber harvest processed in the region.

	Solid wood products[a]					
Impact	Logging	Sawmills	Veneer & plywood	Millwork	Other	Total
Employment (jobs)						
Direct Jobs	1.62	3.08	1.33	0.82	0.95	7.80
Indirect & Induced	1.65	3.74	1.64	0.76	0.96	8.75
Total Jobs	3.27	6.82	2.97	1.58	1.91	16.55
Income (thousand $'s)						
Direct Income	81	107	44	25	37	294
Indirect & Induced Income	87	131	53	31	45	347
Total Income	168	238	97	56	82	641

Source: USDA Forest Service IMPLAN runs.

[a]Solid wood products is defined as SIC 24, except that mobile homes and prefabricated wood buildings are omitted from the statistics.

Outlook for Government Revenues

Declines in federal harvests will reduce federal receipts. While prices are expected to increase, they will not offset the declines in revenues to federal and local governments (table VI-19). The federal receipts noted in table VI-19 are not indicative of returns to treasury because there are administrative costs of approximately 30 percent of gross sales value (U.S. Department of Interior 1992).

Both the federal treasury and the local governments will see reduced revenues. Currently, the federal government shares 25 percent of the gross receipts from National Forest timber sales and 50 percent of the gross receipts from most Bureau of Land Management timber sales (the exception being the Coos Bay Wagon Road Lands that represent 3 percent of the Bureau of Land Management lands and are subject to standard Oregon timber tax provisions). Both due to the location of harvest reductions and the nature of the revenue sharing distribution formulas, southwestern Oregon appears to be the most substantially impacted sub-region. It should be noted that currently a legislative safety net has been safe-guarding the communities from large-scale reductions on a year to year basis.

Table VI-18. Projected state-wide employment and income in Washington and Oregon 1993-1997 by alternative.

State/Year	Alternative 1	2	3	4	5	6	7	8	9	10
Total Employment (thousand wage and salary jobs)										
Washington										
1992	2215	2215	2215	2215	2215	2215	2215	2215	2215	2215
1993	2217	2217	2217	2217	2217	2217	2217	2217	2217	2217
1994	2220	2221	2221	2221	2221	2221	2221	2221	2221	2221
1995	2261	2262	2262	2262	2262	2262	2262	2262	2262	2262
Oregon										
1992	1268	1268	1268	1268	1268	1268	1268	1268	1268	1268
1993	1292	1292	1292	1292	1292	1292	1292	1292	1292	1292
1994	1325	1330	1330	1331	1333	1331	1341	1335	1334	1332
1995	1362	1366	1367	1367	1370	1368	1378	1372	1371	1369
1996	1393	1398	1399	1399	1401	1400	1410	1404	1403	1401
1997	1423	1428	1429	1429	1431	1430	1440	1434	1433	1431
Washington & Oregon										
1992	3483	3483	3483	3483	3483	3483	3483	3483	3483	3483
1993	3509	3509	3509	3509	3509	3509	3509	3509	3509	3509
1994	3545	3551	3552	3552	3554	3553	3562	3558	3556	3554
1995	3622	3628	3629	3629	3632	3630	3640	3695	3633	3631
Total Personal Income (billion 1992 $'s)										
Washington										
1992	104.6	104.6	104.6	104.6	104.6	104.6	104.6	104.6	104.6	104.6
1993	107.0	107.0	107.0	107.0	107.0	107.0	107.0	107.0	107.0	107.0
1994	108.4	108.4	108.4	108.4	108.4	108.4	108.4	108.4	108.4	108.4
1995	111.0	111.0	111.0	111.0	111.0	111.0	111.0	111.0	111.0	111.0
Oregon										
1992	54.4	54.4	54.4	54.4	54.4	54.4	54.4	54.4	54.4	54.4
1993	56.1	56.1	56.1	56.1	56.1	56.1	56.1	56.1	56.1	56.1
1994	58.0	58.2	58.2	58.2	58.3	58.2	58.6	56.1	56.1	56.1
1995	60.1	60.3	60.3	60.3	60.4	60.3	60.6	60.5	60.4	60.4
1996	63.1	63.3	63.3	63.3	63.4	63.4	63.7	63.5	63.5	63.4
1997	64.0	64.2	64.2	64.2	64.3	64.2	64.6	64.4	64.3	64.3
Washington & Oregon										
1992	159.0	159.0	159.0	159.0	159.0	159.0	159.0	159.0	159.0	159.0
1993	163.3	163.3	163.3	163.3	163.3	163.3	163.3	163.3	163.3	163.3
1994	166.4	166.6	166.6	166.6	166.7	166.6	166.9	166.8	166.7	166.6
1995	171.1	171.4	171.4	171.4	171.5	171.4	171.7	171.6	171.5	171.4

Washington forecasts only available through 1995.

Because of the nature of the distribution formulae, the reductions will largely impact county governments and road funds. Studies from western Oregon show that county governments derived 23 percent of their funds from timber receipts in 1988, while schools derived 2 percent of their funds from timber receipts. Because schools represent the vast majority of local government expenditures in Oregon, the sum total of local government tax base reliance was 7 percent (Greber et al. 1991). Southwestern Oregon counties are even more highly timber dependent, with 55 percent of county funds, 4 percent of school funds, and 20 percent of aggregate local funds being derived from federal timber receipts in 1988.

Outlook for National Forest Products Markets

The changes in the management of the Pacific Northwest forests must be placed within the context of the national product markets for U.S. wood products. Many questions surround these changes. Included among these are: where will the future timber harvest come from, what will happen to import trade, and how much impact will there be on consumers? Prior to addressing these questions, some context must be provided for the national softwood markets.

In 1990, the total United States consumption of softwood timber products equaled 12.9 billion cubic feet of removals of roundwood from growing stock. This was 60 percent above the average consumption in the early 1950's, yet not as high as in the late 1980's. Softwood consumption is expected to increase to 14.3 billion cubic feet by the year 2040 with the largest increase in logs sawn for lumber (Haynes et al. 1993). United States softwood lumber consumption rises to 61.8 billion board feet by 2040 (the 1987 peak was 50.6 billion feet). Consumption increments come from increases in residential upkeep and alteration, nonresidential construction, and manufacturing. Plywood consumption falls slowly to 17.5 billion square feet by 2040 (the current level is 18.1 billion square feet) as a result of modest product substitution over the next 20 years.

Growth in the demand for solid wood products is expected to slow after the turn of the century as the population ages, growth in real gross national product slows, and new housing construction stabilizes/declines. Increases in recycling activities keeps wood used for pulp essentially constant, despite an expected 75 percent increase in paper and board consumption by 2040. In addition to slowing domestic demand and increased use of recycled fiber, increased use of hardwoods account for a slowing projected growth in demand for softwood timber.

The United States has been and is expected to continue to be a net importer of softwood forest products. The largest forest products trade flow for the United States is imports of softwood lumber -- over 95 percent of which comes from Canada.

Regional Harvest Levels

The Pacific Coast share of U.S. harvests peaked in the early 1960s at roughly 47 percent, the region's share is currently 38 percent. With changes in federal timber harvests, the share is expected to fall below 27 percent by the year 2000 (table VI-20). Harvest shifts from the Pacific Coast States to other United States regions, primarily the Southern United States. These shifts are the results of reductions in public harvest, which raise

Table VI-19. Historic average and projected annual federal timber receipts, by sub-region and option (by fiscal year).

State/Region	Average 1990-1992	Option 1	2	3	4	5	6	7	8	9	10
		million dollars (1992)									
Washington - Owl Region											
Gross Receipts	N/A	14.2	42.4	45.4	41.7	57.9	51.5	85.9	77.3	62.9	60.1
Local Gov't Share	34.1	3.5	10.6	11.4	10.4	14.5	12.9	21.5	19.3	15.7	15.0
Federal Share	N/A	10.6	31.8	34.1	31.3	43.4	38.6	64.4	58.0	47.2	45.1
Oregon - Owl Region											
National Forests											
Gross Receipts	N/A	28.9	86.2	95.9	107.6	144.1	115.2	240.6	167.2	158.2	132.7
Local Gov't Share	107.7	7.2	21.6	24.0	26.9	36.0	28.8	60.1	41.8	39.5	33.2
Federal Share	N/A	21.7	64.7	71.9	80.7	108.0	86.4	180.4	125.4	118.7	99.5
Bureau of Land Management											
Gross Receipts	N/A	13.4	43.9	46.4	47.6	58.0	51.5	124.5	91.3	84.4	63.8
Local Gov't Share	131.1	6.7	21.9	23.1	23.7	28.9	25.7	62.0	45.5	42.0	31.8
Federal Share	N/A	6.7	22.0	23.3	23.9	29.1	25.8	62.5	45.8	42.4	32.0
California - Owl Region											
Gross Receipts	N/A	6.4	40.9	42.3	34.0	46.2	45.0	73.0	79.2	50.0	69.0
Local Gov't Share	21.4	1.6	10.2	10.6	8.5	11.6	11.2	18.2	19.8	12.5	17.3
Federal Share	N/A	4.8	30.7	31.7	25.5	34.7	33.7	54.7	59.4	37.5	51.8
All States - Owl Region											
Gross Receipts	N/A	62.9	213.4	230.0	230.9	306.2	263.2	524.0	415.0	355.5	325.6
Local Gov't Share	294.3	19.0	64.3	69.1	69.5	91.0	78.6	161.8	126.4	109.7	97.3
Federal Share	N/A	43.8	149.2	161.0	161.4	215.2	184.5	362.1	288.6	245.8	228.4

near-term projected stumpage prices. In the face of rising wood costs, the region's competitive position deteriorates, profits fall, and solid wood output and capacity drop. In addition, the Southern U.S. production shows the ability to continue to increase in the decades ahead (Haynes et al. 1993).

The range in the various harvest levels shown in table VI-20 demonstrate little variability in these regional harvest trends.

International Trade

The United States is expected to remain a net importer of softwood products. It does not appear that the federal sales policies in the region will lead to large changes in wood products importation. Canada is the primary source of these products (Canadian lumber accounted for 30 percent of lumber consumed in the United States in 1992). Lumber imports from Canada show only modest changes in the decades ahead (table VI-21). Again the range of harvest levels considered demonstrates little variability in the import trends.

Much discussion recently has focused on the ability of Canadian producers to respond to higher prices in the United States markets (due to reductions in public timber harvests). Much of the discussion revolves around anecdotal evidence based on what is perceived to be happening in British Columbia. Current Canadian harvest is estimated to be 5.5 billion cubic feet. Recent Canadian Provincial allowable cut (i.e., the regulatory level of cut) estimates by Runyon (1991) show a Canadian harvest of 6.2 billion cubic feet. Except in British Columbia (where surveys have occurred since Runyon's work), Canadian producers seem able to sustain recent levels of production. Like the United States, Canada also faces a number of issues (owls, parks, native land claims, etc.) that could reduce harvests.

Consumer Costs

The changing markets for wood products are apt to have some repercussions for final consumers. Softwood lumber prices do appear headed upward in the decades ahead, even with harvest levels much higher than the options considered by the Team (table VI-22). Softwood lumber prices show a marked increase from 1990 levels to 1995 levels, but much of the inherent increase in price stems from supply and demand considerations beyond the options considered by this Team. The 1992 softwood wholesale price index already stood at 120 in 1992, thus meeting the level expected by 1995. In 1993, the price index surpassed these levels (reaching 172.6 in April), but prices have started to settle back toward the levels shown in these forecasts.

To place these indexes in perspective, the average house in the United States in 1990 used $5,500 worth of lumber and wood panel products (Elmore 1992), and by 1995 this will likely rise to $6,700. The range of harvest levels implicit in the options considered by the Team varies this cost of lumber by less than 1 percent from the costs implicit with a two-fold increase in harvests.

Additional Policy Considerations

Changing federal timber management will reduce harvested wood quantity and quality in the region and place many pressures upon the timber industry and the communities of the region.

Timber Industry Considerations

Forest products will continue to be a major economic factor in the region. The combined federal and nonfederal harvests will still support employment of over 110,000 individuals in the region. Many questions, however, arise as to how to strengthen the operating position of the remaining industry.

Log supplies to mills will continue to be a concern in the region. These supplies may be increased by (1) more aggressively pursuing fiber supplies on nonindustrial private lands, (2) redirecting currently exported logs, and (3) increasing the importation of wood products that are suitable for further manufacturing.

Market forces will promote much of the incentive for active management of nonindustrial private lands, but in addition some education and training is required, and many landowners will still be hesitant to make long-term investments in timber. Increased management of the nonindustrial private lands could thus be further promoted through more active public service forestry, encouragement of industrial/nonindustrial partnerships through cooperative forest management programs, and increased public assistance either through current cost-share programs or forest "trust" programs such as that being proposed in Oregon. Currently, the infrastructure is not in place in the region for mobilizing this valuable nonindustrial private resource. Hastening the establishment of this infrastructure should pay benefits to the region in terms of short-term and long-term timber supply and near term jobs. In the near term, more than 100 million board feet per year could be realized through rehabilitation of poorly stocked lands.

One potential supply response not fully captured in the analysis done for this chapter is the increased short-term conversion of poorly stocked and hardwood stands to softwood stands because of the sharp increases in stumpage prices. Since patterns have been observed by the Oregon Department of Forestry and are illustrated by lower harvest volumes per acre as timber supplies contract. These conversion opportunities could increase harvest in the region 10-20 percent for several years in the early part of this decade.

Export restrictions would likely expand the volume of timber available for domestic processing, but such a ban may not have many of the effects sought. A ban on log exports would reduce stumpage prices in the log-exporting regions. Thus, a ban would adversely affect stumpage owners--public and private-- in the log exporting regions. This would result in less incentive to harvest. Thus, part of the volume of log exports would not be realized as volume flowing into domestic mills. Most discussions of the bans ignore quality and geographic differences between the log export and domestic log markets. Much of the log export activity originates in Washington, yet some of the more impacted regions are in southern Oregon and northern California. Finally, there

Table VI-20. Historic and projected proportion of U.S. harvests from Pacific Coast States.

Region/ Year	Harvest level from federal forests in the owl region			
	500	1000	1500	2500[a]
	percentage of national harvests			
1990	38	38	38	38
1995	29	29	29	29
2000	25	25	26	26
2010	23	23	23	24

[a]Harvest levels in million board feet.

Table VI-21. Historic and projected imports of Canadian lumber into the United States.

Region/ Year	Harvest level from federal forests in the owl region			
	500	1000	1500	2500
	billion board feet - lumber tally			
1990	12.2	12.2	12.2	12.2
1995	13.3	13.2	13.2	13.1
2000	13.9	13.8	13.6	13.4
2010	15.7	15.6	15.8	15.7
2040	12.5	12.2	12.2	11.9

Table VI-22. Historic and projected softwood wholesale price index (1990=100).

Region/ Year	Harvest level from federal forests in the owl region			
	500	1000	1500	2500
1990	100	100	100	100
1995	122	121	121	121
2000	125	124	122	121
2010	136	134	138	136
2040	130	129	129	129

is apt to be a substitution of mill jobs for longshore jobs (in an already troubled coastal economy), and the net effect upon jobs is uncertain.

Sliding-scale tariffs in Japan serve to provide strong effective rates of protection for Japanese wood products manufacturers and provide additional impetus for exporting lessor-manufactured products. These tariffs inhibit the ability of U.S. wood products manufacturers (particularly high value-added manufacturers) to compete within the Japanese markets. A re-assessment of barriers to trade in the Pacific Rim countries may aid in increasing the vitality of the region's producers and redirecting the flow of raw materials. Wood products imports are becoming increasingly important to wood products manufacturers in the region -- particularly secondary wood products manufacturers. Attempts should be made to investigate how the region's Pacific Rim location can be exploited on an import basis. Logs, lumber, and cutstock from New Zealand, Australia, Chile, and other Pacific Rim countries are valuable raw materials to the mills in the region. Policies that can channel more of these materials into this distressed region for further manufacturing will serve to buffer impacts from domestic harvest reductions.

Technology can also help to extend the utilization of raw material in the mills and create new forms of products that are less old-growth dependent. New generation composite wood products include a variety of structural and nonstructural wood products that can be made from smaller trees and combinations of lumber, veneer, particles, fibers, and plastics. The region has not moved aggressively into adoption of these composite technologies. Among the reasons are uncertainty over the timber supply outlook and substantial capital requirements. Overcoming the barriers to capital markets in this time of great uncertainty in the region is of great importance. Many of the composite products can serve as inputs to secondary wood products firms.

Currently, there is a large secondary wood products industry in the region (over 25,000 employees). Many people are looking to secondary manufacturing of wood products as a source of "mitigating" employment opportunities, yet many existing manufacturers are at risk. In addition to wood quantity changing, wood quality will as well. The secondary manufacturers of the region have focused upon the production of high quality molding and millwork for door and window components. The current secondary manufacturing industry will see a large change in the years ahead.

The industry will be seeing greater proportions of "construction grades" of lumber, and less of the type of lumber suitable for the current types of secondary manufacturing. A key to increasing the ability to use construction grades of wood products in remanufacturing is increasing the rate of adoption of manufactured housing and panelized housing. These technologies substitute factory labor for site-based construction labor. The technologies may result in lower wood use per house and may be more economical -- particularly as wood prices rise. The adoption of panelized housing and alternatives to conventional U.S. frame ("stick") housing is slowed by building codes, contractor knowledge, and tradition. Research and development in the area of alternative building technologies may pay long-term dividends to the region and the utilization of forest resources.

Basic technology and business knowledge needs improving, particularly for smaller manufacturers in the region. Industrial extension activities carried out by the region's universities and community colleges could augment technology transfer to these small manufacturers and provide some impetus for growth and diversification in the forest products sector. Manufacturing technology centers could speed the development and implementation of new technologies that could simultaneously increase raw material recovery and business success. Establishment and promotion of manufacturing and marketing networks can aid in providing synergism among the region's various forest products' firms.

Recreation and Tourism Considerations

Policies that aid in providing more of the recreation opportunities deemed in short-supply could bolster the region's tourism activities. This primarily means offering more opportunities for primitive and semiprimitive nonmotorized activities. Retirement of road systems within some Key Watersheds as part of watershed restoration activities could thus provide side benefits for recreation and tourism.

Currently, the failure to fully charge for recreational use of the forest leads one to understate the value of recreation outputs. Recreation fees, while contentious with much of the public, could provide a source of replacement revenues to the agencies and the local governments. Traditionally, much of the recreation improvement had been funded out of timber receipts; with declining receipts, recreational charges may be required to guarantee a continual offering of public recreation opportunities.

Commercial Fisheries Considerations

A key concern in the commercial fishing industry is the failure to institute adequate limits on the off-shore catch and processing of Pacific whiting. The potential job losses to the coastal communities from this resource "drain" are apt to be substantial. While this is not a policy directly related to the management issues at hand, it is a confounding factor in the coastal communities that will be simultaneously impacted by the changes in federal forest management.

Special Forest Products Considerations

This is a rapidly expanding industry in the region. To adequately capture the economic value of these products and guarantee that the inherent productivity of the resources are not adversely impacted by harvesting activities, the agencies need to take a more active role in managing the harvest of these products. Standards and guides for harvesting need to be established, and appropriate fee structures need to be assessed. Sustainable supplies need to be established, and then the appropriate role of these products in the region's economy can be fully considered.

Setting the appropriate permit fees is not a straightforward process. Harvest leases for floral greens and bough contracts could be sold on a competitive basis. However, even though cruising for boughs and floral greens is possible, it's unlikely to be cost effective. Setting harvest fees for mushrooms is far more problematic because the size of the crop varies by location and in volume annually. In addition, all special forest products sale prices are strongly influenced by product quality, which varies by product and the local area. Finally, extensive fee structures may not be justified as the dollar values are not large and the gains could easily be offset by the increased costs of sale administration.

Summary and Conclusions

The economics of the alternatives can be viewed at three scales: national, regional, and local. From a national perspective the assessment of the alternatives indicates that the financial costs are apt to be fairly negligible when one views the aggregate markets. There are gainers and losers among the region's forest products producers, and the consumer costs appear low. The national values placed upon the forests of the region also must be considered and can serve to offset the national costs incurred.

At the regional level, there is an economy that has been rapidly expanding for more than two decades and appears to be poised for continual growth. The changes in federal forest management appear to have modest impacts on this overall rate of growth in the regional economy. In the longer term, maintenance of a high quality environment may be a factor in allowing economic growth to continue.

Much of this regional economic growth is apt to be centered within the more metropolitan areas of the region, and hence these statistics mask much of the hardships that individuals and communities may be confronted with in the decade ahead. Many communities are already distressed, and additional job losses would be forthcoming. The changes in federal forest management will indeed represent severe impacts to many of the individuals, firms, and communities within the region. In addition to job losses, disruption in local government funding is inevitable without compensating legislation. These local economic costs are real and represent a major policy issue in the region -- an issue that cannot be ignored in light of national or broader regional trends to the contrary.

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VII

Social Assessment of Options

Chapter VII

Social Assessment of the Options

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Chapter VII

SOCIAL ASSESSMENT OF THE OPTIONS

...to put it bluntly, we have a mess on our hands... (Hubert Humphrey 1973, in introducing legislation to create the Resource Planning Act)

...to get the practice of forestry out of the courts and back to the forests...(Hubert Humphrey, 1976, speaking in favor of amendments that helped frame the National Forest Management Act)

...a remarkable series of violations of the federal laws, repeated, systematic, deliberate, and political in nature...(Judge Dwyer 1991, in his ruling on the failure of the Forest Service to prepare an Environmental Impact Statement for the Interagency Scientific Committee report)

...I don't want this situation to go back to posturing, to positioning, to the politics of division that has characterized this difficult issue in the past...(President Clinton 1993, in his closing remarks at the Forest Conference in Portland, Oregon)

Executive Summary

Not all is well in the forests and communities of the Pacific Northwest.

There is an image of the northwestern states, conveyed on calendars and coffee table books, of a land of beauty and bounty. It is an image of towering forests, fertile valleys, scenic mountains, abundant fish and wildlife, and a wealth of recreational opportunities.

It is also an image of a productive people, drawn to the region by both its beauty and as a place to make a living and raise a family.

Although this image holds true, within its shadows is a story of potential impoverishment of both culture and biology.

In many forest-dependent rural communities in the region today, unemployment is high, hope is low, and despair has captured many people, as they see their communities, long dependent on the forests where they are located, reeling under changes that have swept across them. As Robert Lee explained to the President at the Forest Conference:

> *We're moving into a process which looks an awful lot like what happened to the inner city. We're seeing the collapse of families, disintegration of families, disintegration of communities, loss of morale, homelessness, stranded elderly people, people whose lives are in disarray because of substance abuse; it's a very difficult situation.*

The disintegration of the social fabric in timber dependent, rural communities has its counterpart in many of the region's forest ecological communities. The once vast forests have been reduced in both extent and complexity by years of overharvesting and human development, impoverishing the rich biological community and bringing many species to the brink of extinction. As Chuck Meslow, speaking to President Clinton, said:

> *At the time of settlement ... the northwest was blanketed with forests ... perhaps 60 to 70 percent was old growth ... over 200 years old. Those stands are mostly gone now. Essentially all old forest has been cut on the private lands. ... on National Forest or [Bureau of Land Management] lands [only] 10 to perhaps ... 50 percent [remains and] ... what remains has been highly fragmented.*

The past decade has been difficult for many rural communities in the Pacific Northwest. In the early 1980's many lumber mills were consolidated and labor forces were reduced to gain efficiency and productivity to be competitive in the international timber market. Mills were not only closed, but dismantled and the pieces trucked away. An era of relative rural wealth in the timber regions of the Pacific Northwest was passing -- mill capacity became more centralized and woods workers became independent contractors not employees. Community studies in the early 1980's found the realization that the old pattern of bust followed by boom would not return led to a malaise among those left behind and to fearfulness among workers and communities yet to be affected.

As the recession of the early 1980's ended, federal timber harvest rose again reaching 5.6 billion board feet by 1987. Apprehension declined in many communities that saw federal timber supply as their future security. Then in 1990, the federal district court put an injunction on timber sales in old-growth forests when the northern spotted owl was listed as an endangered species and old growth forests designated as critical habitat. Efforts to implement a conservation plan adequate to ensure the survival of the owl floundered; new species were listed covering an even broader geographic area; potential listings of threatened fish stocks brought the streams and riparian areas into consideration as critical habitat. Since 1990, land management solutions to ensuring the viability of threatened and endangered species have been ruled inadequate by the district court. As a result, some estimate that by the end of the summer of 1993, most of the timber under contract will be cut.

Again malaise has spread across the Pacific Northwest. This time, however, it is accompanied not only by concerns about the inability of forests to support historical timber harvests and dependent forest communities, but also by the inability of the forests to sustain the complex ecological community. Clearly, all is not well in the forests and communities of the Pacific Northwest. These two themes – timber dependent communities and forest ecology – together define the political issues and values at stake.

It is the clash of values, institutions, organizations, and policy commitments that define this complex policy issue. To break the gridlock of inaction will require moving beyond the politics of division. One wonders how, in a country with our wealth, ingenuity, resources, and capacity, could this have happened?

President Clinton Sets the Stage

On April 2, 1993, President Clinton convened a Forest Conference in Portland, Oregon. The Conference provided a forum for discussions about management of Pacific Northwest forests, from which might come a process to break the gridlock that has gripped forest management in the region.

The Conference is only the most recent chapter in a continuing series of contentious debates about our forests. Popularly characterized as an "owls versus jobs" question, the debate embraces fundamental aspects of our lives: national versus local values, public versus private ownership, short-term versus long-term considerations, individual versus collective rights, and others. It is "more complex than spotted owls and timber supply – it always has been" Thomas et al. (1990, p. 5).

In his closing comments, the President challenged participants "to break the paralysis that presently controls the situation, to move and act." More specifically, he instructed his Cabinet and Administration to craft a balanced, comprehensive, and long-term policy that would, in fact, break the paralysis. This challenge was framed within the context of five key principles:

1. We must never forget the human and economic dimensions of these problems.

2. We need to protect the long-term health of our forests, wildlife, and waterways.

3. Our efforts must be scientifically sound, ecologically credible, and legally responsible.

4. The plan should produce a predictable and sustainable level of timber sales and nontimber resources that will not degrade or destroy the forest environment.

5. We must make the federal government work together and for society.

Underlying his remarks, the President also called for a process based on collaboration, rather than confrontation, one characterized by continuing dialogue and a search for common ground.

Much is at stake here. In the past 5 years, four major scientific task forces have attempted to resolve issues of old-growth forests and endangered species protection. Yet, despite unprecedented levels of expertise and effort brought to bear on these issues, their resolution seems as far away as ever. Moreover, despite the profound consequences these issues hold for people, both in the region and elsewhere, only limited attention has been given to their human aspects, at least in any explicit and systematic fashion. This social assessment affords both an enormous opportunity and an awesome obligation, to remedy this shortcoming.

Purpose and Scope of the Social Assessment

The purpose of the social assessment is to provide policy makers with an understanding of how potential policy options might affect constituents and stakeholders and an analysis of potential effects on important social values and activities. A social assessment must provide accurate and reliable information for the policy making process. In addition, it should clearly state the limits and weaknesses of existing data and discuss what research efforts need to be undertaken to improve it.

A social assessment is, however, a part of the policy process and as such takes as its starting point the problems and issues as defined for the policy analysis. The letter of instruction directed the Forest Ecosystem Management Assessment Team to consider public uses and values, social effects on local communities, social policies associated with the protection and use of forest resources that might aid in the transitions of the industries and communities of the region, and social benefits from the ecological services provided by the alternatives developed. In addition, we were directed, that when locating reserves or developing management guidelines, we should consider the benefits to the whole array of forest values and the potential cost to rural communities. We were further directed to use this information to develop the reserves and guidelines when possible without impairing the conservation plan. In addition, we were directed to identify and assess the benefits and costs of possible additional reserves that are sensitive to scientific, recreational, or cultural values.

The social assessment focuses on these elements: the values and activities at stake and the distribution of social costs and benefits associated with the options under analysis. Our instructions directed that both economic and social consequences, costs and benefits be assessed, and thus this chapter must be considered together with Chapter VI Economic Evaluation of Options. In addition to analyzing the consequences of changes in federal forest policy across the options, we suggest strategies for dealing with expected consequences as well as unanticipated ones. We also identify opportunities for collaboration among resource management agencies and citizens, and opportunities for rural citizens to participate in self-assessments leading to effective new strategies for sustaining rural forest communities. As part of our evaluation, we examine the limits of current research and education and suggest ways to enhance both. In sum, our social assessment covers a wide range of the elements related to the questions and concerns associated with the development of policy options sufficient to address the requirement to develop options for a conservation and management plan for the federal lands in the Pacific Northwest within the range of the northern spotted owl.

Specifically, our objectives follow:

1. Describe the nature and distribution of the social values and uses found in the range of the northern spotted owl.

2. Describe how these values and uses would be affected by the management options.

3. Identify how different constituents are affected by the changes stemming from the options.

4. Identify opportunities or strategies for dealing with the consequences for people.

Within the framework these objectives provide, we seek to understand the nature of the values and uses at stake and the distribution of costs and benefits associated with the options. We suggest strategies for dealing with the consequences and identify opportunities for innovative collaboration among resource management agencies and citizens. We identify areas where limited knowledge constrains informed policymaking and suggest ways in which these constraints might be overcome, through improved institutional structures, increased monitoring and evaluation, research, and utilization of knowledge held by interested citizens.

The assessment must be judged in two important ways. First, **it is to facilitate a policy analysis and is not a research project.** We strive to provide policymakers with an improved understanding of how the proposed options will affect the values and activities of people, including those within rural communities that are dependent on federal timber harvests. Our assessment relies on existing knowledge (in the literature, held by management agencies, and provided by experts). Although it does not test research hypotheses, the assessment does identify key research questions and attempts to alert policymakers as to which priority issues require additional information before informed and effective policy decisions can be made.

Second, **our analysis has been guided by the philosophy of distinguishing between what we *should do* and what we *could do*,** given the constraints imposed on us. The President called for completion of the assessment in 60 days. The geographic area considered is limited to the range of the northern spotted owl on federal lands in northern California, western Oregon and western Washington. State lands, Native American tribal lands, and private lands are not included as directed by the Administration. Consultation with the three states, private sector, Native Americans, and community leaders was also limited. Because forest ecosystems do not recognize ownership boundaries, these limitations necessarily constrain the potential utility of both findings and recommendations. However, all assessments -- biological, technical, economic, or social -- take place in the face of less than perfect knowledge. While acknowledging the limits imposed by the above constraints, we also want to assert that this social assessment represents one of the most significant efforts ever undertaken to examine the social consequences of federal forest management. It complements and supplements traditional measures of economic and technical effects, revealing the profound social dimensions of the forest management debate (Burch and DeLuca 1984).

The following discussion rests on several basic assumptions:

1. The present debate over forest management in the Pacific Northwest is inescapably a social problem that involves conflicting public values, institutions, and power relationships. Because the issue is fundamentally social, its solution must embrace people.

2. The issue is part of a larger set of problems confronting society's decisions and choices.

3. The issue is part of a global, long-term problem; both its causes and its consequences transcend the region and this time.

4. Because the problem is of significant spatial and temporal scale, any solution lies in the formulation of inclusive, on-going processes that transcend administrative, political, and disciplinary boundaries. **Problems that have taken years to take form will not be solved easily or quickly.**

In retrospect, each phase of the social analysis opened new questions. The context of this policy analysis process necessarily focused our attention on some aspects of rural forest communities to the exclusion of others. Naturally, the discussions among participants in the workshops provided a rich description of the social context of the communities, new ways of thinking about rural resource dependent communities, and a thoughtful array of short- and long-term strategies for enhancing rural community life that go beyond the scope of this analysis. These new questions can now provide the basis for continued assessment. In addition, we gathered a wide variety of materials and data across a diverse array of social values and relationships with forests.

The Social Assessment: What Did We Do?

A variety of projects were conducted to complete the social assessment. To the extent possible, each project was intended to supplement and complement the others. Because of the problematic nature of many of the social effects associated with the options, we adopted a triangulation approach whenever possible; we strove to include as many different perspectives as possible. Such an approach seemed particularly important, given the relatively low level and poor quality of existing data, the high level of uncertainty surrounding many key questions, and the multiple, often competing, conceptions of key issues (e.g., community risk). Specific examples of triangulation include the understanding provided through published literature, expert judgments, and review of findings and judgments by independent observers. When results from these various perspectives differed, an effort to discern the cause was made. For example we asked: Were different assumptions being made? Were different time or spatial scales involved?

The following discussion provides a brief summary of projects that were conducted. A detailed description of these various activities, including methodology and findings, is found in specific sections of the social assessment.

Analysis of Public Comments

Many of the issues the social assessment addressed have been identified in the public involvement efforts of the Bureau of Land Management and Forest Service in land planning efforts over the past decade. We examined these records for selected Bureau of Land Management and Forest Service administrative units for key concerns and issues. In addition, a content summary of the proceedings of the Forest Conference was prepared (see Appendix VII-A). We also prepared a content summary of input received in response to an invitation from the Administration following the Forest Conference as a means of supplementing the discussions that occurred there (see Appendix VII-B).

Assessment of Rural Communities

A major concern for the social assessment team was the effect of the options on rural communities throughout the northern spotted owl region. A multi-phase effort was undertaken to help determine the nature and extent of these impacts, their regional patterns, and the opportunities for mitigation.

First, a survey was sent to county extension agents throughout the region. Agents were asked to provide an overall rating of the adaptability of the communities in the face of change and several other types of information about communities in their area of responsibility (e.g., population changes, in-migration.)

Second, two workshops were convened, with participants drawn from a variety of government units to analyze the relative ability of the communities to deal with changes imposed by the options, as well as other factors leading to changes in the region. The workshops provided community-specific levels of analysis, which were summarized in tables and maps.

Assessment of Native American Values

A preliminary review of the particular relation between the management options and Native American lands, rights, and uses was undertaken. Although this analysis was limited by an inability to work directly with the various tribes, it helped identify the critical need to examine these relationships in more detail, given the significant legal obligations embodied in Treaties and Executive Orders related to Native American rights.

Regionwide Assessment of Recreation, Scenic, and Subsistence Values

Outdoor recreation, scenery, wildlife, and related amenity values have long been a focus of public concern. Also interest is growing in forests as a source for a variety of products: firewood, mushrooms, and floral materials. These materials are gathered for personal use and commercial enterprises. A two-phase effort was conducted to understand the range, distribution, and nature of these values within the owl region, and the potential impacts the options may have on them.

First, all Bureau of Land Management Districts and National Forests in the region were contacted and asked to specify the types of information about social values that were available and the form in which it was stored (geographic information system, hard copy maps, and others). This exercise provided a broad picture of data availability.

Forests and Districts were also asked to provide acreage figures for current land-use allocations for a recreation opportunity spectrum and visual quality objectives. The information was used to develop a profile of the current situation, from which it is possible to assess changes resulting from the various management options.

A second project was a workshop for agency representatives from selected case study areas. Participants from the Bureau of Land Management and Forest Service came to Portland for 2 days to help map the location and extent of various social values (such as recreation sites and areas of public concern) and to help the social assessment team evaluate how the management options would affect the current situation. This provided an in-depth supplement to the regionwide descriptive data collected in phase one.

At the close of the workshop, a nominal group exercise was conducted to define barriers and impediments to integrated interagency resource management and to identify opportunities for overcoming them.

Commissioned Papers

A number of specialized papers were commissioned by the social assessment team to provide detailed expert opinion and analysis in key areas. Information contained in these papers is largely incorporated in the text of this report.

Major Findings and Conclusions

This assessment, although restricted in time and scope, produced a rich array of findings. Here we summarize the principle results and conclusions.

Overall findings include:

- The problems facing citizens of the Pacific Northwest are not new, they have no technical solution, and current institutional arrangements sustain them.
- Strong evidence exists that public concern with environmental management in general, and forest management in particular, is significant and enduring; this concern reflects a willingness and capacity to act.
- The social values that forest managers are least able to define and measure is most poorly developed are those that appear to be increasingly important in our society.
- Interdependent social uses and values confound policy formulation when the ecological and social boundaries of an issue transcend political, administrative, and ownership jurisdictions.

Findings for particular portions of the social assessment follow:

Communities

- Communities are not monolithic or uniform in their form or function; a multi-dimensional notion is required.
- Rural forest-based communities are faced with impacts of national and global changes, both political and economic, in addition to those stemming from federal forest policies in the region.
- Variation in allowable sale quantities among the options will differ only slightly in their effects on communities.
- Most negative community effects will be concentrated in rural areas, but some urban areas also will be affected, notably those with substantial forest products

employment. Communities dependent upon recreation, amenity, or other environmental quality resources may be positively affected by the proposed changes in federal forest management.

- Communities that are small, isolated, lack economic diversity, are dependent upon public harvests, and have low leadership capacity are more likely to be "most at risk" than others.

- Both the pattern and severity of consequences associated with changes in federal forest policy differ by states and within states.

- For communities in the three states, there is little difference in the consequences that result from Options 1 and 3, but there is more difference between Options 3 and 7.

- Groups within communities are affected differently by the Options; some groups are better equipped to deal with the changes brought about by the options than others.

- Although poverty in rural forest dependent communities has increased over the past decade for numerous reasons, the current and lengthy gridlock is adding to poverty levels. The increase appears related to a variety of factors that vary by state; in Washington, it appears more directly linked to changes in federal forest management than in California.

- Capacity is an important factor in how communities respond to shifts in federal forest policy or changing state or local funding.

- The desire for stability, predictability, and certainty are key community concerns; attempts on the part of communities to cope with change are greatly constrained by the recent high levels of uncertainty.

Native Americans

- Indian tribes and groups are governments and communities that are potentially affected by the options; impacts on cultural and religious values require special attention by decisionmakers.

- Standards and guides – the specific rules that govern management in the Reserves and Matrix -- have a potential to either constrain or facilitate many of the practices and activities undertaken by Native Americans.

- Tribal members have come to depend on public lands and resources for employment, subsistence, and cultural identity.

Recreation, Scenic, and Amenity Values

- Recreation, scenic, and amenity values have been, and continue to be, key public concerns; however, inadequate knowledge of the nature, distribution, and relation of these values to forest policy changes greatly constrains effective decisionmaking.

- Uncertainty as to how, and what, specific management actions are permitted in the Matrix and Reserve make it difficult to estimate the impacts of the options on recreation values.

- For both recreation and scenic values, the options present opportunities to meet important public concerns and interests.

- Given the conservation objectives and species viability concerns associated with Reserves, it is likely their overlap with dispersed recreation settings will result in additional protection, as well as an opportunity to provide a desired and demanded recreational setting.

- The provision of primitive, nonmotorized recreational opportunities and creation of more naturally appearing landscapes are consistent in many ways with conservation objectives associated with Reserves.

Agency Relationships with Constituents

- Public judgments of the social acceptability of management activities are influenced by beliefs about ecological processes, agency motives, the importance of aesthetics, and the perceived feasibility of achieving alternative forest conditions.

- Although an array of legislative requirements require public involvement in resource management and planning, well-established programs and policies that integrate public input into decisionmaking remain elusive.

- There are a variety of examples of successful collaboration between management agencies and citizens, successes that hold important promise and lessons for improved relationships.

- Ironically, it often seems that agency public involvement programs exacerbate the problem.

- There seems wide concurrence that federal agencies are not working together, at least not as they might or should.

Key Recommendations

Short-term and critical responses to the current gridlock should include the following:

- **Systematic and comprehensive collaboration among all stakeholders is necessary to achieve ecosystem management.**

- **Fundamental changes are needed in the federal land management planning processes that will provide leadership for effective inter-jurisdictional collaboration and problem solving.**

- **A comprehensive, regionwide assessment is needed to analyze the effects of any selected option for federal forest management on communities, tribal rights and values, recreational opportunities, and amenity values.**

- **Because of the immediate impacts on communities resulting from changes in federal forest policy, there is a need to formulate short-term policies and strategies.**

Where to Next?

A long-term response to the gridlock should include the following:

- The forest management issue needs to be recognized as in part a moral question.

- The range of options for responding to the many demands on our resources needs to be recognized as increasingly limited.

- Responsive administrative decisionmaking structures need to be developed, with participative management and shared decisionmaking being key elements.

- Natural resource professionals from multiple jurisdictions must take the lead collectively in interacting with the public to address complex problems.

- Research institutions need to focus on the key questions confronting society and determine how to make the resulting knowledge available to a wide range of constituents.

- Educational institutions need to refocus and become responsive to changing public perceptions and values of forests.

The roots of today's debate over proper management of forests run deep throughout our nation's history. In the next section, we trace a century's worth of evolution in the legal and policy framework on which forest management traditions and current practices rest, a story that makes the situation we face today entirely predictable.

Where Are We and How Did We Get Here: A Historical Overview

Note: this section is based on material provided by Robert Wolf, former Director, Natural Resources and Environment Division, Congressional Research Service, Library of Congress, Washington, D.C.

The lesson of the past 100 years is clear: a tyranny of incremental decisions has led us to the current gridlock. We have yet to find the right way to deal with either our forests or the people who depend on them.

A pessimist might observe that neither government nor industry are capable of understanding or managing complex relations between forests and the diverse demands society places on them. The optimist might suggest that at least we keep trying.

In 1993, we try again, and the clock keeps ticking.

The Present Day Forest Crisis Has Long Historical Roots

The nineteenth century "cut out and get out" era of migratory forest harvesting in the United States spawned a political reaction that culminated in a reform movement – conservation. After the Civil War, the ravages of war, railroads, and commerce on the forests were extensive enough to become of political concern to many, including the newly forming scientific community. Western lands were suffering from increasing levels of timber harvest as well as substantial grazing. In the mid-1800's George Perkins Marsh and Charles Darwin focused the attention of scientists, politician, and citizens on the environmental consequences of human use.

On the public domain lands, concerns rose that illegal lumbering was consuming vast acreages of valuable timber rendering the land worthless for sale to bona fide settlers and businesses. To stop these practices, in 1891, Congress authorized the President to "set aside and reserve" lands to be designated as forest reserves. To the dismay of some, the forest reserves were reserved from uses other than local needs of settlers. As long as the reserves were few and existing uses and land claims unaffected, nothing came of the discontent.

In 1897, President Cleveland added 21 million acres to the Forest Reserves. These areas included lands where Anaconda and Homestake Mining companies had major operations. Placing these areas in Reserves prohibited mining as well as timber cutting for the mines. These actions led to the 1897 Organic Act, as part of the General Appropriations Act of June 4, 1897 (Chapter 2, 30 Stat. 34). The 1897 act declared that:

> *no public forest reservation shall be established, except to improve and protect the forest within the reservation, or for the purpose of securing favorable conditions of water flows, and to furnish a continuous supply of timber for the use and necessities of citizens of the United States; but it is not the purpose or intent of these provisions, or of the Act providing for such reservations, to authorize the inclusion therein of lands more valuable for the mineral wealth therein, or for agricultural purposes, than for forest purposes.*

The Early Fashioning of a Forest Conservation Policy

Between 1876 and 1910, much of what became "forest conservation policy" was fashioned by activists of the era, many of whom were scientists. This conservation movement was galvanized by the effects of logging activities on forests in the Appalachian Mountains and mill closures on towns as well as across the South and Great Lakes states. Central themes of the conservation policy, as compiled by Gifford Pinchot (1910), were:

- The lumber industry should develop roots, not *cut out and get out.*
- Selective cutting should prevail, leaving much of the forest for future harvest.
- The forest should be protected from railroad engine fires, as well as natural and human-caused fires.

- Practicing forestry would protect watersheds and soils.

During this time, concerns with revenue from public lands continued. Officials in the Department of the Interior, responsible for administering the Reserves, worked with Pinchot and the Bureau of Forestry to develop plans that would allow for orderly and predictable harvest of public forests. Nevertheless, the revenues were small, partly because of the lack of markets and partly because the Organic Act stipulated that timber sold must be used within the state and not be exported. As fraud and theft became greater problems, as population increased near Forest Reserves, concern with how to regulate use and enforce boundaries grew. The vastness of the area and the small size of the budget and administrative staff precluded any effective administration or enforcement. In this climate, the concept of forestry as a method of managing and paying for the management of the Forest Reserves grew ever more attractive.

Supported by a 1905 national convention on forest conservation, Pinchot, in a second try, secured transfer of the Reserves to his Bureau of Forestry in the Department of Agriculture. He promised that, if provided an appropriation of $1,000,000 a year and receipts, he would cover all costs by 1910. Pinchot's central argument for transfer of the Reserves to Agriculture from Interior was that he would make the Reserves profitable; something Interior had not done. The premise of his forest conservation policy was that a small amount of immediate profit might be lost in practicing forestry, but there would be perpetual profits, more livable towns, stable logging operations, and gains to society (e.g., fire protection, protection of water flows, protection of the productivity of the land).

Lumbering continued its march across the country, until in 1910 lumber production peaked at 44 billion board feet. At this point, the Pacific Coast states together accounted for 17 percent – 7.5 billion board feet – of this total. However, the National Forests contributed only 1.1 percent of the national lumber supply (484 million board feet). Nevertheless, 104 million board feet (21.5 percent) came from National Forests in the three Pacific States. Indeed, as is commonly recited, public timber was only a minor part of the U.S. timber supply through the 1950's. In 1950, the National Forest contribution to timber supply in the Pacific states was 1.6 billion board feet, or a bare 8 percent of the total 3 state harvest of 20 billion board feet. The rapid sweep of lumbering across the country accompanied the transformation of society from a rural agrarian collection of small communities to an urbanized and industrialized society. Wood fueled and built this industrializing economy. Slowly, fossil fuels replaced steam and home heating turned to coal, oil, and gas. Electricity soon powered lights and then industry. Nevertheless, the land use issues created by rapid harvesting of forests across the country continued to shape natural resources and land policy over the next decades.

The debate over private land practices extended into areas regarding wildlife, fisheries, livestock grazing, and mineral leasing policy. Since the turn of the century, policies for these natural resources have included setting aside land reserves for migratory wildlife, developing exploration and leasing programs for minerals in the sub-surface public domain, and regulating use of public domain for livestock grazing. The large proportion of the public domain lands were never specifically reserved for special purposes, however, and these lands were put under the jurisdiction of the Bureau of Land Management when it was created in the Department of Interior in 1946. Prior to creation of the Bureau of Land Management, the Taylor Grazing Service in U.S. Department of the Interior regulated grazing allotments on the public domain and the

General Land Office disposed of land to settlers, miners, and other claimants. These two functions were combined to create the Bureau of Land Management. Although the policy of disposing of the public domain did not change until 1976 in the Federal Land Policy and Management Act, little land was transferred after 1946. Further, the grazing service moved toward professionalization after 1946, and university degrees in agriculture science and range conservation became more commonly the prerequisites for hiring (Gregg 1979). Generally speaking, the federal natural resources agencies moved toward hiring university educated specialists, and away from local people with knowledge of particular places and experience in resource-based activities such as ranching, logging, or mining.

Even in states with significant portions of federal lands, much of the federal domain is characterized by complex patterns of intermingled land ownership. As the principles of forest conservation policy took root on federal lands through various laws and policies, actions by other landowners, seen as inconsistent with them, were defined as in need of correction. Three basic ways were open to secure correction: education, subsidies, and regulation. Education was applied through the information system already in use in agriculture. Indeed, demonstrations had been subsidized on private lands since 1899, when Pinchot took over the Bureau of Forestry. Regulation of private land practices was, and remains, a volatile policy debate.

Achieving Security and Stability in Timber Supply

During this period, in response to the central themes of security and stability, two other demonstration strategies were developed. First, from 1910 to 1950, over 50 long-term National Forest "development" sales of timber were made. Development sales were based on the technology of railroad logging and could encompass a whole watershed. The theory was that the company would begin construction of the railroad at the bottom of the watershed and cut timber as railroad construction moved upstream. Logically, by the time the upper reaches of the watershed were accessible for harvest, maybe 50 years later, the areas initially harvested would be nearly ready to cut again. Typically, these were at least 20-year contracts (often longer), with fixed prices for the first 5 years and subsequent prices geared to the lumber market. Based on the "working circle" concept, these sales created an operating area for the bid winner that became a little monopoly. The Forest Service often encouraged companies, especially those with intermingled land holdings, to apply for these long-term contracts on the theory that the availability of federal timber would produce more permanent and stable operations.

Second, David T. Mason (Loehr 1952), a consulting forester in Oregon, advocated a grand plan that pooled land held by large companies with federal land under 99-year, "sustained yield" agreements. Faced with fluctuating markets and prices, Mason argued for a sustained production interpretation of "stability." Such federal-private agreements would lead, he believed, to a stable supply, firm prices, and adequate timber. However, this forestry practice also meant that long-term investments of time and money would have to be made by both the company and the government. It is useful to note that this concept of sustainable production is in contrast to the Forest Service vision of sustained supply.

Sustained production combined with sustained supply were ideas of their time. Modern corporations were evolving as vertically integrated and managed systems of predictable inputs aimed at producing predictable levels of outputs. The economy was viewed as a collection of economic actors (individuals and firms) making self-interested choices. To secure the desired goals, one only had to pull the right levers, and response would follow as rational actors made rational choices. To proponents of sustained production and sustained yield, the problem was to get the system right -- right behavior would follow. Scientific management seemed the logical means to securing economic, technical, and administrative rationality.

The concentration of power in a few corporations and houses of finance concerned populists, and the latter decades of the 19th century saw the emergence of federal regulation as an alternative to public ownership of utilities, railroads, and transportation. In this political context, however, the forest reserves were already in public ownership and proponents of public management found a ready opportunity to try out ideas of scientific public administration.

Nonetheless, although scientific management could secure the sustainability of federally owned timber, what could secure the nation's supply of timber? This concern with supply, combined with the fact that the vast percentage of forest land was privately owned, spawned a movement for federal regulation of private timberlands. Proponents of regulation believed simply that the correct incentives, like stable prices in return for stable production, would produce the desired outcome -- sustained-yield forestry.

Federal regulation was hotly debated for 50 years, but proponents saw an opportunity to indirectly regulate private lands through sustained-yield agreements with federal lands. The "carrot" of secure access to public timber could indirectly promote the virtues of stable timber supplies, stable communities, good land management, and reasonable supplies. "*More and more individuals, companies, and communities were becoming actively interested in sustained yield. Some communities suddenly woke up to the realization that their existence depended upon the sustained yield of the forests*" (Loehr 1952, p. 195). Nevertheless, many timber companies did not heartily embrace this concept. Actual sales on federal lands remained small and few, and during the 1930's, depression fell to practically nothing.

In 1937, a new opportunity emerged for promoting the sustained yield concept based on allocating federal lands to companies, with the enactment of the Oregon and California railroad land grant. David Mason testified before Congress and was successful in inserting the germ of this idea into the Sustained Yield Act of 1937 (50 Stat. 874), which charted the course for 2 million acres of land administered by the Bureau of Land Management in western Oregon. These lands are the residual of a revested railroad land grant, and thus are in a checkerboard pattern. Mason's idea was to divide these lands into marketing areas and to allocate some 90 percent of the timber to 30 firms with intermingled timberland. However, when the first serious effort was made to create such a unit in 1948, with the now defunct Fisher Lumber Company located in Marcola, Lane County, Oregon, it created a firestorm of opposition from non-timber firms and labor organizations. Despite the existence of the law, there were no company sustained yield units carried out on O&C lands under the 1937 Act (Williams 1993a, p. 5).

Support for the concept of sustained yield within the Forest Service remained high. During testimony on the 1937 Act, Forest Service Chief F.A. Silcox described the boom and bust timber communities common in the Great Lakes region. He recalled many communities that were "*dependent on forest resources and later abandoned when those resources were exhausted. Whole communities had been wiped out when timber had been treated as a mining resource, rather than as a reproductive resource*" (Loehr 1952, p. 195).

As early as 1935, the Willamette National Forest in Oregon, in conjunction with the U.S. Resettlement Administration, proposed to declare the communities of Westfir and Oakridge eligible for rehabilitation as forest-dependent communities (Williams 1993a, p. 5). Ten years before, these same towns were part of an unofficial sustained yield area in the drainage of the North Fork Willamette River. In 1935, they were being studied to determine the best way to "*eliminate direct relief, elevate living standards, and fortify the community against sub-normal economic conditions* [brought on by the Depression]" (USDA Forest Service 1935, p. 1). For 3 years, these communities were studied (USDA Forest Service 1938), but no federal help arrived (Williams 1993b, p. 5).

David Mason persisted in his effort to make sustained yield a national policy. His persistence paid off when, in 1944, Congress passed the Sustained Yield Unit Management Act. This Act provided broad authority to use federal land to secure long-term agreements by private timberland owners to manage their lands under sustained yield provisions. One was created between the Forest Service and Simpson Timber Company, under a 99-year agreement. In addition, the Forest Service created five "community units" -- no private land committed. One was at Grays Harbor, Washington, near the Simpson unit. However, this area failed to supply enough timber to maintain the mill capacity then in Grays Harbor.

Other "community" units were created in the West: one in Lakeview, Oregon; two very small ones in Big Valley, California and Vallecitos, New Mexico; one near Flagstaff, Arizona on the Coconino National Forest (now abolished). For the most part, these units were islands of timber physically separated from other sources. No units were created where the cross-currents of competition swirled. Indeed, attempts to do so were thwarted at the time by the alert opposition of organizations representing mills that did not own timberland and labor unions. However, the **idea that federal timber could stabilize production, stabilize prices, assure sustained yield cutting on industrial lands, and maintain employment were powerful expressions of the principles of stability and security**. Nevertheless, these principles were directly contradictory to the dynamics of a market economy, especially after World War II.

Up to the 1950's, the Forest Service generally practiced long-rotation forestry with a typical rotation of 120 years or more. The "timber primacy" of this era is in a context of normative values of what kind of forests there "should be" in different regions of the country. The reigning view was that the "pre-European settlement" forests should be restored. In many parts of the country, most notably from a policy perspective the Monongehela National Forest in West Virginia, the centuries of use had transformed the pre-European settlement forest totally. Thus, restoring this normative image of the ideal forest could easily ignore the existing uses and values of local people and the American public.

Public forestry, as promoted by the Forest Service, continued on its multi-pronged approach of education, subsidies, and regulation from 1920 through 1950. After public statements by the Chief of the Forest Service that the agency would no longer advocate regulation of private forest lands, the other two elements remained. Both education and subsidies drew from basic utilitarian concepts of the forest that embodied the idea of multiple dominant uses (Wolf 1990, p.32). The increases in demand for wood, forage, recreation, and water led to various attempts to change Forest Service direction and authority from 1948 onward.

Multiple Dominant Uses or Integrated Multiple Uses?

Many argue that what won World War II was outproducing the enemies in war materials; indeed, after the first year of American involvement, United States' war material production was greater than all the allies combined. This feat exhausted the timber supply on many private industrial lands, and for the first time, timber harvests on the federal forests began to rise. Foresters, trained to see their mission as producing the lumber needed by society, took up this challenge in the Forest Service.

In pursuit of increased per-acre yields, the Forest Service dropped its pursuit of "pre-European settlement" forests. In response to alleged timber shortages, foresters sought to increase yields through the "allowable-cut effect." In essence, the concept meant that younger, faster growing trees on every acre of commercial forest land would produce greater yields than the larger, slower growing trees already there. Thus, the agency moved to "liquidate the old growth" as rapidly as possible. During the 1950's and early 1960's, this shift in timber management philosophy lead to the agency shrinking the areas administratively designated as wilderness, wild or primitive in order to gain access to the timber. Nevertheless, the Forest Service could not produce as much timber as its proportional land base might suggest because of the low biological potential to grow timber on most of the lands (Waddell et al. 1987).

World War II brought unexpected affluence to working people in America. Personal incomes began a steady rise and reached the highest level in the history of the world in the late 1960's. In addition to purchasing refrigerators, washing machines, cars, and houses, working people gained leisure time, and on the new highways being built across the country, flooded into the forests and parks.

Americans valued wood for houses and also valued forests for leisure and recreation. Since the 1920's Forest Service administrative policy recognized both the wood products and the wilderness values of the forests. But foresters continued to place higher priority on the wood products values, and were willing to trade away the wilderness values to gain greater timber outputs. Recognizing this opportunity to increase the size of the National Park system, the Park Service set out to have lands designated as valuable for recreation and transferred to it from the National Forests. Their successes in this effort lead the Forest Service to try to protect the National Forest System from becoming only "timber lands." Thus, the Forest Service conceived of the Multiple Use, Sustained Yield Act of 1960 to give it specific legislative authority for "outdoor recreation" (the "outdoor" put it at the front of the alphabetical list of multiple uses). While this Act slowed the transfer of lands to the Park Service, the foresters view of multiple use was frequently ridiculed as "many ways to use timber."

While the wilderness battles expanded the size and scope of both the Sierra Club and the Wilderness Society, broader social concerns with nuclear fallout, water pollution, air pollution, endangered species, along with toxic pollutants of all kinds galvanized a broad social movement -- environmentalism. The proliferation of local, regional and national environmental groups politicized federal forest management by greatly expanding the stakeholders and organized constituency groups managers had to work with. The story of federal forest management from 1960 to now is sadly one of denial that forest land and resource allocation decisions are fundamentally political choices amongst values (Cortner and Richards 1983). The scientific model of forest management hid this political reality.

In the midst of the contentious battles of the 1960's, Behan (1966) criticized professional foresters for seeking to determine the purposes of forest management based on their view of "what's good for the land." Calling it the "myth of the omnipotent forester," he argued that:

> *As foresters we can supply the technological means to these sociological ends, and not confuse the one with the other (Behan 1966, p. 400).*

The debates of the 1950's and 1960's centered around the increasing diversity of social values versus the strong commitment of the Forest Service to intensive timber management. The lack of agency respect for the "multiple uses of the forests" led to the use of federal legislation directed toward specific "multiple uses" ranging from trails to scenic rivers to wild horses and burros. By the late 1960's, this battle over values culminated in the acrimonious legal challenge of the Forest Service's interpretation of "multiple use." Around the country -- from Alaska, to Oregon, to Texas -- lawsuits contended that the agency violated the letter and spirit of the Multiple Use Sustained Yield Act with its narrow interpretation of "multiple use" as many ways to use timber. The motivation for the lawsuits was public dislike of clearcutting, but most of the suits based their reasoning on how clearcutting violated multiple use. Expectedly, given the standards of judicial review of administrative decisions, courts found each time that interpretation of broad statutory mandates are "committed to agency discretion."

The environmental movement grew exponentially at the close of the 1960's; April 22, 1970 was celebrated across the country as the first Earth Day. The idea of Earth Day was conceived by Gaylord Nelson, principal architect of the National Environmental Policy Act of 1969. On November 18, 1970, the "Bolle Report" on timber practices on the Bitterroot National Forest in Montana was delivered to Senator Metcalf. The Report, "A University View of the Forest Service" (Senate Document 91-115, December 1, 1970), found that the timber bias of the agency led to "timber mining" not sustained yield. This report enraged many foresters in the agency, but led Congress to reconsider how to make federal forest management accountable to both the local people who depended on the resources and the national public trusting in agency stewardship. From this dissension came the call for increased rationality and for a longer time frame in the making and implementing of forest management. Thus, **the response to the obvious politicization of public forest management was more scientific management -- rationality would be achieved when all of the values were placed in the same decision framework.**

The theory of the 1974 Renewable Land and Rangelands Resources Planning Act (16 U.S.C. 1600-1614, August 17, 1974) is central to this history. Consistent with 175 years of national policy regarding public lands, **the Resources Planning Act required the development of national thinking and national planning on the federal lands.** This national perspective necessarily included all of the nation's lands and renewable resources. The first requirement of the Resources Planning Act was for the Forest Service to develop an Assessment of the Renewable Resources of the country. The Assessment, consistent with costs and other uses which federal lands can best provide, was to cover all lands, all renewable resources, all current and expected public demands for resources and forest products of all kinds, and especially to consider "emerging resources". Thus, the Assessment fit the traditional role of the federal government to provide information for the development of public policy. Based upon the Assessment but consonant with the limitations of federalism and private property, the Forest Service

was then directed with providing a national plan for the national forests subject to meeting the federal share of the resource supply requirements as well as with complementing surrounding land uses. The intent was to develop a national program for the national forests that placed them in ecological, social, and economic context. **This entire process was expected to lead to a more rational, stable, and secure program of Forest Service management, budgets, and personnel.**
The Resources Planning Act was formulated while the agency was in court over the interpretations of multiple use. One purpose for the Resources Planning Act was to get the agency out of court. To date the agency had prevailed in each challenge to its interpretation of multiple use. However, the West Virginia Division of the Izaak Walton League contended that the silvicultural practices of the agency violated the 1897 law specifying the conditions under which timber could be harvested:

> *For the purpose of preserving the living and growing timber and promoting the younger growth on national forests, the Secretary of Agriculture, ... may cause to be designated and appraised so much of the dead, matured or large growth of trees found upon such national forests as may be compatible with the utilization of the forests thereon, and may sell the same.... Such timber, before being sold, shall be marked and designated, and shall be cut and removed under the supervision of some person appointed for that purpose by the Secretary of Agriculture....(*16 U.S.C. 476)

The Forest Service, having prevailed in Alaska on March 21, 1971 (Sierra Club v. Hardin, 325 F.Supp. 99) when the District Court agreed with the agency that "presale markings of individual trees would be so onerous that only isolated sales on small tracts could be made," was confident it could continue to win on the basis of seventy years of de facto silviculture. Congress was writing the Resources Planning Act at this time and Senator Talmadge offered to insert language in the bill changing the statutory language for timber management. Confident of winning in court, neither the agency nor the industry wanted the language to appear in the bill. When the West Virginia Division of the United States District Court ruled in favor of the plaintiffs, both returned to Congress to get the language reinstated. To the dismay of the agency, the Fourth Circuit United States Court of Appeals agreed with the District Court and ruled the timber management practice of clearcutting illegal (West Virginia Division of the Izaak Walton League of America, Inc. et.al. v. Butz, U.S. Court of Appeals, 4th Cir., Aug. 21, 1975). This "crisis of authority" was the impetus for new legislation.

The National Forest Management Act is an accidental amendment to the Resources Planning Act. With the necessity for new legislation to change the statutory authority for timber management, a House committee staff lawyer suggested it be added to the Resources Planning Act that had just been passed the year before. To ensure that the National Forest Management Act fit with agency policy and would provide the kind of authority deemed necessary, the Chief of the Forest Service was part of much of the deliberations over construction. In this role, the Chief of the Forest Service, John McGuire, testified continuously that the requirements of the National Forest Management Act were achievable and in most cases consistent with agency policy.

In one sense, the overall vision of the National Forest Management Act continues the belief in scientific management and emphases rationality as a product of comprehensive assessments and planning. In contrast to previous legislation, the Act prescribes acceptable management practices, restricts the application of clearcutting, requires analysis of suitability of land for timber harvest and the designation of lands unsuitable, and requires that integrated national forest plans be prepared and serve as the governing documents for forest management. Consistent with nearly all federal legislation then and since, the Act was based on responsiveness to the full range of public values in forests, including emerging values. In these and other ways, the Act was strikingly different than existing agency policy and management direction. In part the intent was to get federal forest management out of the courts and back in the forests. To accomplish this, the agency needed an "early warning system," in the words of Senator Henry Jackson, and with the "facts" in hand be able to continuously evaluate the appropriateness of actions and then change management direction and projects as warranted.

At the same time that Congress was crafting the Resources Planning Act and National Forest Management Act, it was working on giving clear management authority to the Bureau of Land Management in the Federal Land Policy and Management Act (43 U.S.C. 1701 et seq., October 21, 1976). The Act also adopted a comprehensive planning and problem-solving approach to federal land and resource management. The express intent was to increase the rationality of management by increasing the accountability of management decisions to public values, science, and ecological reality. **This forward-looking approach was intended to enhance national thinking on public lands, and to ensure consideration and responsiveness to the full range of social values when making land management decisions.**

Responsive Planning Flounders on the Shoals of Politics

> *The Forest Service now confronts a political resource-allocation task in addition to the traditional scientific land management task to which it is accustomed. The decision-making process, however, remains one based on technical expertise. It provides no means for resolving the disputes that inevitably arise. It cloaks political problems in technical analysis* (Wondolleck 1988, p. 153)

Wondolleck found the same problem social scientists have been consistently documenting since passage of Resources Planning Act/National Forest Management Act (Cortner and Schweitzer 1981, 1983, 1993; Cortner and Richards 1983; Shannon 1981). Adding more rows to the linear program models did not lead to politically responsive decisions.

The planning and management processes called for by these Acts ran into the same problem as the Multiple Use Sustained Yield Act -- power concentrated in the timber management division and maintained by annual budgets. Of particular interest here in the Pacific Northwest, the ideal forest as fully regulated stands of very valuable sawlogs persisted as the governing value of the forest. The national forest plans of the 1980's posed the image of the fully regulated forest as the goal of federal forest management.

Associated with this image, the specter of waste through mortality and nonuse dominated professional forestry discussions for decades. The silviculture staff argued that it was essential to cut trees to reduce mortality from age, insects, or fire. Obviously, such mortality is spread throughout the forest and across the age classes of trees. When, however, clearcuts are laid out to sell the most valuable trees based on accessibility, from a silvicultural standpoint this approach does not effectively address the problems of mortality. Silviculture, thus, remained separated both from the timber management staff and from ecological reality. Nevertheless, the timber sale levels remained high with fluctuations in harvest levels caused by the market -- not shifting agency policy. And, although timber management rests on the gathering and evaluation of relevant facts at the district and forest level, the timber program is funded based upon policy developed by the Forest Service, the Department of Agriculture, the Office of Management and Budget, and the Congress. Thus, the ultimate control of timber harvest schedules was, and is, a closely held source of power in the upper echelons of the agency.

What are viewed by many as "promises to the communities" might be more accurately seen as rhetoric used to shield agency preoccupation with alleged timber shortages from critics. Whether in the debates over Wilderness designation or forest plan analysis of suitable lands, the rhetoric of "dependent communities" served the purpose of justifying harvest levels in excess of local growing stock. Theories of "one supply" for public and private lands encouraged private owners to liquidate their timber inventory in the expectation of drawing upon public timber while theirs grew back. The costs of holding federal timber under contract are low, and thus it was rational for companies to buy more sales than they expected to cut in a year. As a result, the timber under contract remained high, reaching four times the annual harvest by 1981 (approximately 11 billion board feet were under contract).

From the late 1970's, timber under contract averaged 11 billion board feet (Bbc). In 1987, while the timber under contract was still 11 Bbc, 5.3 Bbc was offered that year for sale, 5.3 Bbc sold that year, and 5.6 Bbc actually harvested. In 1988, timber under contract dropped to 10 Bbc, in 1989 to 7 Bbc, in 1990 it was 8 Bbc, in 1991 it dropped to 5 Bbc. Nevertheless, the cut vacillated between 4 and 5 Bbc until 1990 when it dropped to 3.9 Bbc and then to 3.1 Bbc in 1991. More telling is that while 5 Bbc was offered for sale in 1990 and 4 Bbc purchased, only 1 Bbc was offered in 1991 and 2.1 sold (the extra 1 Bbc is the holdover from 1990). This sharp decline is not due to changed policy commitments by the agency, or to new silvicultural knowledge, or to reduced power in timber management staffs, or even to the new ecosystem management direction. It is due to a court injunction requiring the agency to justify the harvest of remaining old-growth forests that provide habitat for several species and are highly valued by society for a whole range of uses and purposes.

The crisis of today is caused by not allowing forest planning to be an "early warning system" as Senator Jackson envisioned. It is caused by not practicing multiple use management wherein all of the resources are valued and managed on a sustained-yield basis. It is caused by not providing adequate rationale for liquidation of old-growth trees when the "allowable cut effect" was discredited as silviculturally impossible. It is caused by not embracing a vision of the federal forests as repositories of diverse resource values but rather holding a narrow definition of the value of forests as commercial timber lands. It is caused by ignoring the comments of people around the country on forest plans, wilderness designations, wild and scenic river designations, and even on Resources Planning Act programs. At every opportunity, the American public states that the Forest Service is the steward of conservation on the federal forests, and should provide for the diverse range of values and resources found on federal forests -- and often found no where else in the country.

Rhetoric today still pits isolated rural communities against the urban leisure users or rare wildlife species. However, in every instance of a successful challenge to the rapidity and extensiveness of timber harvest on public lands, it was a local community who raised the concern. On the Monongehela, it was the turkey hunters worried that the clearcutting of the forest would eliminate the turkeys which were culturally important to them. On the Bitterroot, local environmentalists as well as local loggers who worried that the rapid cutting of the trees would end their jobs soon joined in raising the concerns with the rate of clearcutting. On the Bitterroot, the issue of timber mining versus sustained yield when the costs of regeneration greatly exceeded the value of the timber harvested was pointedly analyzed. From that time forward, the issue of "below cost" timber sales has remained a contentious one (Cortner and Schweitzer 1993; Wolf 1990).

Why have the Forest Service and Bureau of Land Management failed to adequately incorporate the diversity of values recognized on the public lands? One has to ask this question in reverse to seek an answer: why have the agencies remained focused on the production of timber to the exclusion and even degradation of the other resources and values within their mandates? The institutional commitment of organizations to programs is a frequent topic in academic research. In this instance, the convergence of training, career paths, reward structures, incentives for meeting timber targets, the need to maintain markets in order to meet timber harvest targets, the professional society and its value commitments, the organization and power of functional program staffs, and the annual appropriations from Congress that provides specific funding for timber sales and road building all maintain the policy commitments of the agencies.

The challenges of land management, however, are not in the production of sawlogs or fiber. Rather, the challenges of land management are in the rural-urban interface where people are moving into the forest lands and living right next to national forests or resource districts. The continuing diversification of the face of America is bringing new demands for forest products like mushrooms, beargrass, decorative greens for floral arrangements. New technologies are developing new products used for medicinal purposes from forest products like yew trees. Issues of ethnicity regarding resource use patterns, of cultural diversity in the exploration of new forms of leisure, of workforce diversity in the shifts of residential use are likely to be the challenges of federal resource management in the 21st century.

Conserving rural communities from a national policy perspective may require new visions of the relationship of federal resources to commercial users. The simple relationship of harvest level and community stability was, in fact, never simple and never ensured. Past efforts to constrain commercial enterprise in the interest of stability have seldom gained much support from business. Today the demise of timber-dependent communities follows the pattern of the last centuries. However, the stability of communities is not a timber supply problem; it is a social and economic policy problem. To adequately address the relationship between federal land management and communities whose primary employer is a timber company fully dependent upon federal timber requires innovative social, labor, and economic policies.

Ecological Problems Are Social Problems

The current debate surrounding forest management in the Pacific Northwest is often framed in polar terms: owls versus jobs, economy versus environment. Unfortunately, such a conception obscures the multi-faceted nature of the problem, pits neighbor against neighbor, and acts to discourage the search for common ground.

This is Neither a New, Nor a Regional Problem

These difficult issues that command our attention today took root over a century ago; today's headlines are merely the most recent manifestation of our continuing struggle to make decisions about those things that matter most to us. From the Wilderness Act to the Roadless Area Review and Evaluation, to the spotted owl controversy, **the central debate revolves around unroaded old-growth forests.** Today's dispute represents only the latest act in a century old play. Moreover, the debate about appropriate forest management is not confined to the Pacific Northwest. The fundamental issues that underlie disputes about jobs, old growth, and endangered species can be found throughout the nation, as well as around the world. Consequences of decisions that eventuate in the region and of the processes through which they are reached, will reverberate across the country and beyond.

This is Not a Scientific Problem

Many factors contribute to the intransigence of this conflict, but a key reason is the failure of the natural resource management profession (as well as society in general) to acknowledge its fundamentally socio-political and value-based character. Natural resources are human constructs; it is through the perception of value and utility that features of the natural environment come to be defined as resources. As these social conceptions of value change, so do the definitions of a resource and our conceptions of what constitutes appropriate management; witness how the discovery of the Pacific Yew as a source of the cancer-treatment drug, Taxol, has led to the species changing from a weed to a valued forest resource.

If these problems are not new, local, or scientific, what are they? To answer this, we must first acknowledge that **forest management is inherently a political undertaking.** It is so, not in the partisan sense of "being political," but in the sense that it involves the production and distribution of values, whether commodity, amenity, spiritual, or scientific -- in society to meet the needs of people. In this framework, **science is a means to an end; it is a mechanism through which we obtain information about possibilities and consequences.** Science will yield few, if any, "answers"; answers are found in the choices made in the policy arena. Good science is necessary but not sufficient condition for sound policy.

What then is required for sufficiency in a policy context? The answer is embraced in the notion of informed governance. Yankelovich (1991) has observed that *a major barrier to making effective and informed choices in the complex world in which we live is the lack of forums in which the process of "working through" can occur.* That is, our society lacks places in which people can learn, question, debate, and come to an informed judgment of what choices are best. When the options involve complex, problematic, and ambiguous choices (features that characterize many environmental issues), when experts disagree (Schwarz and Thompson 1990), how can citizens come to informed judgments? How can they act in a responsible fashion to govern?

There are no easy answers to such questions. Indeed, **it is the lack of appropriate institutional structures to facilitate such a process that explains our inability to resolve forest management conflicts.** A key starting point is recognition that these problems are not a function of insufficient scientific understanding, and are not amenable (with sufficient time, money, and skills) to scientific solution. Rather, they are inescapably social problems that demand social solutions which address fundamental questions about the values that we seek to satisfy. Science can and should inform these difficult value choices, but it cannot make them.

The inability to respond adequately to changing socio-economic conditions has placed the forest management agencies under intense public scrutiny. Several features characterize the current situation:

1. An intensified political context for decisionmaking about forestry issues.

2. Diminished trust in forest management agencies and a perception that forest management does not represent the broad public interest.

3. Dissatisfaction with forest management programs and the processes that established those programs.

4. Fragmented administrative, organizational, and disciplinary structures and institutions that diminish the capacity of forestry agencies to be responsive.

5. Concern with the spatial and temporal dimensions of programs, as well as the linkages between different components of the ecosystem.

6. Concern with the lack of agency responsiveness to emerging understanding of ecosystems across space and time, and consequent agency inability to provide people with understanding of the long-term consequences of policy and management decisions.

With this review of history and the nature of the current forest management controversy as background, we now focus on the many values that forests hold for society.

Defining and Measuring the Values of Forests to People

The public debate about forests in the Pacific Northwest is only part of a wider debate that is occurring at the national and global level. Increasing public concerns with a host of forest values – commodity, amenity, spiritual – have elevated this issue on the political agenda, not only in the Pacific Northwest, but at the international level. Headlines in newspapers, such as *The Oregonian, The Wall Street Journal, and The International Tribune*, reflect the growing public concern with forestry and environmental issues.

This growing concern with the environment, from the international to local levels, appears linked to some fundamental structural changes taking place in industrialized societies. Shifts in educational levels, population distribution, and composition and make-up of the labor force all combine to bring increased concern with issues related to the quality of life and other types of personal attitudes, including natural resources and the environment. The development of environmental consciousness and the environmental movement has challenged many traditional political and economic institutions (Steger et al. 1989; Van Liere and Dunlap 1980). More profoundly, these changing value orientations within society have led to changing expectations concerning the management of public lands.

Values About the Environment are Changing Globally

Not only have value changes occurred in the industrialized nations of the west, but increasingly we find evidence of their occurrence around the world. Increased scientific knowledge concerning the ecological consequences of human activities, worldwide communication networks, and the growth of the mass media all contribute to this phenomenon. As Caldwell (1992, p. 64) notes:

> *worldwide communication made possible the spread of information on all issues of universal concern, and threats to the human environment are prominent among them.*

For example, responses from selected nations to a 1992 Gallup International poll ("The Health of the Planet Survey") reflect a high level of citizen awareness of environmental deterioration and support for environmental protection throughout the 22 nations surveyed (table VII-1). Those nations where environmental problems are likely to be seen as serious include both the rich (e.g., the United States, Germany) and the poor (e.g., Mexico, Hungary). Generally, respondents are more likely to rate their nation's environment as worse than that of their local community. Most striking, perhaps, is the clear perception on the part of most respondents that the world environment is in bad condition. With the exception of respondents in India, Turkey, and The Phillipines, between 65 to 90 percent rated the world environment as fairly bad or very bad.

There is also specific concern with loss of species and rain forests at the international level. Respondents in most nations reported that such losses were a very serious concern (table VII-2). In all but two nations (Japan and Korea), 45 percent or more of respondents rated the loss of species as very serious. A majority of respondents in 20 of the 22 countries surveyed described the loss of rain forests similarly. Obviously, concern for the environment in general and the loss of species and rain forests specifically is not unique to the ongoing debate regarding forest management in the Pacific Northwest. Moreover, the presence of such global concern suggests that the future of the Pacific Northwest forests is an issue whose resolution is under scrutiny, not only within the region, but also around the world.

Environmental Attitudes Across America are Changing

In a recent review of trends in American public opinion toward the environment, Dunlap (1991) concludes the following:

- Public environmental concern grew dramatically in the late 1960's, coinciding with other new social movements.

Table VII-1. Rating of environmental quality in local community, nation, and the world.

Percent Rating Very/Fairly Bad

	In Community (%)	*In Nation* (%)	*In World* (%)
North America			
Canada	18	27	79
United States	28	46	66
Latin America			
Brazil	42	49	64
Chile	42	68	88
Mexico	31	55	70
Uruguay	28	37	73
East Asia			
Japan	31	52	73
Korea	57	74	66
Phillipines	28	52	57
Other Asia			
India	44	51	42
Turkey	44	42	45
Eastern Europe			
Hungary	49	72	71
Poland	71	88	73
Russia	70	88	66
Scandinavia			
Denmark	12	19	92
Finland	13	13	73
Norway	10	11	88
Other Europe			
Germany	22	42	85
Great Britain	27	36	76
Ireland	11	14	88
Netherlands	24	45	84
Switzerland	20	27	86

Source: Gallup (1992) *The Health of the Planet Survey*

Table VII-2. International concern over loss of animal and plant species and rain forests and jungles.

Percent Saying "Very Serious"

	Loss of Species (%)	*Loss of Rainforest (%)*
North America		
Canada	57	70
United States	50	63
Latin America		
Brazil	74	78
Chile	72	72
Mexico	81	80
Uruguay	76	80
East Asia		
Japan	37	47
Korea	33	24
Phillipines	45	65
Other Asia		
India	48	54
Turkey	61	63
Eastern Europe		
Hungary	47	46
Poland	76	72
Russia	61	65
Scandinavia		
Denmark	62	84
Finland	48	71
Norway	61	80
Other Europe		
Germany	69	80
Great Britain	60	79
Ireland	55	67
Netherlands	45	70
Switzerland	61	78

Source: Gallup (1992) *The Health of the Planet Survey*

- After a decline in environmental concern in the 1970's, there has been a significant and steady increase in both public awareness of environmental problems and support for environmental protection efforts.

- By Earth Day 1990, public concern for the environment reached unprecedented levels in the United States.

Support for environmental issues is strong across the country. A 1989 Gallup survey reported that 75 percent of Americans described themselves as environmentalists, 85 percent reported they worry about the loss of natural habitat, and that nearly half (49 percent) had contributed money to an environmental, conservation, or wildlife preservation group (Gallup Report 1989). Although one can argue as to what is meant when people refer to themselves environmentalists or what specific knowledge they possess regarding habitat loss, such figures nonetheless are impressive measures of the status of the environment on the political agenda and are certainly indicative of why resource management agencies find their every step under close scrutiny.

Public attitudes about resource management vary, but not greatly. A recent general population survey of 800 Oregon residents and 1,100 people nationally found no majority support for any commodity-based policies (Steel et al. 1993) Even in a region of mill closures and threats to the timber work force, less than 30 percent of the Oregon sample (25 percent of the national sample) felt "*federal forest management should emphasize timber and lumber products.*" There was a consistent pattern of support for environmentally-oriented policies and a similar pattern in the lack of majority support for commodity-based policies (table VII-3). For example, over 75 percent of the national sample called for greater efforts to protect the remaining old growth in the region while slightly more than 50 percent of the Oregon sample concurred.

However, it is also obvious, especially in the Oregon sample, that a diversity of opinion on these issues exists. For example, opinion is evenly divided on the statement, "*the economic vitality of local communities should be given the highest priority when making federal forest decisions.*" Support for protecting the environment is torn by the concern with protecting people and while these survey results suggest a fairly strong environmental disposition, in both Oregon and Washington, there also seems to be evidence that policies which propagate an "owls versus jobs" mentality are seen as inappropriate.

A recurring theme in local timber communities is the concern that their future is being decided by an extra-regional majority. The data in table VII-3 indicates support for this idea; the national sample results consistently support a more pro-environment approach than does the Oregon sample, although the differences are relatively small on some items. When asked to consider trade-offs between economic considerations and environmental conditions (table VII-4), most respondents (both national and Oregon) support a balanced policy position. A priority for economic considerations received little support in either sample.

Table VII-3. National and Oregon support for commodity-based management.

	Percent Saying "Very Serious" National (%)	Oregon (%)
A. Survival of timber workers and their families is more important than preservation of old growth forests.		
strongly disagree	29	20
disagree	24	25
neutral	27	20
agree	10	21
strongly agree	10	15
B. Some existing wilderness areas should be opened to logging.		
strongly disagree	32	35
disagree	20	16
neutral	20	17
agree	20	21
strongly agree	9	11
C. Federal forest management should emphasize timber and lumber products.		
strongly disagree	19	18
disagree	25	21
neutral	31	29
agree	12	16
strongly agree	12	16
D. The economic vitality of local communities should be given the highest priority when making federal decisions.		
strongly disagree	17	17
disagree	25	27
neutral	21	11
agree	17	26
strongly agree	20	20

Source: Steel, List and Shindler (1992) *OSU Survey of Natural Resource and Forestry Issues.*

Table VII-3 (cont.). National and Oregon support for commodity-based management.

	National (%)	Oregon (%)
A. Greater protection should be given to fish and wildlife habitats on federal forest lands.		
strongly disagree	5	9
disagree	7	16
neutral	10	21
agree	29	25
strongly agree	49	30
B. Greater efforts should be made to protect the remaining "Old Growth" forests.		
strongly disagree	7	15
disagree	5	18
neutral	13	17
agree	24	16
strongly agree	52	35
C. The management of federal forests should emphasize a wide range of benefits and uses rather than timber and wood products alone.		
strongly disagree	3	3
disagree	2	5
neutral	15	10
agree	33	38
strongly agree	46	44
D. Clearcutting should be banned on federal forest land.		
strongly disagree	11	12
disagree	10	18
neutral	16	12
agree	19	22
strongly agree	44	35

Source: Steel, List and Shindler (1992) *OSU Survey of Natural Resource and Forestry Issues.*

Table VII-4. Economic versus environmental trade-offs: National and Oregon samples compared.

	National (%)	Oregon (%)
The highest priority should be be given to maintaining natural environmental conditions even if there are negative economic consequences.	42	37
Both environmental and economic factors should be given equal priority in forest management policy.	47	44
The highest priority should be given to economic considerations even if there are negative environmental consequences.	11	19

Source: Steel, List and Shindler (1992) *OSO Survey of Natural Resource and Forestry Issues.*

Urban and Rural Residents Differ in Environmental Values

Another aspect of local concerns is that people in the urban areas of the region have little awareness or sensitivity to local concerns and are imposing their values on local residents. As a part of the Steel et al. survey (1993), attitudes of urban residents of Portland, Oregon, and Vancouver, Washington, were contrasted with those from a sample of rural Washington residents (see table VII-5). In general, rural residents are more likely to support commodity-based management of federal forests while those in the urban areas are more likely to support ecosystem-based management. However, a majority of all groups lent support to providing greater protection to fish such as salmon.

The data in table VII-5 also reveal the diversity of values held, within urban as well as rural areas. Simply put, people in communities -- large or small -- are not all the same. There is a diversity of opinion reflecting a range of values, whether one is examining a metropolitan area or a rural, timber-dependent community. For example, nearly 30 percent of the rural population disagreed with setting aside endangered species laws to preserve timber jobs; conversely, nearly 30 percent of the urban residents agreed with opening some existing wilderness areas for logging. It is particularly interesting that, among rural residents, there is equal support for, and opposition to, greater efforts being made to protect old-growth forests.

Table VII-5. Local community policy preference for federal forest lands.

Commodity Based Management		Disagree %	Neutral %	Agree %
The economic vitality of local communities should be given the highest priority when making federal forest decisions.	Portland	38	18	44
	Vancouver	33	19	48
	Rural Wash.	22	9	69
Some existing wilderness areas should be opened for logging.	Portland	54	19	27
	Vancouver	49	21	30
	Rural Wash.	42	14	44
Endangered species laws should be set aside to preserve timber jobs.	Portland	52	17	31
	Vancouver	46	10	44
	Rural Wash.	32	13	56
Federal forest management should emphasize timber and lumber products.	Portland	40	28	32
	Vancouver	37	26	38
	Rural Wash.	23	20	57
Ecosytem Based Management				
Clear-cutting should be banned on federal forest land.	Portland	26	13	62
	Vancouver	31	19	50
	Rural Wash.	36	18	46
More wilderness areas should be established.	Portland	21	26	53
	Vancouver	29	25	47
	Rural Wash.	43	29	28
Greater protection should be given to fish such as salmon on federal forest lands.	Portland	8	21	71
	Vancouver	13	19	69
	Rural Wash.	19	22	59
Greater efforts should be made to protect the remaining "Old Growth".	Portland	20	19	61
	Vancouver	27	15	59
	Rural Wash.	41	19	40
Greater efforts should be given to wildlife on federal forest lands.	Portland	14	25	61
	Vancouver	15	21	64
	Rural Wash.	28	32	40

What Do We Make of These Results?

Interpreting results of public opinion surveys is a problematic, even risky business. Results can swing wildly from one time frame to another, and from one survey to another. For instance, in a telephone survey of people in Oregon, Washington, and northern California (Bennett, Petts & Associates 1993), 60 percent of those surveyed opposed a halt to logging old growth, nearly 50 percent indicated they would be willing to lose no jobs to protect the spotted owl, and about 60 percent indicated they favored changing the Endangered Species Act to require a consideration of economic and social consequences in protecting species.

One can argue about the shortcomings of surveys at length, about the problem of "putting words in people's mouths," about sample selection, question wording, and other methodological shortcomings. These are key issues and need to be examined before data gathered from such surveys are used, particularly in the policymaking process. Such problems make the interpretation of public opinion surveys problematic; as Yankelovich (1991, p. xi) comments in the preface to his book, *Coming to Public Judgment*, "*what impresses me most in these years of studying people's feelings is how difficult it is to understand public opinion in all of its shadings and complexity.*" In light of this, it is tempting to reject public opinion in policy considerations, dismissing it on the grounds that it is always subject to such variable interpretation that it holds little value. Yet, the world is full of ex-politicians who dismissed public opinion only to regret it later at the polls.

The weight of evidence supports the view that public concern with environmental management in general, and forest management in particular, is significant, it is enduring, and it reflects a willingness and capacity to act. In short, the public is concerned about environmental deterioration and wants to see something done about it (Dunlap 1991). The public opinion reported here reflects one measure of the various voices that seek attention in the policy arena (we will shortly look at some of the other voices which also command attention). Much of this opinion has crystallized around the old-growth forests and endangered species debate in the Pacific Northwest; survey results suggest a strong regional and national commitment to protect what are seen as key values.

There Are Many Kinds of Forest Values

All forest values represent social valuations of the worth and importance of aspects of the forest. Many kinds of values are found in forests. The exchange value of some forest products gives commodity value to them. The use value of places, products, and experiences locates them in human experience. The existence value of places and qualities of the forest invests cultural meanings in forests of a different kind than either use or exchange values. Such spiritual or sacred values are usually central to important cultural institutions and may be viewed as impediments to utilitarian uses.

In a society that values rationality and empirical science, only values that can be empirically measured are most often counted as "real." The paradox is that **those social values for which our ability to define and measure is poorest, are the very ones that appear to be of increasing importance in our society.** For example, the value of old growth as a source of timber can be established in the marketplace; the high quality, clear grade lumber it provides commands premium monetary returns. When we account for the existence values of old growth as the repository of scientific knowledge about forest ecosystems or for the spiritual rejuvenation it brings us, we move beyond the market place and easy ways to express, much less measure, these important social values.

Resolving these conflicts among social values is a political problem and cannot be corrected by simply counting better. It is not a measurement problem. Different kinds of social values relate to fundamental differences in world view. Thus, different institutions in society become the repository of different world views, associated value orientations, and ethical stances. For this reason, the clash of values plays out in the political arena. Politics is the forum for choosing among values and promoting some values over others. This social assessment begins from these premises and addresses the full range of social values and places them within their institutional, organizational, and social context.

The following typology helps frame and segment the various forms of social values that forests provide:

- **Commodity values** - timber, range, minerals.
- **Amenity values** - life style, scenery, wildlife.
- **Environmental quality values** - air and water quality.
- **Ecological values** - habitat conservation, biodiversity, threatened and endangered species.
- **Public use values** - gathering, subsistence, recreation, tourism.
- **Spiritual values** - sacred places.
- **Health** - medicines.
- **Security** - sense of social continuity and heritage.

These values -- their specific expressions, the processes used to maintain or enhance them, and the constituencies that desire them -- lie at the center of the forest management debate in the Pacific Northwest today. **As these values play out in a world of change -- changing conceptions of resources and importance, changing constituencies, changing distributions of those who pay and those who benefit, and changing institutions -- the conflict escalates, the decisionmaking space shrinks, and risks to people and resources grow.**

Our discussion of forest history clearly reveals that commodity values (timber, forage) have dominated management attention. Today, however, growing public concerns for a host of other values such as clean air and water, biodiversity, wilderness, recreation, and so forth, have led to a fundamental shift to what Hays (1988) has described as "the new environmental forest." In this view, commodities still play an important role, but their relative importance has declined.

The Options May Lead to Many Consequences for People in Rural Communities

Before presenting results from the community workshops, we first turn to a discussion of the community concept. We also discuss some major global and national forces that hold important implications for the future of rural communities.

The Concept of Community

The relation between communities and forests has long been a concern in forest management. The concept of community stability, for example, has been a central, if not well-defined, focus of public forest policy. Schallau (1990, p. 70) writes "*the specter of more destitute communities -- like those stranded in the Great Lakes states as the lumber barons moved to the South and West -- gave rise to a fundamental tenet of public forest management in the West; namely, the need to achieve community stability.*"

Despite the difficulty encountered in defining the notion of community stability, the concept of community remains central to discussions about forest management in general, and specifically with regard to the potential impacts associated with the options under consideration in this report.

An unresolved issue in the literature is the lack of consensus on the meaning of the term "community," particularly as it applies to rural society. According to Fitchen (1991, p. 245) "...(It) *has become less clear what rural really means and what the rural community is*" especially to the people of these communities who feel the cumulative effects of many societal changes.

Community in the sociological literature can be organized into three broad categories: community as geographic area, community as local social system, and community as a type of relationship (Society of American Foresters 1989). Three different conceptions of community might seem to present formidable analytical problems, but further examination suggests that each category is useful in its own way for understanding community dynamics and problems found in communities.

Community as Geographic Area

This is the common sense view of community that extends back to Galpin (1918) who delineated community boundaries on the basis of the prevailing direction of ruts created by wagon wheels turning from the door yards of individual residences in the direction of one settlement or another. The geographic dimension of community is important from an economic standpoint, particularly in the case of relatively isolated settlements whose economic fortunes are linked to their physical locations:

> *People in a given locality share a common fate because they reside in a place having unique advantages and disadvantages as sites for capital investment* (Humphrey et al. 1993, p. 152).

Most economic analyses of communities, particularly those which examine the impacts of resource allocation, plant closing, and economic development activities are geography specific. The limitation of this view is that it only refers to physical or political boundaries and not to the relationships among people who reside within such boundaries.

Community as a Local Social System

This view, similar to that taken by ecologists who study plant and animal communities, focuses on the nature of the interrelationships and interdependencies among people and social institutions. Such interdependencies tend to be more informal, visible, personal, and self conscious among people in small community rural settings than in larger urban centers (Gold 1985). Interrelationships often extend beyond the boundaries of individual towns or settlements, where one community must rely on another to supplement what the other lacks and vice versa. Communities that consider each other when planning for goals and implementing programs can be viewed as a "micro-region." This type of interdependency and cooperation is becoming more important in promoting rural development than the more familiar macro-region. The deliberate fostering of institutional cooperation and interdependence among rural communities can be a key in achieving economic and social stability. Communities possessing such interrelationships also are more likely to develop relations with other micro- regions thereby gaining strength and vitality (Baker 1990). As noted in a recent report by The Wilderness Society (1992, p. 17)

> *individual communities are not well equipped to address the multiple obstacles to economic development and diversification. Conversely, when small communities...begin to work together...important benefits accrue.*

Community as a Type of Relationship

This definition is derived from a long standing theme in literature that emphasizes the decline of community in United States society. Wirth (1938) documented that the kinds of close, multi-faceted, and usually lifelong relationships that characterized life in the small towns of the agrarian United States were disappearing with the rise of the industrial age and urbanization. However, Bender (1978) later challenged the community breakdown thesis, arguing that just because communal social relationships were no longer located exclusively or even primarily in small town settings, it did not imply that they were not found in society.

Community as a kind of social relationship that is understood, in part, by studying patterns of social networks is useful because it allows one to further understand the relationship of rural people to each other and to the landscape in which they live.

Forest-Dependence Means Many Things

Forest-dependent communities are defined as immediately adjacent to forests or with a high economic dependence on forest-based industries, such as timber, or tourism-related jobs and services. This definition of forest communities, which recognizes economic relationships of communities to forests, but goes beyond them, is helpful for three reasons.

First, the term "forest-dependence," in the narrow economic sense, suggests that a community's primary relation is to a biological forest, and, as it is commonly used, the relation is to wood products. Although it is true that forest-dependent communities rely on the biological forest resource, a community's dependence is also a function of its economic and social structure. Within the forest products industry, a community's ability to prosper economically is a function, not only of the biological condition of the forest, but also (1) the extent to which those who control the supply permit commercial timber harvesting, (2) the extent to which those who control wood products jobs create them in or near the community, and (3) the terms for which these jobs become available.

Second, communities can be economically dependent on the forest without any forest-based commodity production (Machlis and Force 1988). There are many communities whose *raison d'etre* is forest tourism or as a retirement locale, and their numbers are increasing.

Third, forest dependence can occur with little or no direct economic relationship to the forest resource. Dependence can be defined in terms of quality of life attributes, such as an unpolluted environment, and as repositories of social meaning, including the provision of opportunities for escape and spiritual rejuvenation. Noneconomic attributes lead to a relation of the community to the forest that is a different type than commonly envisioned in conventional economic terms, but arguably one no less important. The forest, and the clean air, water, and escape it provides, is a vital locational attribute that attracts people to forest communities. In this manner, forests take on symbolic and locality-based importance (Burch n.d.; Hester 1985).

External Changes Will Affect Forest-Based Communities

The current dilemma facing forest-based communities is only a subset of the difficult economic, social, and political difficulties facing rural communities across the nation in an era of rapid change. Among such difficulties are those related to the economic implications of the rise of the information age and the globalization of the world economy. Drucker (1986) outlines two aspects of recent global economic change that have important consequences for forest-based communities. Moreover, the specific impacts of these changes will probably vary, given the different conceptions of forest community just discussed.

Economic Uncoupling: Primary Products

The first aspect is termed as the "uncoupling" of the primary products economy from the industrial economy. Throughout the industrial era, there has been a theoretically predicted and empirically observed linkage between the production of primary products and outputs in the manufacturing sector. Periods of high (and low) production in manufacturing tended to coincide with similar trends in raw material outputs. In recent years, however, this relation has not prevailed. Prolonged drops in raw material prices no longer reliably predict recession in the manufacturing sector, and periods of economic recovery in the manufacturing sector (largely in urban areas) have not been accompanied by similar recovery in primary production activities (which generally occur in rural areas). This asymmetric phenomenon helps explain the existence of "The Two Faces of Washington" (Smith and Barron 1990) and "The Two Oregons" (Miller 1990).

Economic Uncoupling: Employment

Another relevant aspect of economic change is the uncoupling of production in the industrial economy from industrial employment. This is largely a function of industrial mechanization and the growing relative importance of information-based technology in manufacturing to physical and skilled manual labor:

> *Increased manufacturing production in developed countries has actually come to mean decreasing blue-collar employment...Thus it is not the American economy that*

is becoming 'deindustrialized'. It is the American labor force (Drucker 1986, p. 775-776).

This trend is notable in saw mills as mechanization has resulted in fewer employees per unit of output. Drucker (1986) suggests that debate on industrial policy that focuses on production versus employment is likely to be a contentious political issue for the balance of the century. Echoes of this issue are clearly heard as debate rages over the future of the Northwest's forests and their role in the rural economy.

Economic Complexity

In addition to Drucker's two concerns, a third aspect of global economic change related to those outlined above is that economic relation and interdependencies are becoming increasingly complex and difficult to understand and manipulate:

> *Resources and commodities extracted by small communities around the globe have become increasingly entangled in international linkages, leading to changes in prices and technologies that may be outside the control of even the most powerful of corporations and insightful of communities (Gramling and Freudenburg* 1990, p. 555).

A practical manifestation of this is that it is increasingly difficult to gauge specific economic or employment benefits particularly for a specific local area of harvesting a particular stand of trees, or to separate the economic role of the local timber worker from other actors in the economic chain of events involved in producing a "2-x-4."

Implications of Economic Changes

Although these economic trends are complex and multi-faceted, their practical implications for resource-based rural communities are evident:

> *The rural economic crisis of the 1980's sharpened public awareness of the turn in fortunes of rural America. Conditions have turned seriously worse in rural America. Rural Americans now have lower incomes, fewer job opportunities, higher unemployment rates, and are more apt to live in poverty. And things are getting worse* (Wade and Pulver 1991).

Although the rural areas that were historically founded on extraction and primary production of natural resource commodities play a vital role in the life support system for an increasingly urbanized-suburbanized consuming society, their place in the larger economy has become more uncertain and marginalized in recent years.

Green Politics and Forest-Based Communities

A related set of developments center around the reasons for, and consequences of, the rise of environmentalism as a global political force (Buttel et al. 1990; Buttel 1992; Buttel and Taylor 1992). The argument is that environmentalism has arisen in the western countries not simply because of increased public concern about the environment, but more fundamentally because of changes in political coalitions resulting from the decline of labor as a political force. The decline of labor in response to mechanization has led to a political vacuum filled by new social movements such as the peace movement, the women's movement, and the environmental movement. Although environmentalism and other movements have, in one sense, replaced the labor movement, their composition is different than that of the old labor coalition and they are frequently at odds with labor. This has been particularly true in the case of rural labor.

Buttel (1992) applauds the rise of environmentalism as a political force in the nation and the world. However, he also expresses concerns about the current lack of a strong social-justice element in the "green agenda" and the tendency to frame environmental issues in a technocratic manner, pushing aside such questions as, "Which groups (and indeed, nations) pay disproportionate costs of environmental protection?"

Buttel also expresses concern about a potential impact of environmentalism that he terms the "environmental symbolization" of rural spaces. The author poses some related questions that are central to the present chapter:

> *What, then, will be the future of rural America if it becomes defined in strong symbolic terms as forest sites or prospective forest acreage needed to curb the greenhouse effect, as pristine ecosystems to ensure clean water for urban use, and as more desirable to the degree that fewer people are there to pollute, disrupt natural habitats and the like? Will we, in other words, witness a further erosion of commitment to improving the livelihoods of the rural poor and to rural development? Can we think meaningfully of "sustainable development" in nonmetropolitan contexts of the advanced countries* (Buttel 1992, p. 23)?

The spotted owl and ancient forest controversy frequently is portrayed as a "people versus the environment" question. There is a need to get beyond this dichotomy and to craft a solution that addresses both environmental protection and social justice. The welfare of forest-based communities is clearly an important element of this equation.

Clearly, rural forest-based communities are faced with major political and economic change at the national and global level. Communities in the owl region will be faced with these impacts even in the absence of the current crisis. The juxtaposition of these larger forces of change with the current crisis present a particularly challenging set of circumstances for many forest communities.

The Growth and Diversification of Rural Forest-Based Communities

The services and development that result from having to deal with in- migration of new people into rural regions (e.g., retirees, inhabitants of bedroom communities, tourist services) generally are seen as advantageous for communities. Geographically remote communities tend to be less able to cope with rapid immigration because they lack access to many urban services. However, research indicates that many long-term rural residents (including those who espouse environmentally conscious and low-energy use lifestyles) see themselves as apart from the dominant urban culture of their societies (Brandenburg and Carroll work in process; Bell 1992). Indeed, it is the very lack of infrastructure and the ability to attract outsiders that often contribute to the sense of place and perceived quality of life such communities provide. The lack of diversity (industrial as well as cultural), especially for traditional rural residents, contributes to the social cohesion found in many isolated rural communities (Gold, 1985). Although such conditions may not contribute to adaptability as defined by economic development specialists, they are valued by many rural people.

The Composition of Forest Communities

Although the need for economic growth, diversification of industry, and financial viability seem obvious for many communities, less is said about the importance of sociocultural distinction and cultural continuity. Not all groups within communities either welcome or can readily cope with rapid economic and social changes that some policy commentators view as necessary "adaptation" by forest-based communities. This section attempts to summarize research results from the region that document the existence of, and circumstances faced by, community groups and individuals within communities that might be missed if one focuses exclusively on the community level.

Research conducted on the social impact of timber harvest reductions in Washington State (Lee et al. 1991) attempted to reveal how decisions to reduce timber-harvest levels would affect the lives of residents in selected communities in the spotted owl region of Washington. The following paragraphs summarize the results.

Loggers

Impacts of the crisis on loggers was reasonably well anticipated because of prior research on this group (Hayner 1945; Carroll 1984, 1989; Carroll and Lee 1990). Prior work suggested that loggers in the Pacific coast region constitute an occupational community characterized by a strongly felt occupational identity and a generally high degree of commitment to the occupation.

The interviews revealed patterns of occupational community dynamics among loggers strikingly parallel to those identified in previous research. The following comment by a logger captures a common sentiment:

> *Most all my friends are loggers. I have a lot of respect for other loggers because I know what they do. It comes out of really knowing the hard work and the danger that they face. Besides, a logger is someone you can really count on anytime, for anything.*

Field interviews revealed a heightened self-conscious identification with the occupation in response to the crisis. Accompanying this, interviews revealed a ground swell of anger at those whom loggers view as threatening their way of life. One observer noted that most loggers had, until recently, spent their lives believing that if they worked hard, their families would be provided for. Now it seemed that the rules had changed with little notice and disastrous consequences. Another interviewee echoed the same theme:

> *I worry about my kids. What are they learning from this? I have always taught them to work hard and be honest, yet now they see me suffering despite the fact that I have worked hard my whole life. It has to make them cynical to watch what is happening to me.*

Sawmill Workers

Unlike logging, the work carried out by most sawmill employees tends to be repetitive and routinized. The ability to complete a specified task consistently and efficiently is valued over independence and creativity. The work environment tends to be closely controlled. Due, in part, to these circumstances, there is a stronger tradition of unionization in the sawmills and more worker-management conflict than found in other sectors of the forest products industry in the region.

Interviews suggest that occupational identities of the sawmill workers, and the importance placed on the occupation as a life interest, tend to be different than is the case for loggers. Sawmill workers are as likely to identify with organized labor as with sawmill occupations *per se*. Still, many express concern and resentment at the possibility of being forced from their occupation with few viable options, although they would be happy enough to take equivalent employment if such was available in their community. Most expressed serious reservations about the disruptive consequences for themselves and their families if they are forced to relocate to an urban area. In addition, most expressed a strong attachment to small-town life, citing its advantages for raising children and its personalized atmosphere.

Shake and Shingle Workers

Another relevant stakeholder group is comprised of people in the shake and shingle industry. These typically are workers employed in independent, often family-run mills. Those interviewed for the impact study tended to express less commitment to their occupation than did loggers, but revealed strong attachment to their homes and family-friendship networks. Many stated that moving would be the last thing they would do if they lost their jobs, because at such a stressful time, their support network would be critical.

Women

The interviews revealed that women play a complex variety of roles in the communities. The roles vary from head sawyer in a sawmill, shingle worker, and small business owner to logger's spouse. Most women interviewed had jobs outside the home and primary responsibility for housekeeping, household financial management, and child care. Most cited financial need as the primary reason for working outside the home.

The complex situation with respect to women in forest communities prompted additional data collection and analysis (Warren 1992). This revealed a perception on the part of women that they absorb a lion's share of the stress resulting from proposed harvest reductions, stress that is centered around possible job losses and on the resulting emotional and economic strain on families. Specific reasons for their perceptions range from tension resulting from changes in long routinized activities, to the stress of moving away from extended families, to fears concerning their husband's ability to adapt to other kinds of work. Women also expressed concerns related to their own ability to hold up in the face of family financial crises and demands for emotional support from husbands and children.

Ethnic Groups

The diversity of voices among rural communities also can be described by the variety of ethnic groups that live in communities near forests or that migrate into the area at the time of harvest dependent on particular forest products. Although the Native American voice is being listened to more recently, Latinos, African Americans, and Asian Americans represent an often unrecognized rural population. When various minority experiences are represented and listened to, we will have at least the tools to begin to construct an account of the world sensitive to the realities of race and gender as well as class. Unfortunately, we possess only a limited understanding of ethnic populations in rural areas and how the management options might affect their lives and cultures.

Others in the Community

People in this category are, for the most part, proprietors or employees of small independent businesses such as grocery, drug and hardware stores, restaurants, and service stations. They tend to be committed to small-town life and often work hard to promote the image and well-being of the "town" as the center of the local lifestyle. Local business people tend to comprise the political leadership of communities and are usually at the core of any locally based economic diversification efforts. Such people often have invested their life savings in local enterprises and their fortunes have tended to rise and fall with those of the timber industry in the immediate area. It should be noted, however, that the interests of local business people can be different than those of timber workers. Business people tend to value an environment of economic stability for their enterprises and thus are often at odds with forest products people over the issue of economic diversification. An example is the following comment:

> *As a community member, and especially as a business person, I am under a tremendous amount of pressure to 'take sides'; [in the Spotted Owl controversy] to commiserate for people here constantly about the situation. Don't get me wrong, I am concerned for them and for the community, but I think I am personally going to make it. My future is bright here in town regardless of downturns in the timber industry.*

In many rural communities, recent immigrants who bring recreational and environmental values and lifestyles, are distinctively different -- in their dress, behavior, and attitudes -- from **traditional** residents. In addition, many rural communities have a **back-to-the-land** population: immigrants of the 1970's and those who seek out low-energy lifestyles. These residents tend to espouse environmentally conscious lifestyle choices and counter-culture values. Still they appear to be more accepted by the traditional rural residents than recent, ex-urban **new-comers**, in part because the back-to-the- landers tend to express respect for the traditionally rural ways of life.

The **back-to-the-landers** often make all or part of their living from the land in roles that range from organic orchardist to tree planter. They tend to be conservative in energy use and typically do not demand increased government services and amenities. In contrast, the newer rural immigrants, who bring an urban lifestyle with them, tend to place less value on traditional ways. They might make a living through a direct link to urban sources, by means of computer modems and fax machines. They tend to use more consumer goods and energy, and believe more strongly than the back-to-the-landers that traditional practices are destructive to the environment. This view appears to be a result of why the new-comers are moving to rural areas: not to get back to the land, but rather to get away from what they perceive as the poor environments of the urban-suburban areas. One "ex-urb" now living in rural southwest Washington stated:

> *I moved here just last year to get away from the suffocating environment of the city. Living in an awful suburb would make anyone want to save the little pieces of healthy environment that we have left. It just makes me so mad when I see the rivers and forests around here being converted into industrial landscapes. Enough is enough!*

Preliminary research in rural communities in northwest Oregon and southwest Washington indicate that accelerated social change has broadened the traditional value base and symbolic meaning that residents apply to their social community and their relation to the ecological communities around them. However, the findings indicate there is an important difference between general attitudes concerning the forest (use, preservation, etc) that are often created by political dynamics and adherence to occupational and social community norms, and those expressed when a person or group has an attachment to a particular place. As one respondent stated:

> *I don't like what I am seeing and feeling (when I think of the future). We once were seen as good workers, of stewards of the land, and in a few years our town has lost just about everything that I have cared about. People talk about adaptation but there are some tough times coming on. We have an unemployment rate like the inner city, and there are no new jobs coming in.*

In the on-going sociological debate over rural-urban differences, rural social conflict over natural resources is often attributed to environmental attitudes of new residents from urban areas. An alternative hypothesis is that in some instances, new residents should provide not new attitudes, but a new voice for attitudes already held by many local residents (Fortmann and Kusel, 1990). However, when outside political pressure threatens the livelihood of working class people in communities, and when the dominant urban culture shows little respect or tolerance for the rural cultural heritage, there is often clear community resistance to social change, including that relating to the expression of environmental values. The perception of a community being under attack seems to limit the prospects for community development, economic diversification, land-use planning and the like. Under such circumstances, actions that are intended to ward off outside influence or make the community unattractive to outsiders are often apparent.

A related pattern is that job loss attributable to political decisions "from above" (e.g., resulting environmental restrictions, endangered species rulings, timber sale appeals) tends to generate angry individual and group responses, and often contributes to a sense of political alienation. There appears to be two primary reasons for this: (1) a sense that, unlike economic fluctuations that are seen as uncontrollable, such decisions are viewed as choice-based and preventable; and (2) that local interests have little voice in such decisions.

Interviews indicated that resistance to this social change by certain groups influences the creation of, and adherence to, traditions and the subsequent development of social groups and the acceptance or disapproval of other groups. Therefore, **the once singular rural community seems now more than ever to contain a plethora of communities**

often within the same geographic locality. Awareness of this is important in understanding the impacts of the current political log jam and specifically the way the local social fabric has been torn by natural resource disputes in the Spotted Owl region.

Summary: Rural Communities are Complex

One clear message emerges from the preceding discussion: any attempt to characterize rural timber or forest communities on the basis of one or two sociological dimensions ignores much of the richness, complexity, and -- under the present circumstances -- human suffering found in such places. Any one rating of the impact of forest management scenarios on a community can mask the different impacts on groups and individuals within the community.

If one focuses on those groups and individuals most directly affected negatively by the issue, it is apparent that even in communities near urban centers, some occupational groups and their families have felt profound impacts. Economic dislocation is not made easier by the fact that one's neighbors are prospering. In some locales, social service providers are overloaded as the number of displaced workers has increased dramatically. There are increasing reports of social service providers experiencing overwhelming stress and burn-out. These problems will likely increase as timber supplies decline (whether federal, state, or private).

The ability of occupational and cultural groups to cope with dramatic change is complicated by a number of factors. Among these are occupational and cultural identities, attachment to rural life, attachment to place, age, formal education levels, and absence of available jobs similar in skills required, location, and compensation rates.

It is difficult to overstate the potential long-term effects of this conflict and its eventual resolution on civic relation in the region, and, in particular, on rural community governance. It seems essential that any decision take into account the interests and desires of all stakeholder groups, not the least of which are those who stand to pay the highest immediate personal costs. The long-term ability of people in this region to successfully work together to solve problems depends in part on the outcome of this dispute.

There is concern that consequences of the management options will fall particularly heavy on rural communities in the owl region. Such concern underlies the first principle identified by the President at the Forest Conference as a guide for future efforts: we must never forget the human and economic dimensions of these problems. Some argue there is a reciprocal relationship between communities and forests as well. Testimony at the Forest Conference by Professor Robert Lee from the University of Washington reflects this:

> *...the security that people have in their community, in their families, in the tenure relationships they have, and that their children feel about their futures are key to healthy forests.*

Problems of Transition in Rural Communities

> *It isn't the changes that do you in, it's the transitions. Change is not the same as transition. Change is situational: the new site, the new boss, the new team roles, the new policy. Transition is the psychological process people go through to come to terms with the new situation. Change is external, transition is internal.* (Bridges 1991, p. 3)

Rural communities can experience considerable difficulty in adapting to altered socioeconomic conditions, particularly when they involve a fundamental transition in the direction or rate of change (Little and Krannich 1989). For example, social disruptions have been documented in rural communities suddenly confronted by extremely high rates of economic and demographic expansion resulting from large-scale industrial development associated with natural resource extraction or processing (Greider et al. 1991; Krannich and Cramer 1993). Similarly, periods of transition involving sharp economic and demographic decline, such as occurred in many United States agricultural communities during the mid-1980's, have been shown to substantially affect the well-being of rural residents and have important ramifications for broader community social structures (Bultena et al. 1986; Fitchen 1991).

One reason for the difficulties encountered by rural communities confronting major socioeconomic shifts involves their relatively limited structural diversity (Wilkinson 1991). In most rural places, the array of both formal and informal social structures is limited, because of low population numbers and increased tendencies for residents to secure services outside the local community (Wilkinson 1991; Little and Krannich 1989). Local infrastructure, including the number and capacity of local government offices or other formal organizational structures, is fairly limited. As a result, local residents suffer from constrained access to facilities and services that might help them cope with changes.

These conditions are especially problematic in rural communities affected by economic or demographic fluctuation and instability. The cumulative effects of sustained instability and associated cycles of socioeconomic transition limit the capability of the local community to even react to problems associated with either growth or decline, let alone to act in any organized, proactive manner (Krannich and Luloff 1991; Tilley 1973). This occurs for several reasons. First, residents accustomed to a long-term pattern of cyclical expansion and decline may see little use in mobilizing local efforts to address economic or demographic changes, because past experience suggests that such changes are likely transitory (Carroll 1984). Such experiences can cause rural residents to deny the possibility that things won't get any better, thereby impeding both individual and collective adaptation.

Second, rural residents are often aware of their vulnerability to economic and political forces over which they exert little control. This awareness contributes to a sense of powerlessness that discourages involvement in community development efforts and restricts local capacities.

Third, periods of in-migration or out-migration can contribute to the emergence of a "rootless" population, with limited attachments or commitments to the local community. Under such circumstances, residents find it difficult to think seriously about, or commit efforts to the community's future.

Fourth, the draining of human capital during periods of out-migration can reduce the number of locals capable of addressing the problems of community change and transition. Out-migration has left many rural communities with a scarcity of those capable and willing to devote an effort to effectively organize local development and self-help efforts. Such deficiencies in human capital are also exacerbated by a process of overadaptation to resource-based economies. For example, there is a tendency for residents to deemphasize the value and importance of education in the face of high-wage employment opportunities in some extractive industries (Freudenburg 1992).

Periods of transition do not always result in severe social disruption, and in many instances, the disruptive consequences of instability and rapid change are temporary (Krannich and Cramer 1993). The magnitude of socio-economic change and the extent to which changes are permanent or of short duration appear important in accounting for community outcomes. Research suggests that in cases where a period of sharp growth or decline is followed by a return to relatively "normal" baseline conditions, social problems and indicators of disruption are attenuated (Krannich and Cramer 1993). In cases where a transition to modified social and economic conditions is sustained but gradual, some communities have demonstrated considerable resilience, in part because such conditions allow more time for both individual adaptation and the emergence of collective response capabilities.

Transition in the Context of Timber-Dependent Communities

In many ways, the transitions that have confronted timber-dependent communities over the past decades mirror those outlined above. Cyclical episodes of stability and decline have been commonplace, although increasingly have occurred within the context of sustained economic and demographic decline that is associated with reduced labor force requirements which result from changes in technologies.

However, the circumstances associated with possible changes in management of old-growth forests substantially alter the nature and pace of transitions confronting some rural communities of the Northwest. A decision to eliminate or sharply reduce timber harvest from federal lands would not only cause a sharp downturn in some communities, but would cause a permanent rather than transitory shift in the social and economic context.

Broad Effects of The Forest Issue

Effects of the issue extend beyond those whose jobs and financial well being are at stake. The manner and the prolonged time over which the issue has played out has served to create and exacerbate internal and external community conflict. In many timber communities, there is a sense that the urban majority is making decisions which will destroy the rural way of life. Describing sentiments encountered in his social impact work, Carroll (1992) wrote:

> *Perhaps the most important general observation... is the fact that the Spotted Owl controversy is widely perceived in the communities... as fundamentally a clash of urban and traditional rural cultures in which the latter are being overwhelmed and devalued by the former. The Owl is seen as a stalking horse furthering the interests*

of environmental groups at the expense of people whose lives and livelihoods depend on harvesting and processing trees. This has led, for many, to a profound sense of anger and betrayal...

This clash of values and cultures is typical when urban migrants move into rural communities. Rural sociology has its roots in studies of farming communities during the 1960's (Field and Burch 1988). Brown, reporting on a study in southern Oregon, found:

> *Several of my interview subjects complained about the comments popular among the newcomers... Casual jokes about how backward and reactionary the locals are can be heard in any crowd of non-locals. I heard a typical one just the other day when a friend said she just didn't want to go to a meeting where she had to "hear the yokels yammering away about jobs"* (1991, p. 13).

Clearly the conflict has torn the fabric of governance and civility in the owl region and diverted energy that might have been spent solving other problems. If there is one conclusion on which virtually all sides in the controversy agree, it is that the **current gridlock and conflict is far too costly in both environmental and human terms to be allowed to continue.**

Objectives for Community Assessment

Previous task force reports (e.g., Thomas et al. 1990; Johnson et al. 1991) provide some discussion about community effects, but generally only at an abstract, non-geographically specific level. As a result, it is difficult to distinguish patterns and differences in community effects and to fashion appropriately responsive public policies in light of these patterns and differences.

One major task of the social assessment is to provide a more geographically specific linkage between option consequences and these communities. It is recognized at the outset that these consequences may be either positive, negative, or a mixture. Even where the consequences are positive, certain groups within the community may be disadvantaged. It is our belief that we need a more discriminating examination of community consequences so that more useful and responsive public policy can be formulated. We also need to discriminate between changes induced by federal forest policy and those stemming from broader society-wide level effects; again, this knowledge should enable more informed policymaking.

Specific objectives of the community assessment are as follows:

1. To develop a rich understanding of the region's forest-based communities with a particular emphasis on their capacity to successfully cope (or not cope) with shifts in forest management and other externally based change.

2. To assess the likely community impacts of a range of possible forest management options.

3. To discuss appropriate policy considerations and responses in light of the likely community impacts.

What We Learned about Rural Communities

This section summarizes findings from two workshops held to examine the effects of the options on rural communities. Because time limitations constrained our analysis, these results should be considered as interim conclusions or propositions. These findings are a foundation upon which management implications and further assessments can be devised, and provide policy-makers and others with an understanding of the range of effects the options have on rural, forest-dependent communities in the region.

Key Conclusions

This community assessment differs from past impact assessment efforts. First, the definition of community and of community-forest linkages is based on social theory and economics. Previous efforts have focused more on the latter. This approach requires that we rely on a broad set of data.

Second, this assessment moves beyond the county to focus on communities. Communities are an appropriate level to examine the effects of changes in forest management policy because they are social units rather than statistical categories or administrative units. More importantly, their features and functioning have strong influence on the kinds of consequences felt by community members.

Third, this assessment strives to recognize that all social systems are human inventions with some important subtleties. Rather than focus on one data set, one definition of impact or risk, or one level of analysis, this assessment has employed several of each. Such an approach helps provide a rich foundation for policy formulation.

The assessment does not provide an evaluation of all communities in the owl region, nor is it designed to provide state or subregional characterizations of conditions. The selection and total number of communities assessed was constrained both by time limitations and the site-specific knowledge of panelists. The assessment does provide a framework for estimating the range of impacts and for implementing a more comprehensive assessment.

A sudden drop in harvest levels creates more than an economic shock or the sudden loss of jobs. It creates a social shock that can reduce the ability of a community to respond to economic change. Persistent poverty, increased commuting, emigration of community members, the breaking up of family and community support networks, changes in leadership, low morale, uncertainty, heightened conflict among groups within communities, deep cuts in school budgets are all factors that result from shifts in forest policies if community needs are not addressed.

Panelists felt that community capacity (that is, the ability to adapt to internal and external forces) was a critical factor in determining how a community would be affected by changes in harvest levels. Conversely, they also felt that changes in forest management can directly affect the capacity of a community.

The interaction of capacity and consequences (the outcomes of management decisions) is critical to understanding communities and their relative ability to adapt to forest management options. Capacity and consequence ratings can be used to develop characterizations of community types based on the relationship of capacity, consequences, and sensitivity to differences among the options. This relationship offers an approach that allows analysts to identify communities that are both negatively affected by a range of shifts in management and less able to respond to these shifts. In turn, this multidimensional approach can be used to identify communities "most at risk." For example, of the communities assessed, about one-third would be "most at risk" if Option 1 were selected.

The kinds of technical, economic, and social policies that accompany ecosystem management will be critical factors in determining the consequences for communities. Management programs that include provisions to increase skilled work in the forests, provide capital for diversification, reformulate the tax basis for school budgets, foster locally owned businesses, and provide technical assistance for community improvement efforts can act to bolster the capacity of communities.

The role of capacity in mediating the consequences to communities is a key finding because it points to where policy can be most effective. Polices that improve capacity not only help communities meet their present needs in the face of declining timber yields, but also promote the community's ability to pursue development that is appropriate to their locale and culture.

The Workshops

About 300 rural communities in the owl region are affected in some way by the forest management issues in the Pacific Northwest. To better understand the effects and possibilities the options might have on or offer these communities, we conducted a survey of state extension agents familiar with individual forest communities and conducted two workshops with panelists familiar with local communities and conditions.

More than 50 people participated in the two workshops, each session lasting for one and one-half days. Both workshops were held in Portland, Oregon, and all panelists were employed by or funded through public bodies; state or local government, school districts, etc.

Workshop one was designed to measure the ability of rural communities to adapt in their response to changes in forest management. It also led to discussion and rating of community success -- a measure of the ability of communities to meet the needs of its residents and achieve goals. Information from this workshop allowed us to fashion a preliminary understanding of the state and regional patterns and how they would be affected by changes in forest management. At the time of workshop one, sufficient detail about the options was not available, so we used three scenarios to represent a range of timber harvest levels: a "no harvest" scenario, a "current harvest" scenario, and the 1985-87 harvest level (this period was picked as representing a "mid-point" in recent years). Workshop one helped identify key questions about possible community effects and possible mitigation measures.

The second workshop was similar to the first. The primary goal was to estimate consequences (positive, negative, and a mixture of both) from the options that might affect communities and to assess their capacity to adapt in response to these consequences. Panelists were asked to identify factors that predisposed communities to lower capacity and more negative consequences, as well as higher capacity and positive consequences. This allowed us to assess how and why certain communities might respond to changes in federal forest management. Additional information on the options was available at the time of the second workshop; however, due to time limitations and the complexity of the options, we asked panelists to evaluate only Options 1, 3, and 7 as well as a 1985-87 management scenario.

Workshop panelists were provided with census information, the results from the state extension survey, and, for the second workshop, the results from workshop one for their respective states.

The evaluations provided by the panelists were confined to the individual states; that is, they did not participate in any exercise designed to provide cross-state comparisons. Differences in the backgrounds of participants representing the three states and differing assumptions made by participants during the course of the workshops require that any inter-state comparisons be made with caution.

The workshops were the primary means by which we arrive at conclusions tied specifically to the region and its communities. Data on which these conclusions are based include both quantitative information (for example, ratings for capacity or consequences, census, or other secondary information about subjects such as public assistance) and qualitative information gleaned from discussion with panelists. We also base our evaluation on relevant information and concepts contained in the literature and derived from extensive discussions with several community sociologists.

As described above, workshop one focused on the concepts of adaptability and success; communities were rated on a seven-point scale (from very high to very low) on these dimensions. In examining the relationship among these measures and those of capacity and consequences, obtained in workshop two, we found very similar results. Because of this similarity, and to streamline the discussion of community effects, the following discussion of community effects focuses on the results from workshop two. Results of workshop one regarding success and adaptability, are presented in Appendix VII-C.

The Concepts

Community Consequences

The concept of "consequences" is used as a measure of community outcomes from federal forest management. Panelists were asked to rate the likely consequences of the options within one to three years with a single measure ranging from very positive to very negative (one, very low; seven, very high). Because of infrequent use of "very low" and "very high" the seven point scale was collapsed in subsequent analyses to a five-point scale with the extremes being termed "low" and "high". The consequence measure often contains a mix of positive and negative effects. For example, a community considered to have moderately positive consequences from an option is likely to have some negative consequences as well (and the converse, a community with moderately negative consequences would likely have some positive consequences). An "even" rating contains a balance of positive and negative consequences.

Consequences considered by the panelists included the degree to which forest management influenced the ability of local residents to have their needs and expectations satisfied by community conditions and opportunities; how well basic income and sustenance needs were addressed; the relative adequacy of facilities, services, and infrastructure (both public and private sector); the needs for association, affiliation, and social integration (for example, array of organizations and institutions for expression of interests, provision of emotional support, and so forth) and whether employment and income generation opportunities were adequate. Throughout the rating process, panelists discussed a number of other consequences which enriched overall understanding of the effects of the options on communities.

Community Capacity

Community capacity involves the ability of residents, and community institutions, organizations, and leadership -- formal and informal -- to meet local needs and expectations. Processes and structures are important components of community capacity; they assist or restrict residents' abilities to respond to changing conditions and internal or external limiting factors.

Community capacity involves a wide variety of factors that can be divided into three broad areas: (1) physical and financial infrastructure, (2) human capital, and (3) civic responsiveness.

Physical infrastructure includes water and sewer systems, business and industrial parks, roads and proximity to larger urban areas, transportation corridors and financial capital. Economic size and diversity of businesses are also associated with physical infrastructure. Related to economic size and diversity is access to public and private timber, the ability to process it locally, and the presence or absence of local wood remanufacturing capabilities. Community capacity is related to structural and spatial characteristics, and varies in reasonably predictable patterns. For example, communities with the best access to transportation, markets, raw materials, and that have the greatest economic diversification tend, on balance, to have the greatest capacity.

Human capital includes skills, experience, and educational levels of individuals in a community. It includes the occupational skills in which community members will be economically competitive. Understanding human capital offers policy-makers insight into those areas where community members might be politically effective.

Civic responsiveness involves the reciprocal and interdependent relationship between individuals and their community. Communities are composed of and sustained by individuals, and individuals are shaped by their communities. Implicit in civic responsiveness is the idea that a collective good is worth pursuing. The capacity of individuals to develop may differ from actions directed toward community development and collective response to external or internal change. Civic responsiveness encompasses actions that include responsibility to relationships in a community. Leadership, formal and informal, and institutional infrastructure are included in this category insofar as they are directed toward community and not solely toward individual benefit. The presence of energetic, active, inclusive leadership, well-connected with community assistance agencies, leads to higher capacity. Such leadership varies widely across communities and suffers in communities with divisive politics.

Communities with lower capacity have reduced ability to maintain community relationships and improve well-being. These same communities are less resilient, and have reduced ability to contend with changes of any sort. A community's capacity is only as high as its physical infrastructure, human capital, and most importantly the manner in which residents and groups devote energy to community issues.

This assessment is based generally on the community capacity approach discussed by Kusel and Fortmann (1991) in their study of forest communities in California and also links to the human ecological work of Wilkinson (1991). The factors of physical and financial infrastructure, human capital, and civic responsiveness parallel those discussed by Flora and Flora (1993) who stress that they are vital components of rural communities, and that they are used to assess the ability of local people to grapple with problems they face in the short and long term. This approach is similar to a needs assessment that, as Mueller and Burdge (1993, p. 1 and p. 12) point out, is undertaken to evaluate "*changes in the society and how society provides for the needs of its citizens*" and to "*provide a framework for a new way of looking at rural social issues.*"

Community capacity assists in understanding the implications of federal timber harvest policy.

Assessing community capacity involves evaluating community processes and structures, including: local response to internal and external stresses or problems; how individuals and the community are able to take advantage of existing opportunities and create new ones; the ability of residents and community leadership to retain a variety of social groups and processes; how well issues of concern to majority and minority groups are addressed and balanced; local conflict resolution skills; local access to capital; and local control over resources and local influence over resource management.

Panelists were asked to rate community capacity on a seven-point scale (very low, low, moderately low, medium, moderately high, high, and very high). Similar to the measure of consequences, because of infrequent use of very low and very high (for example, California panelists did not use them at all), the seven-point scale was collapsed to a five-point scale ranging from low to high.

Community capacity is one focus for this social assessment because it is closely related to the ability of a community to respond to changing forest management. Forest management decisions made by the federal government and others (local and absentee) affect the well-being of residents in forest dependent communities. The capacity of a community can be reduced by forest management decisions that do not take into account local needs nor involve local residents.

This relationship between forest management and community capacity is also affected by a variety of intervening variables (for example, different land ownership, local production facilities and their degree of modernization). It is also important to note that improving the ability of a community to respond to and influence decisions made beyond community boundaries is another way to improve capacity and well-being of forest communities.

Overall Findings

The environments, economies, and cultural traditions of rural communities in America are extraordinarily diverse. They nevertheless share some characteristics, notably their isolation, size, and strong ties to natural resources. Although tradition and homogeneity have often been associated with rural life, change and diversity have also long been part of the rural experience, particularly as new federal policies and global market forces emerge. Panelists at our workshops spoke of these factors and their consequences in rural communities in the northern spotted owl region of the Pacific Northwest.

The panelists discussed the erosion of autonomy, identity, and pride that, for some communities and occupational groups, have depended on forest management. They listed examples of economic difficulty: business closures, worker dislocation, underemployment, and new poverty. They were troubled by some of the land management practices reported in recent years, including panic cutting, cut and run corporations, and inadequate reforestation. They also cited concern with what they saw as arbitrary and excessively restrictive environmental controls.

Although community conflict and social disruption were common themes, there was also talk of communities that had "turned the corner" and were making various transitions into new futures. These perceptions -- both the pessimistically bleak and the optimistically hopeful -- are entirely consistent with our general understanding of rural communities and the complex and varied ways they respond to changes in the world around them.

Although the management of forest resources affect communities and individuals in a variety of ways, the most significant economic ties to forest resources in the region are through the timber industry and the harvest and processing of timber. The three states differ in the size of the timber industry as a proportion of the economy, the structure and distribution of tax receipts to county and local government, and the distribution of federal and private timberland ownership. As an example, we find that in the early 1970's, employment in the timber industry in the owl region in Washington was about six percent of total employment, while in Oregon it was nearly 12 percent and in California, 31 percent. By the 1985-1989 period, its relative importance had declined in all three regions by virtually 50 percent (three, seven, and 15 percent, respectively). California panelists indicated that regional decline in forest employment has been accompanied by significant restructuring in the forest products industry, away from older large log mills to more capital intensive small log mills. Such variability contributes to differing consequences associated with the options among the states and sub-regions.

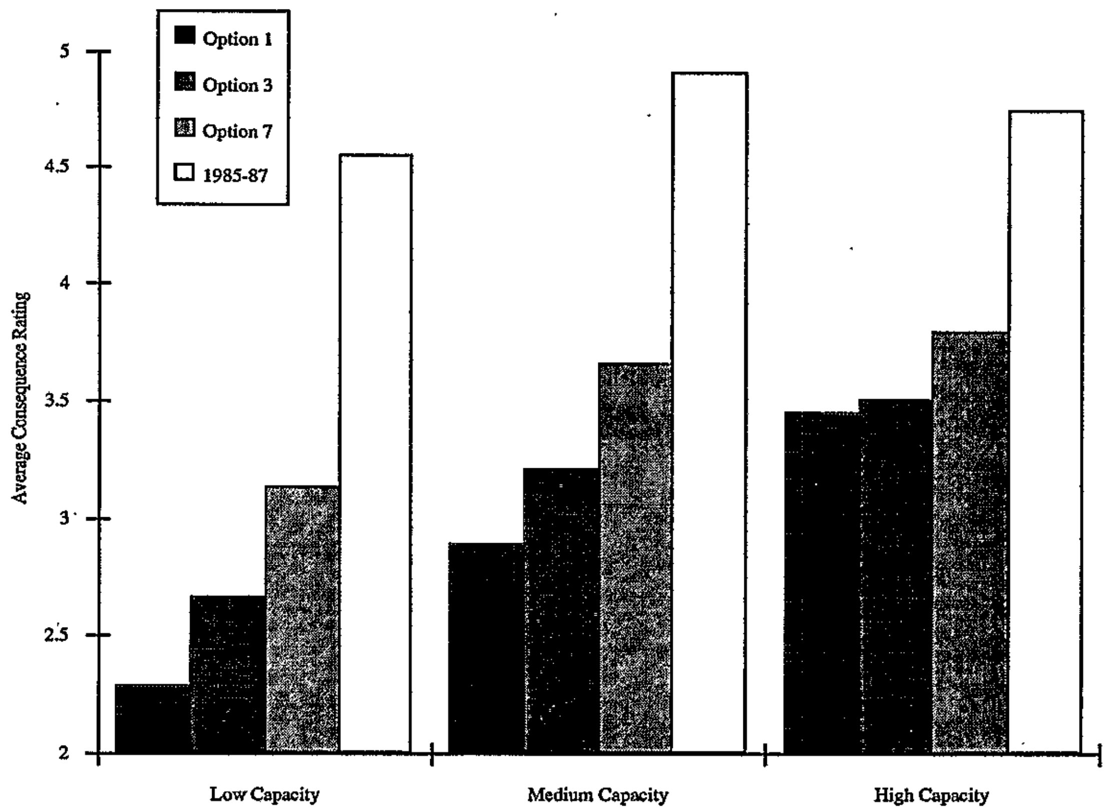
Characterization of Communities by Patterns of Capacity and Consequence

Consequence ratings for the options for high capacity communities tend to be close to the mid-point of the scale (even mix of effects) and ratings for each option are close to one another, while ratings for low capacity communities tend to be concentrated more toward the negative end of the consequence scale (See fig. VII-1). Consequence ratings for low capacity communities for the options also vary more from one another, reinforcing the notion of these communities' greater reliance on federal timber. Using Option 1 as an example, 82 percent of communities with medium low and low capacities have moderately negative to negative consequences; only 46 percent of communities with medium high or high capacities have moderately negative consequences or worse.

The Capacity-Consequence Relationship

Capacity as a measure of a community's ability to respond and adapt to change can be used with measures of consequences to characterize communities both by effects of the options and the communities relative ability to respond to the option. The relationship of capacity and consequences for the assessed communities is shown in table VII-6 for each option and the 1985-87 scenario. The individual table for each option can be divided into quadrants representing communities with: (1) low capacity and positive consequences; (2) high capacity and positive consequences; (3) high capacity and negative consequences; and (4) low capacity and negative consequences.

Figure VII-1. Consequence ratings by option by capacity category.

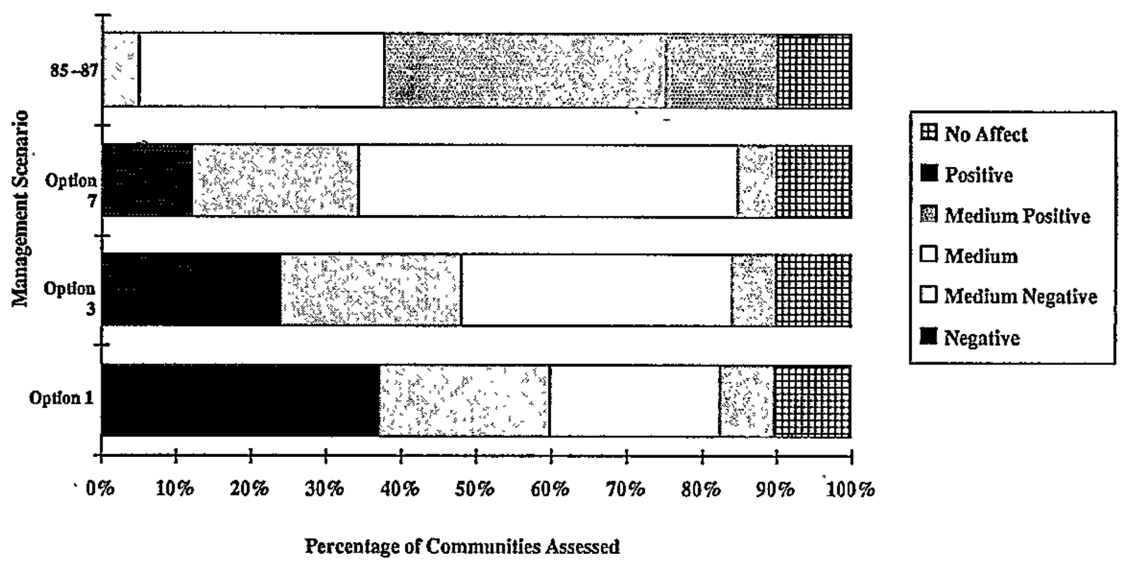


As shown in the table, communities generally cluster between low capacity and negative consequences in the upper left corner to high capacity and moderately positive consequences in the lower right corner in each option. As a result, communities are concentrated on a left to right sloping line that tends to shift to the right as Options 1 to 3 and 7 and the 1985-87 scenario are considered. This indicates that as Option 7 and the 1985-87 scenario are considered, and specifically as harvest levels from federal lands increase, a greater number of communities have more positive consequence ratings. The capacity-consequence relation offers a perspective of communities that allows analysts to identify communities that are first negatively affected by shifts because of management and secondly, those less able to respond to those shifts.

Sensitivity to Harvest Changes

By examining the variation in consequence ratings for individual communities among options (that is the change in consequences as options with higher harvest levels are considered) we can begin to understand the relative sensitivity of communities to shifts in federal timber availability. For example, some of this variation in sensitivity to changes in options is apparent even in the aggregate state ratings. The difference between average consequence ratings for Options 1 and 7 are nearly twice as high – and between Options 1 and 3 are over 3 times as high – for California as compared to the other two states. Although these state-level differences may be caused by a variety of factors (see discussion below on variation in capacity and consequences) they do indicate an underlying variation in responsiveness to management changes and, specifically, to harvest level changes.

Figure VII-2. Predicted consequences of four federal land management scenarios on communities in Northern California, Oregon, and Washington.



In some of the heavily timber dependent communities, consequence ratings increase several points (that is, become more positive) moving from Option 1 to the 1985-87 scenario. Ratings for other communities are unchanged across the options, indicating either a balance of positive and negative affects, or communities less affected by federal forest policy. Still other communities have ratings that are negatively related to increases in timber harvest levels. As seen in Figures VII-2 movement is from negative to more positive consequences moving from Option 1 through Options 3 and 7 to the 1985-87 Scenario.

Table VII-6. Relationship between community capacity and consequences

Option 1	Consequences to Communities (%)				
Capacity	*Negative*	*Moderately Negative*	*Even*	*Moderately Positive*	*Positive*
Low	12	3	0	1	0
Medium Low	13	5	3	2	1
Medium	8	8	7	1	0
Medium High	7	4	4	3	0
High	2	4	9	4	0

Option 3	Consequences to Communities (%)				
Capacity	*Negative*	*Moderately Negative*	*Even*	*Moderately Positive*	*Positive*
Low	7	5	1	1	0
Medium Low	9	6	6	2	0
Medium	4	10	10	1	0
Medium High	6	3	9	1	0
High	1	3	12	3	0

Option 7	Consequences to Communities (%)				
Capacity	*Negative*	*Moderately Negative*	*Even*	*Moderately Positive*	*Positive*
Low	4	6	3	1	0
Medium Low	6	6	10	1	0
Medium	2	6	15	2	0
Medium High	1	5	11	1	0
High	1	2	16	1	0

1985-87 Scenario	Consequences to Communities (%)				
Capacity	*Negative*	*Moderately Negative*	*Even*	*Moderately Positive*	*Positive*
Low	0	2	6	4	4
Medium Low	0	1	12	9	2
Medium	0	0	8	10	6
Medium High	0	1	4	10	3
High	0	2	4	11	2

Community Typology

Capacity and consequence ratings can be used to develop characterizations of community types based the relationship of capacity and consequences and sensitivity to federal harvest changes. Preliminary cluster analysis of the rating data was used to develop a community typology based on general capacity, consequences to options, and differences (both in strength and direction) in the relationship of management options to consequence ratings. Because of the focus on general patterns, rather than individual ratings, these characterizations extend across communities in all three states. Six different community types are described here.

1. **Communities with very low to medium capacity with negative consequence ratings under all three management options, but where consequences to**

federal land management appear to be positively and strongly affected by increased federal timber harvest levels. This group of communities is clearly timber dependent. They lack local leadership, diversity, or other aspects of capacity that would facilitate transition from a timber-based economy. With both low capacity and negative consequences under all options their continued existence appears threatened regardless of the options, although a 1985-87 management scenario would lead to more positive consequences.

2. **Communities with low capacity that received negative consequence ratings under all three of the options under consideration, but where increased federal timber-harvest levels appear to have only a very minor, slightly positive effect on consequences to options.** This group of communities, although timber dependent, appear to lack the capacity to respond to the different options, perhaps because they have already lost the skills or processing capability necessary to capitalize on increased log flows from federal lands. In the consideration of risk definitions in the next section, communities falling within this category or the one previous might be termed "most at risk."

3. **Communities with low to medium capacity and with negative consequences under Options 1 and 3 but even to moderately positive consequences under Option 7.** Consequences from the options in these communities appear to be positively and generally strongly related to increased federal timber harvest level (to the extent that panelists perceived harvest levels to be sustainable). Most of these communities are only marginally threatened by potential decreases in federal harvest levels as they appear to be capable of responding positively to certain options.

4. **Communities with generally medium capacity and with generally even consequence ratings under all three options considered.** Consequences of federal land management in these communities appear to be unaffected by timber harvest levels. These communities are not strongly dependent on resources from federal forest lands.

5. **Communities with medium to moderately high capacity that received negative consequence ratings under Options 1 and 3 but moderately positive consequences ratings under Option 7.** Consequences to the options in these communities appear to be positively affected by alternatives with higher timber harvest levels. These communities are economically tied to timber. Similar to the type 3 communities above, these communities may be negatively affected by the options with lower timber flows. Unlike the type 3 communities, they appear to have the capacity to adapt, at least to some extent, to these negative changes.

6. **Communities with high capacity that received generally even consequence ratings under all three options.** The relationship of timber harvest levels to consequences in this group is mixed. Some communities appear unaffected by federal harvest levels, others have a slight positive relationship, and others have a slight negative relationship. The high capacities of these communities will allow them to adapt to a variety of federal land management scenarios. Because of their economic and social diversity, positive and negative consequences of changes in harvest levels are likely to balance out in these communities. This is

not to say that all groups will be affected equally in these communities. Some might have forest product related sectors that will benefit from increased harvest levels. Others might have tourist-related sectors that benefit from decreased harvest level. All, however, in the aggregate have the combination of human resources, civic involvement, and economic diversity needed to adapt to a variety of situations.

Some communities will not fit into these general profiles. For example, one small tourism-based community located on a main thoroughfare in a heavily forested area was rated with moderately low capacity and with increasingly negative consequences ratings for options with increased timber harvest levels. Panelists felt that increased log truck traffic would adversely affect the community's tourist economy.

Table VII-7. Predicted level of consequences of four management scenarios expressed as a percentage of communities by consequence level.

Combined for Northern California, Oregon, and Washington						
Management Scenario	*Negative*	*Medium Negative*	*Medium*	*Medium Positive*	*Positive*	No Affect
OPTION 1	36%	22%	22%	7%	0%	10%
OPTION 2	24%	24%	36%	6%	0%	10%
OPTION 7	12%	22%	50%	5%	0%	10%
85 – 87	0%	5%	33%	38%	15%	10%

Table VII-8. Summary of consequences of three management options and the 1985-87 scenario on communities in California (expressed as a percentage of communities assessed).

California	%						
	Negative to Very Negative	*Moderately Negative*	*Even*	*Moderately Positive*	*Positive Very Positive*	*No Affect*	*# Cases*
Option 1	27	43	17	13	0	0	30
Option 3	3	13	73	10	0	0	30
Option 7	0	7	63	30	0	0	30
1985-87	0	13	30	47	10	0	30

Table VII-9. Summary of consequences of three management options and the 1985-87 scenario on communities in Oregon (expressed as a percentage of communities assessed).

Oregon			*%*				
	Negative to Very Negative	*Moderately Negative*	*Even*	*Moderately Positive*	*Positive Very Positive*	*No Affect*	*# Cases*
Option 1	32	28	26	14	0	0	81
Option 3	17	38	40	5	0	0	81
Option 7	4	27	68	1	0	0	81
1985-87	0	1	30	42	27	0	81

Southwest Oregon Region			*%*				
	Negative to Very Negative	*Moderately Negative*	*Even*	*Moderately Positive*	*Positive Very Positive*	*No Affect*	*# Cases*
Option 1	34	38	16	13	0	0	32
Option 3	13	50	31	6	0	0	32
Option 7	3	41	53	3	0	0	32
1985-87	0	0	28	41	31	0	32

West Central Oregon Region			*%*				
	Negative to Very Negative	*Moderately Negative*	*Even*	*Moderately Positive*	*Positive Very Positive*	*No Affect*	*# Cases*
Option 1	40	30	20	10	0	0	30
Option 3	23	43	30	3	0	0	30
Option 7	7	20	73	0	0	0	30
1985-87	0	3	17	57	23	0	30

Central Oregon Region			*%*				
	Negative to Very Negative	*Moderately Negative*	*Even*	*Moderately Positive*	*Positive Very Positive*	*No Affect*	*# Cases*
Option 1	33	0	33	33	0	0	3
Option 3	33	0	67	0	0	0	3
Option 7	0	33	67	0	0	0	3
1985-87	0	0	33	33	33	0	3

Northwest Oregon Region			*%*				
	Negative to Very Negative	*Moderately Negative*	*Even*	*Moderately Positive*	*Positive Very Positive*	*No Affect*	*# Cases*
Option 1	13	13	56	19	0	0	16
Option 3	13	13	69	6	0	0	16
Option 7	0	13	88	0	0	0	16
1985-87	0	0	56	19	25	0	16

Table VII-10. Summary of consequences of three management options and the 1985-87 scenario on communities in Washington (expressed as a percentage of communities assessed).

Washington	*Negative to Very Negative*	*Moderately Negative*	*Even*	*Moderately Positive*	*Positive Very Positive*	*No Affect*	*# Cases*
Option 1	43	10	21	5	1	20	108
Option 3	36	16	22	6	0	20	108
Option 7	23	22	32	2	0	20	108
1985-87	0	5	36	32	6	20	108

Lower Columbia Region	*Negative to Very Negative*	*Moderately Negative*	*Even*	*Moderately Positive*	*Positive Very Positive*	*No Affect*	*# Cases*
Option 1	67	7	0	0	0	27	15
Option 3	40	33	0	0	0	27	15
Option 7	13	53	7	0	0	27	15
1985-87	0	0	27	47	0	27	15

Central Washington Region	*Negative to Very Negative*	*Moderately Negative*	*Even*	*Moderately Positive*	*Positive Very Positive*	*No Affect*	*# Cases*
Option 1	44	11	6	22	0	17	18
Option 3	39	17	6	22	0	17	18
Option 7	28	22	28	6	0	17	18
1985-87	0	11	39	17	17	17	18

Puget Sound Region	*Negative to Very Negative*	*Moderately Negative*	*Even*	*Moderately Positive*	*Positive Very Positive*	*No Affect*	*# Cases*
Option 1	21	3	55	0	0	21	38
Option 3	21	3	55	0	0	21	38
Option 7	11	8	61	0	0	21	38
1985-87	0	5	32	37	5	21	38

Olympic Penninsula Region	*Negative to Very Negative*	*Moderately Negative*	*Even*	*Moderately Positive*	*Positive Very Positive*	*No Affect*	*# Cases*
Option 1	54	19	3	3	3	19	37
Option 3	49	22	5	5	0	19	37
Option 7	38	24	16	3	0	19	37
1985-87	0	3	43	30	5	19	37

Table VII-11. Community capacity: percent (%) of communities assessed by state.

STATE	Low to Very Low	Moderately Low	Moderate	Moderately High	High to Very High	*TOTAL%*	*CASES*
California	20	20	27	23	10	*100*	*30*
Oregon	16	26	23	24	11	*100*	*82*
Washington	12	21	25	12	30	*100*	*84*
TOTAL%	*15*	*23*	*24*	*19*	*19*	*100*	
CASES	*29*	*45*	*48*	*37*	*37*		*196*

Understanding Variation in Capacity and Consequence Ratings

Although there appear to be significant differences in the summary statistics among the three states and among subregions (tables VII-7-10 and figs. VII-3-5), it is not possible to determine if the consequences of new management options will be more severe for communities in one state or subregion than in another. This is because experts did not explicitly make cross-state evaluations, because assumptions, interpretation of options and expertise varied among panels, and because communities were not selected to represent any geographic subregion. The three panels did, however, describe strikingly similar patterns of consequences occurring in communities with similar types of capacity and intervening variables. Thus, although subregional variations can effect consequences, the main processes determining how communities are affected by changes in federal forest polices is similar throughout the region.

There is considerable variation in community capacity and consequences among communities. This is apparent in the state and sub-regional aggregations presented in tables VII-7-11 and figures VII-3-6. Although ratings for community capacity appear to be distributed similarly across the three-state region (fig. VII-6 & table VII-II), capacity ratings vary considerably among subregions (table VII-8-10). A differential pattern of consequence ratings is also apparent, both across the three states, and among sub-regions within the states (tables VII-7-10 and figs. VII-3-5). Descriptions of some of the factors that affect variation follow.

Community Structure and Spatial Factors

Communities with moderately high or high capacity tend to be larger communities. Based on limited population data for about two-thirds of the communities and comments from panelists, high capacity communities have almost twice the population of medium capacity communities and three to four times the population of low capacity communities.

Although examples exist of small communities with relatively high capacity, smaller communities tend to have limited infrastructure, lower levels of economic diversity, less active leadership, more dependence on nearby communities, and weaker linkages to centers of political and economic influence that contributed to lower capacity ratings. These communities also are likely to have less control over resources and capital. As a result, small communities are more vulnerable to external change, such as shifts in forest management and their secondary effects.

Although arbitrary regional constructs such as the state subregions tend to show highly variable community ratings, some regional patterns do emerge directly from the data. The ratings define a region of lower capacity-negative consequences in the isolated interior Coast Range of Oregon and along the west slope of the Cascades. Two other groupings of low capacity-negative consequences lie in the central Olympic Peninsula and along the North Cascade range.

Several spatial factors appear to be significant in determining community capacity and consequence ratings, including transportation corridors, coastal access, and isolation. Washington communities with lower capacity are likely to be smaller, highly dependent on the timber industry, and, like Oregon, beyond primary transportation corridors. Preliminary analysis of the community ratings in all three states indicates that only

Figure VII-3. Consequences of options 1,3,7, and the 1985-87 scenario for the State of California.

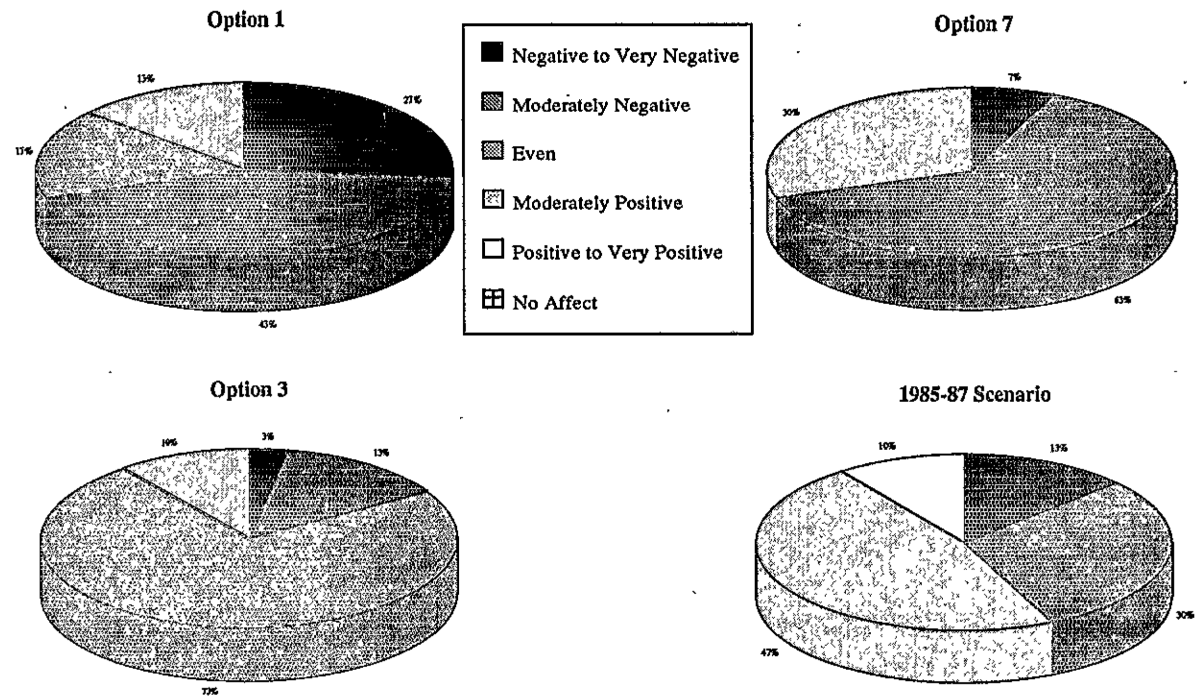


Figure VII-4. Consequences of options 1,3,7, and the 1985-87 scenario for the State of Oregon.

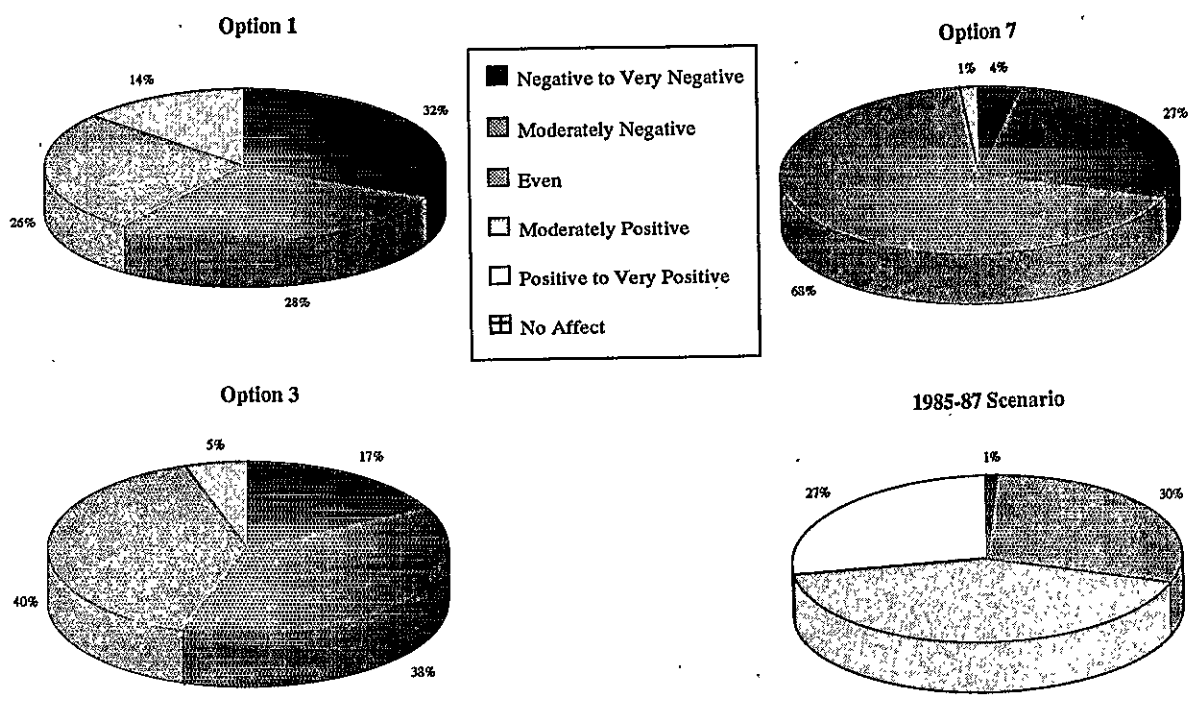


Figure VII-5. Consequences of options 1,3,7, and the 1985-87 scenario for the State of Washington.

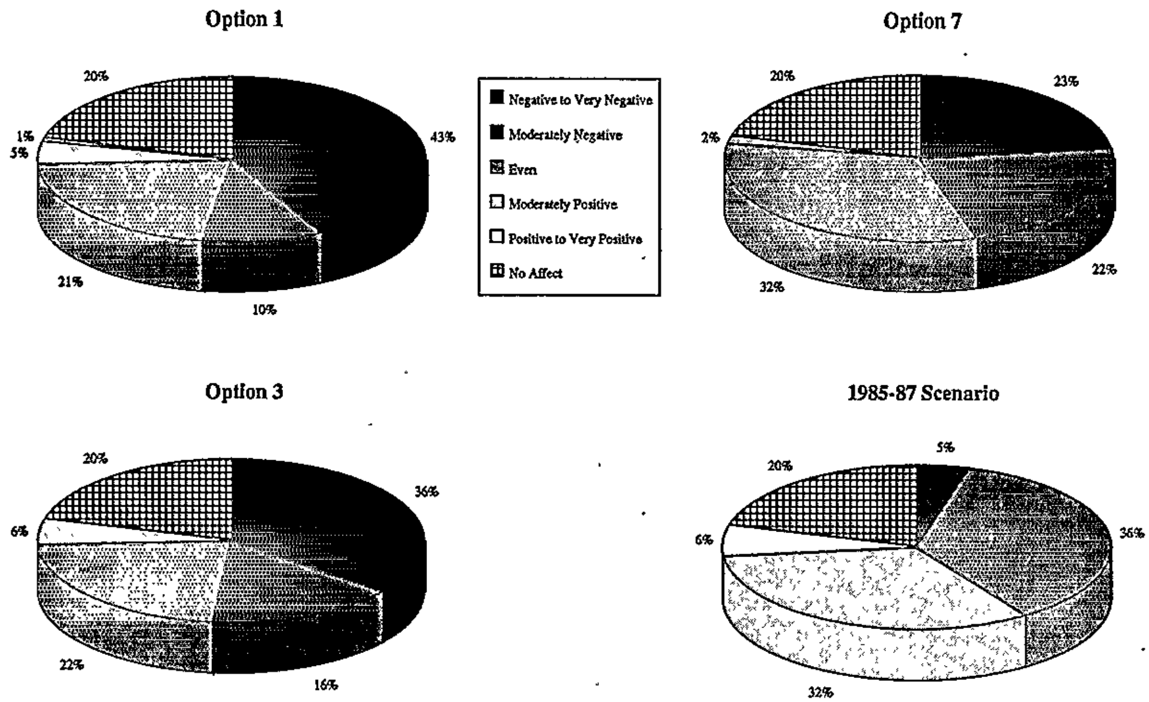
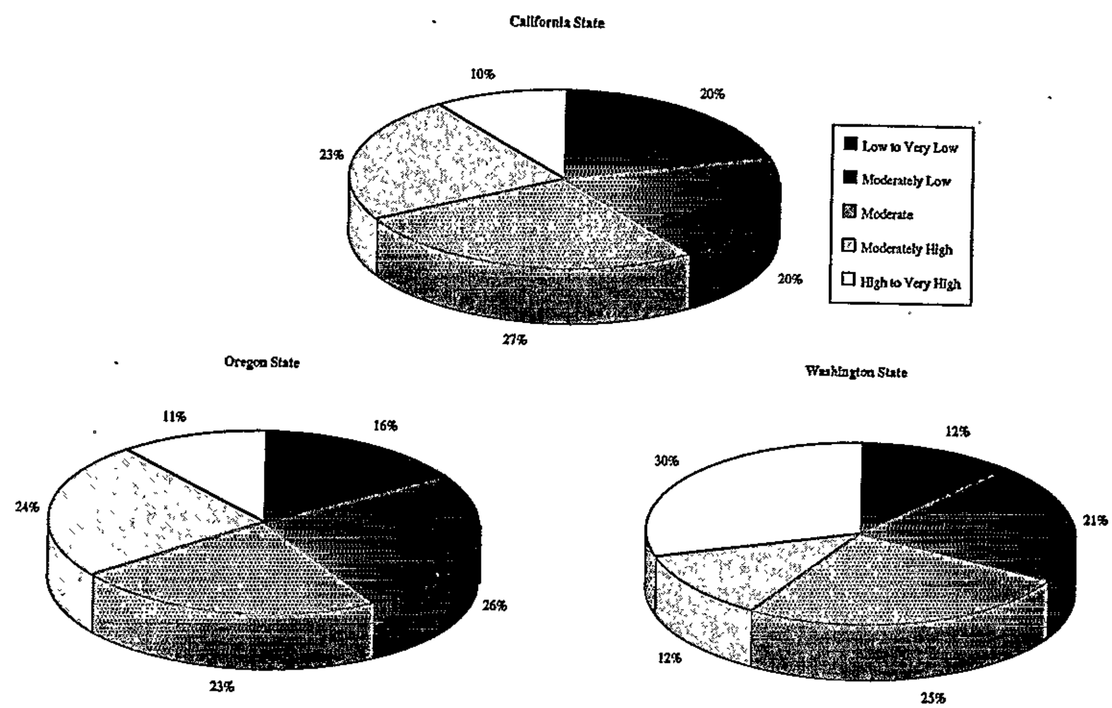


Figure VII-6. Community capacity in the States of California, Oregon, and Washington.



about 20 percent of low capacity communities lie within 10 miles of interstate highways, compared to nearly 60 percent of high capacity communities.

Coastal communities in all three states tend to have higher capacities and more positive consequences, due in large part to more developed tourist industries and more diversified economies. Panelists indicated that communities surrounded by federal lands (typically smaller and in isolated mountainous areas) are likely to have low capacity and more negative consequences regardless of the options. Preliminary analysis of communities rated in all three states indicates a negative relationship between capacity and the closeness and density of surrounding federal forest land.

Panelist Variation Factors

Discussion among the panelists identified a variety of factors that affect perceptions of community capacity and consequences to external policy changes. These factors also explain some of the variation in ratings and verify the limitations of direct cross-state comparisons.

Panelists in the three state groups considered many attributes in common when rating community capacity. The factor most commonly mentioned by panelists was economic diversity, including the degree of timber dependence based on employment and availability of private timber resource. Local leadership and location were also cited as critical components of capacity. Other factors include a history of community-based improvement efforts, community cohesion and conflict, civic involvement, local control of resources, community attitude, cultural identity, population size, and income levels.

Other factors affecting capacity differed among the state panels. For example, in California, emphasis was placed on intra-community conflict over forest issues, control of key resources by outsiders, and positive effects of in-migration to forest communities. In Oregon, community size, planning capacity, county-community relations, outside versus local control, and access to outside resources appear to be significant factors. In Washington, discussions of capacity focused on the percentage of timber dependence (as derived from employment statistics) and the negative effects of in-immigration (mostly retirees) and the poor.

Panelists also emphasized both similar and different factors when assessing consequences. Specific consequences estimated under Options 1, 3, and 7 generally depended on participants understanding of age-class distribution of forests across Matrix lands, assumptions regarding distances bidders are willing to haul logs in a rapidly changing market, and assumptions about availability of timber on state and private lands as well as federal lands outside the region.

Workshop panelists differed in their interpretations of what options meant for consequences to their state's communities. California panelists considered present conditions to be similar to Option 3, whereas Oregon panelists equated Option 7 to current conditions. In Oregon, Options 1 and 3 were considered to improve fisheries and, hence, consequences in coastal and fishing communities. Washington panelists, however, felt that three years was not adequate to improve fisheries.

California panelists viewed the 1985-87 scenario differently than other state panels. Tending to see it as an option, they rated its consequences more negatively because they felt it included a harvest level that was not sustainable. In other states, panelists regarded the 1985-87 scenario more as a base or historic reference point against which to judge change. As an example, in about one-quarter of the California communities the panelists saw positive consequences associated with Option 7 compared to Option 3, but saw generally negative consequences for communities facing a shift from Option 7 to the harvest levels of 1985-87. This pattern of rating occurred in less than three percent of the communities in the other two states.

Panelists in Washington elected to apply a "no effect" rating for a number of communities (about 20 percent) that they felt would not experience any effects of federal forest management. The California and Oregon groups did not use this label; they felt all communities would be affected in some manner and tended to give "even" ratings to communities lacking direct timber-dependency.

The panelists who rated northern California communities considered a larger set of complex interactions affecting communities as a result of federal forest management than did panelists in the other two states. The California group -- rating one-third of the number of communities as the Oregon and Washington panels -- may simply have had more time for detailed discussion and evaluation.

Regardless of these factors, our conclusions represent the general relationships between the management options and rural communities. Because the panelists at the workshops focused on issues of "risk" and "transition," and because those concepts have been an important part of the discussion in the federal forest controversy, the next sections examine these areas in more detail.

Communities at Risk

The concept of risk attracts much attention in a technological society such as ours. As a result, much attention is given to systems of risk analysis and risk assessment (e.g., Krimsky and Plough 1988; Environmental Protection Agency 1992; Krimsky and Golding 1992). In general, risk is defined as the possibility that an undesirable state of reality may occur as a result of natural events or human activities (Renn 1992). At the core of risk analysis and risk assessment systems is a concern with estimating both the probability or likelihood that some event will occur and the severity or seriousness associated with that occurrence. Risk assessment is a risky business, in part, because many of the consequences that we are ultimately concerned with are not only unanticipated; they are unanticipable (Schwarz and Thompson 1990).

There are many forms of risk as well as recipients on whom the risks fall. In the case of the forest management issue in the Pacific Northwest, rural residents who depend upon the forests for employment and other values are major stakeholders and are potentially "at risk." But there are other people to consider; people who are concerned with the fate of old-growth forests and endangered species also feel a sense of risk because the values they hold concerning the forest are threatened by proposals that favor development or timber harvesting.

In this effort, we have attempted to provide a basis for estimating the consequences of the options on people, especially those who reside in the region's rural communities. People in these communities have faced, and will continue to face, direct effects upon their jobs, lives, and lifestyle as a result of federal forest management policy. Panelists predicted that Options 1, 3, and 7 likely would lead to additional mill closures and reduced employment in the forests and that the economic and social infrastructure in these communities would suffer.

The risk to rural communities has been examined in the literature (Carroll and Lee 1990; Lee et al. 1991; Machlis and Force 1988), in various state and federal undertakings (USDA Forest Service 1987; U.S. Department of the Interior, Fish and Wildlife Service 1992; Oregon EDD 1991; Washington State Timber Team 1991), and in various unpublished reports (for example, Lee 1990a; Sturtevant 1993). These studies have focused on different sets of variables or thresholds to define risk. For example, the State of Washington (1991) identified the relative economic risk of 100 communities affected by federal timber harvest reductions. Those communities defined as "high risk" were those in which more than 20 percent of the population was employed in the wood products industries and where significant portions of the local wood products industries were dependent upon national forest timber. Twenty-eight communities were so ranked.

In Oregon, the Economic Development Department's Timber Response Program (1991) carried out a similar analysis. A community was judged to be severely affected if:

- It had a four-percent decline in employment in the timber and wood products industries since 1989 compared to the total 1990 workforce.

- Its annual average unemployment rate exceeded the state's annual average by more than 50 percent.

- The director of the Oregon Economic Development Department determined that the community had suffered, or was likely to suffer, a severe economic decline.

Over 90 Oregon communities were judged to be severely affected by reductions in federal harvest levels. In the Oregon and Washington studies, the definition of risk rests largely on statistics or economic consequences. This focuses on a fairly narrow definition of the factors that might underlie risk, and leads to an overly narrow view of the ways communities might depend on federal lands. The variables used to assess community impacts will also affect policy responses. If the assessment rests on the basis of economic structure, then the policy response is likely to key on those variables as well. As we have previously noted, communities are more than just bedrooms for wood products workers.

People who live near and work in forests value their relationships with the lands in ways that extend beyond their jobs. In addition, events that emanate from beyond federal lands may either mitigate or exacerbate the effects of harvest changes on forest-dependent communities.

For this assessment, we have defined "risk" as a function of the relationship between community capacity and the consequences associated with alternative forest management options. Communities with combinations of low to high capacity and negative to positive consequences illustrate the interaction of capacity and consequences. From a social and policy perspective, this relationship can be used to depict communities likely to be most negatively affected by changes in forest management, and least able to adapt.

To illustrate this, as well as to how differing conceptions of both capacity and consequences can alter the resultant notion of risk (and the communities so defined), table VII-12 shows communities "most at risk" in the shaded areas in the upper left corner of each individual table. These communities "most at risk" are defined as those that are rated with either low or medium-low capacity and that also have negative or moderately negative consequences associated with each option.

Based on this definition of risk, as the illustration shows, Option 1 would result in about one-third of the 167 surveyed communities in the "most at risk" category. The reductions in the number of "most at risk" communities using Options 3 and 7 are relatively small. In all three options, however, the number of communities in the "most at risk" category are large compared to that for the 1985-87 scenario, where only three percent of the communities are so ranked.

As an alternative, "most at risk" communities can be defined as those with medium to very low capacity and even to very negative consequences. With this definition the proportion of communities defined as "most at risk" increases dramatically (note the dotted line on table VII-12). One could also define risk using only capacity or only consequences. These three alternative approaches, however, have serious limitations. Expanding the definition of risk to include medium capacity communities and those with an even balance of consequences pulls in communities that either are not negatively affected or already have the same internal capacity to adapt to negative affects. Moreover, inflating the "most at risk" pool in this manner dilutes the importance of the "most at risk" category and those communities most in need. Likewise, single measure definitions of risk neglect either the internal strength and capacity of communities to respond to management changes or the notion that some communities will be more or less affected by external change than others. However, even in communities that are not defined at risk, there might be groups within these communities who are.

The decision as to how to define the level of acceptable risk is ultimately a political matter. Commonly, debates about risk and, more importantly, what constitutes "acceptable risk" have been dominated by technical and scientific discussions. However, the scientific community is neither qualified nor politically legitimated to impose risks or risk management policies on a population (Renn 1992). Differing concepts of how to define risk held by different stakeholders will lead to different conclusions. Unfortunately, because of the technical nature of much of the risk discussion, the impacts of most concern to those affected by a decision often are not considered at all.

Because risk has variable meanings and different constituents are involved, any judgment as to what will be considered as "acceptable risk" must involve political negotiations among all relevant stakeholders, with scientists and technical specialists playing the role of advisors. Good risk management requires both democratic processes and competent technical input (Otway 1992; Whipple 1992). The information provided in table VII-12 can help policy-makers, scientists, and citizens understand the scope and distribution of the risk issue and how it varies with different management options.

When communities defined as "most at risk" in the above example for Option 1 were compared to other studies (USDA Forest Service 1987, USDI Fish and Wildlife Service 1992, Oregon 1991a, Oregon 1991b, Washington 1991) capacity emerges as an important factor. Of the sample of communities rated in this study and evaluated by other studies (133 communities), 44 (33 percent) were rated "most at risk" in this analysis and at least one of the other three studies. Of the 65 communities rated "most at risk" by at least one of the other studies, but not by the capacity-consequence measure, more than half (53 percent) were not considered at risk solely because of their high capacity rating.

Table VII-12. Relationship among community capacity, consequences of options and risk to local communities (expressed as a percentage of communities assessed).

Option 1	Consequences to Communities (%)				
Capacity	*Negative*	*Moderately Negative*	*Even*	*Moderately Positive*	*Positive*
Low	12 33%	9	0	1	0
Medium Low	13	5	3	2	1
Medium	8	8	59% 7	1	0
Medium High	7	4	4	3	0
High	2	4	9	4	0

Option 3	Consequences to Communities (%)				
Capacity	*Negative*	*Moderately Negative*	*Even*	*Moderately Positive*	*Positive*
Low	7 27%	5	1	1	0
Medium Low	9	6	6	2	0
Medium	4	10	58% 10	1	0
Medium High	6	3	9	1	0
High	1	3	12	3	0

Option 7	Consequences to Communities (%)				
Capacity	*Negative*	*Moderately Negative*	*Even*	*Moderately Positive*	*Positive*
Low	4 22%	6	3	1	0
Medium Low	6	6	10	1	0
Medium	2	6	58% 15	2	0
Medium High	1	5	11	1	0
High	1	2	16	1	0

1985-87 Scenario	Consequences to Communities (%)				
Capacity	*Negative*	*Moderately Negative*	*Even*	*Moderately Positive*	*Positive*
Low	0 3%	2	6	4	4
Medium Low	0	1	12	9	2
Medium	0	0	29% 8	10	6
Medium High	0	1	4	10	3
High	0	2	4	11	2

"Most at risk" communities differ from others in significant ways. These communities tend to be small; they averaged about 3,000 people, compared to the mean of nearly 6,500. They are located in counties with low population density; the average population density in these counties is about half that for those higher capacity communities (37 as opposed to 73). However, low population and low population density are likely more related to capacity than risk. Workshop panelists judged that isolated communities were more likely to experience negative consequences with Options 1, 3, and to a lesser degree 7, because they have few options available locally or in nearby communities and because of limited access to capital and other resources.

Communities that are small, isolated, lack economic diversity, and have low leadership capacity are also more likely to be classified as "most at risk" than others. Residents of these communities may find it difficult to mobilize and respond to changing conditions. They are likely to suffer unemployment, increased poverty, and social disruption in the absence of assistance. A total of 18 communities were defined as having "poor leadership," and 56 percent of these were rated as having moderately low or lower communities with high economic diversity and strong leadership qualities often show a greater ability to respond. For example, of the 30 communities identified during workshop discussions has having "good leadership," 70 percent were rated as having medium or higher capacity and less than one-quarter were defined "most at risk" under Option 1.

In many communities classified as "most at risk", there appears to be a somewhat higher proportion of income from public assistance. This is particularly the case in California where five percent of income was so derived, compared to an average of 2.5 percent in other "most at risk" communities and 1.9 percent in all subregions.

Risk labels can be a double-edged sword. Among the many problems associated with determining risk is the question of how to predict social and individual resilience. The presence of risk in a community may lead to increased survival strategies of individuals. For example, woods workers as an occupational group have shown themselves to be resilient and innovative, capable of subsistence and survival strategies during economic downturns. But at some point, persistent stress will overcome personal, cultural, and social reserves. Labeling communities "most at risk" can also paralyze and demoralize community members, increase social disruption, and, from the labeling itself, create indirect impacts on communities (for example red-lining of communities by banks). It is for these latter reasons and because of the need to involve locals in a self-assessment process that we chose not to report individual community ratings. Further assessment must involve community leaders as appropriate to facilitate self-assessments of individual communities.

Because factors other than federal forest management policies can place communities at risk, policy responses crafted to assist "most at risk" communities should focus on much more than timber and jobs. Policies must also address limited structural diversity, lack of infrastructure, and other factors contributing to low capacity and negative consequences.

Communities in Transition

Some Negative Consequences can be Explained by Economic Shifts Already Underway

Globalization of the economy and replacement of labor by technology profoundly affect the economic well being of many rural communities (Fitchen 1991). Economic uncouplings, described previously, have been partially responsible for unemployment and other economic and social difficulties in many mill towns (Hibbard 1992). These trends are particularly noticeable since the recession of the early 1980's and the subsequent restructuring of the forest products industry.

It is difficult to clearly separate effects of shifts in technology and markets from those of harvest restrictions. This is not to minimize the effects of either; both are happening and are significant. Many arguments, however, have focused on one trend or the other and as a result have often been unproductive.

Uncertainty about Federal Timber Harvest Levels Exacerbates Negative Social Consequences on Communities

Uncertainty over federal forest management has been a recurring concern to many rural residents. Although timber harvests from federal lands have never been guaranteed, residents of communities are currently experiencing a period of extreme uncertainty. This has led to feelings among some residents of intense frustration and helplessness. Prolonged periods of helplessness can negatively affect important aspects of individual well-being and lead to personal and social problems.

Uncertainty has also led to increased social conflict. Local residents' time and energy that might be more usefully devoted to preparing for the future are instead spent on confrontation. There is an important distinction to be made between productive disagreement, that which may improve community cohesiveness, and protracted and divisive conflict as a result of uncertainty, which does not.

The past twenty years have witnessed an ever rising level of discontent and conflict over the management of federal forests. There is evidence that the promulgation of process-oriented legislation and associated planning procedures requiring increased public input and documentation about potential environmental impacts of timber harvest have exacerbated, rather than resolved this discontent (Behan 1990b; Wondolleck 1988). These developments have increased uncertainty about whether and when timber will actually be put up for sale and harvested. Many panelists indicated that any federal forest policy decision -- even if it spells bad news -- will be an improvement over the current situation as it will provide communities with a level of certainty on which to base their efforts.

Communities Undergoing Positive Economic and Social Transitions May Only Have Limited Options

For communities facing the transition from a commodity-based economy, issues related to economic diversity and isolation will remain. Any area not having a diverse economy, and where demand for local goods and services is set in the larger economy, will face fluctuations beyond local control.

Workshop results indicate a number of forest communities have begun to make a transition from traditional timber dependence, and are on their way to alternative economic futures. These futures run the gamut from recreation-tourism, to secondary wood products, to reliance on government-funded facilities such as prisons. Some communities in the region have capitalized on their location near forest or coastal amenities by shifting to a tourist economy. There are thriving tourist communities with high capacity in the region. Although these alternative futures are not problem-free, they do avoid the highly cyclic nature of the wood products industry.

Many of these communities are more diversified (one has a college, another a scientific institution). The presence of institutions such as a community college or even a prison, can have positive effects; in the 18 communities classified as benefiting from the presence of such an institution, two-thirds had capacity ratings of medium or better. For these communities, uncertainly over federal harvest levels is less of a consideration than it once was.

Tourism and in-migration are related, either because tourists discover areas and move there, or because economic opportunities in tourism attract migrants. Therefore, tourist communities may see continued growth through in-migration. However, although tourist related entrepreneurs (hotel, restaurant and gift shop owners, recreational guides) may be successful, tourism jobs are not equivalent to logging or mill jobs. Average wages tend to be lower, jobs tend to be seasonal and part-time, and may offer little in the way of the cultural identity commonly associated with timber related jobs. A community economy based on tourism is also vulnerable to fluctuations in the outside economy. Tourism, by itself, may not add diversity to the local economy.

"Main Street" revitalization plans, attention-grabbing tourist attractions, and other efforts to "dress up" a town to attract outsiders may enhance community image, restoring pride and hope in the future. Such efforts may improve the attitudinal component of community capacity, but also carry the risk of catering more to the needs of visitors than residents.

Growth in the retail sector also faces constraints. Although retail jobs are increasing in many transitional communities, they are likely to have a wage structure similar to tourism. Recently the Pacific Northwest has witnessed a number of new retail operators -- especially discount chains -- and the accompanying development of additional shopping malls, even in smaller communities. Independent retailers in small communities find it hard to compete. As timber jobs decline, small local shops can be expected to feel the impact of lower spending to a larger degree than large discount retailers.

Retirement homes and health care facilities are becoming major employers in some areas as rural economies reflect the shifting demographics of their populations. Jobs in these businesses, other than those requiring higher levels of education and training, are much like those in tourism and sales, but are less likely to fluctuate seasonally.

Other growing economic sectors include food processing plants and retail agricultural products. Low-wage levels, seasonal fluctuations, and poor working.conditions in these industries make them less attractive to many wood workers.

Some communities have explored the possibility of locating both light manufacturing and industry. Del Norte County California bid aggressively for a state prison that has become a major employer in that formerly timber dependent area. Such projects may provide jobs, but also carry liabilities that can diminish the quality of rural life.

Any one sector -- be it tourism, health care, agriculture, or light industry -- is not a panacea for timber-based communities. No single alternative necessarily will provide a lasting economic base. Isolation and dependence on a limited number of employment opportunities will continue to limit economic growth and wage levels for workers in many timber-dependent rural communities.

Because many factors are more important to community capacity than lack of education and job skills, economic development must consist of more than job training. Constraints are not all economic -- but many can be addressed by state and federal policy policies. For example, credit, grant, and rebate programs that put capital in the hands of local communities may address two of the most important factors that reduce community capacity according to the panelists: lack of diversification and outside control of resources.

Community Ties to Outside Organizations Affect Their Capacity in Different Ways

Although small communities are noted for internal ties -- social, economic, and political -- among community members, they are increasingly linked in significant ways to outside organizations and interests. As social theorists note, the trend for rural communities in America has been to shift their focus of "systemic integration and equilibrium" from the community's horizontal (local) axis onto its vertical (extra-local) axis (Warren, 1978). Parts of rural communities are tied more strongly to extra-local community systems than to one another.

Examples of vertical linkages in rural communities are local schools consolidated into a larger school district, churches linked to denominational centers, and branch plants controlled by their central offices. Other linkages include mass media, mall shopping centers, and chain discount stores.

In the Pacific Northwest, a significant linkage for community capacity and consequences are the federal land management agencies, state fiscal and institutional support services, and private industry headquartered outside the community. Workshop panels from all three states indicated that the community capacity of some isolated, small communities is enhanced by a Forest Service or Bureau of Land Management District office in their community. Removal of these offices might devastate some of these "dependent" communities.

The influx of professional staff linked to outside institutions in a community can raise average levels of education and income and add to community leadership. Although these institutions may add to local human capital, however, communities only benefit if this resource is invested in civic responsiveness. Agency downsizing in response to declining timber harvest levels and budgets has demoralized personnel on similar ways to their private sector counterparts; this can compound problems in some communities.

Outside institutions can also have negative effects. The objectives of external agents that control or manage local land, businesses or other resources, may not adequately take into account local interests and lead to negative local effects. An example of this is a mill owner choosing not to reinvest in a local mill which eventually leads to its closing. Lack of reinvestment in rural communities throughout the owl region has led to what some have characterized as deindustrialization in rural areas, which, in turn, has led to lowered community capacities.

Organizations and institutions can provide a range of employment opportunities for individuals in communities from office work to tree nursery stock raising. In some cases, however, the exact skills and experience required by employers do not exist locally. Communities cannot benefit from these opportunities unless institutions make local investments in human capital rather than relying solely on the importation of more skilled outsiders.

Employment opportunities provided by larger institutions can also result in dual economies and local conflict and frustration. Many low skilled jobs (for example, reforestation and forest improvement work) often have substandard pay scales. These jobs offer insufficient benefits and future options. In many cases, locals refuse to take these jobs because of their low pay and low status. Instead, these jobs may be filled by migrant or transient workers who often are not connected locally and initially offer little to local communities.

Panelists from California and Oregon identified a nascent trend in the forest industry, of the hiring of workers at lower wages not only in the "lower end" jobs but also in jobs in the woods and the mills. These jobs are increasingly being filled by recent immigrants and undocumented aliens. The dual economies created under these situations can result in increasing local resentment that is often heightened by the transfer of local jobs to individuals who are culturally different.

Increasing Poverty in Rural Communities

Poverty in rural areas has been growing nationwide (Deavers and Hoppe 1992; Rural Sociological Society Task Force on Rural Poverty 1993). Poverty rates in rural forest dependent communities in the northern spotted owl region are no exception. The recession of the late 1970's and the early 1980's, which was prolonged in rural areas and more severe than in metropolitan areas (Bluestone and Hession 1986), hit forest communities particularly hard (Brunelle 1990). For the 125 communities for which we have both 1979 and 1989 poverty data, the average poverty rates increased from 12.9 to 16.1 percent.

Numerous panelists reported that poverty in forest communities in the region was increasing, with a large proportion of it occurring in female-headed households. Poverty increases through two primary pathways: impoverization "in place" and the "importation of poverty" (Fitchen 1991). Sources of impoverization in place include: industry restructuring leading to job loss (Brunelle 1990; Cook 1992); wages that have not kept pace with inflation (Deavers and Hoppe 1992; Rural Sociological Society Task Force on Rural Poverty 1993); increasing low-wage, often service-sector employment (Gorham 1992) and, more recently, job loss because of declines in federal harvesting.

The "importation of poverty" involves the poor, many from urban areas, moving to forest communities. Economic decline leading to lowered housing costs has been cited as one reason for the importation of poverty (Fitchen 1991; Kusel 1991; Lee et al. 1991.)

Though the workshop was not geared to addressing poverty, nor the complexity surrounding its origins, it is clear that poverty in forest communities is real and a growing phenomena. Many panelists expressed concern about the effects of increasing poverty on already impoverished communities that lack resources. They also pointed out that the effects of poverty in the communities extends beyond those who are poor.

Several panelists indicated that individuals in communities struggling with severe economic declines and local impoverishment have devised creative ways to survive. They recognize, however, that this capacity to survive, although important for individuals, does not necessarily lead to community well-being. This suggests that external support to high-poverty communities directed through community self-development and long-term community improvement programs, may be far more complex than generally conceived.

Groups Within Communities Vary in Ability and Willingness to Respond to Economic Shifts

Attempts to characterize rural forest communities on the basis of one or two sociological dimensions ignore the richness, complexity, and, human dynamics that characterize communities. Similarly, any one rating of the impact of forest management scenarios on a community can mask the differential impact on groups and individuals within the community.

If one focuses on those groups and individuals most negatively affected, it is apparent that, even in communities near urban centers, some occupational groups and their families have felt profound effects.

Social group dynamics and culture shape individual identities and world views; these in turn influence adaptation strategies available and acceptable to group members. Thus what might seem like rational adaptation from one perspective, may be "out of the question" for others. For example, family ties and established personal networks often provide individuals with far stronger links to rural communities than local jobs.

It is important to look within the community to understand social effects of changes in forest management and possible effects of mitigation strategies. Although a community might appear to be doing well on the surface, particular individuals or groups may actually be falling behind. Social mitigation strategies may backfire if not sensitive to cultural differences among community groups, and may even exacerbate conflicts and frustrations on the part of groups left behind. Additionally, mitigation strategies that do not reflect the fundamental changes in context within which they must operate will prove useless.

Demographic Changes can Lead to Conflicting Values Within (and between) Communities

Many forest-dependent rural communities have undergone profound demographic changes in the past decade. Both high and low income immigrants have been attracted to forest communities for their low-cost housing, clean and beautiful settings, and safe, friendly, rural lifestyle. These immigrants bring both problems and opportunities; for example, their presence can increase economic activity and add new and vital leadership, but also lead to changes in traditional community culture.

Both long-term and recent declines in the timber industry and greater societal changes have promoted demographic shifts that affect community capacity. Some social organization components -- leadership, community identity, and cohesion -- remain in transition. Leadership traditionally has been less an issue when a community is able to rely on one or two major employers for both economic and social stability. This is not the present situation in the Pacific Northwest. When mills and forest land are bought by outside interests and local owners leave, community capacity often suffers.

Demographic changes exacerbate inter-group conflict both within communities and between local and extra-local groups. These conflicts pose serious questions relative to the ability of groups in the region to work together to solve common problems. Community capacity will also be threatened by social and cultural dislocation of particular groups. Pressure on social service agencies is critical at a time when public revenue sources are decreasing (for example, as a result of Oregon's Measure 5, reductions in Oregon and California counties tax receipts, or the fiscal crisis in California).

Conclusions From the Community Assessment

Not all communities will be affected in the same way or at the same level of magnitude. However, there are some discernible patterns: most negative effects will be concentrated in rural areas, but some urban areas are also likely to be affected, notably those with substantial forest products employment. Communities dependent upon recreation, amenity, or other environmental resources, on the other hand, may experience positive effects as a result of the proposed changes in federal forest management.

Social assessment at the community level is critical. Variation among communities is lost at county or other aggregates, and measures at other levels, such as the county, lack meaning for people (Perry 1986). In addition, social indicators alone, consisting of aggregated individual data are not only difficult to obtain for unincorporated communities, but also ignore structural conditions at the county and state level and institutional arrangements that influence community well-being (Kennedy and Mehra 1985; Kim 1973).

We recommend that further region-wide assessment should include a community self-assessment component. Self-assessment is a logical part of any mitigation measure as it will reflect the values of people living in the communities; provide a vehicle for integrating local knowledge in policy decisions; and contribute to a sense of community-level ownership in the resulting recommendations.

Community assessment can be a time consuming and costly process when involving panelists throughout a region. Involving communities themselves in a self-assessment does not avoid these time and monetary costs, but still may prove cost-effective. This is, in part, because it will reflect the values of people living in the communities. It also represents a way in which local knowledge can be more effectively integrated into decisions and can contribute to a sense of ownership in the resulting recommendations. Finally, self-assessment may prove beneficial by stimulating dialogue about local conditions among locals that can lead to community self-development. A role for social scientists in such efforts would be to work in collaboration with communities to help devise approaches for self-assessment.

Understanding the effects of federal timber harvest policy requires knowledge about details of the local situation, both in terms of the community and forest conditions on public and private lands. A challenge in social impact assessment is how to distinguish between those effects that stem from general or society-wide forces and those that are situation-specific. For example, panelists generally agreed that industry-wide changes in technology, the globalization of markets, and the dynamics of international trade produced impacts upon rural communities that transcend any shifts in federal forest policy. However, they also expressed frustration when estimating impacts of forest management options without knowing details such as age-class and spatial distribution of forests in Matrix lands, or the capacity or age of local mills. Similarly, details such as changes in quality of local leadership and local land ownership patterns are often crucial. Thus, it is possible for two apparently similar communities to be affected differently by outside influences. Sorting out the relative effects of these respective influences confounds our efforts to define consequences associated specifically with the options.

Panelists tended to rate the difference in consequences from Option 7 to the 1985-87 scenario considerably higher than the difference between Option 1 and 7. As reported in the chapter Economic Assessment of the Options, major reductions have already occurred in timber harvest levels in the owl region (from a peak of about 4.5 billion board feet per year between 1980 and 1989 to 2.4 billion board feet per year from 1990 to 1992). Because the amount of timber in the options offered for harvest is yet another major reduction in harvest levels and the harvest-level difference between the options is relatively small (with the exception of Options 1 and 7) the variation in consequences between options appears relatively small as well. On the other hand, discussions among Washington panelists suggested likely negative consequences, both economic and psychological, from timber harvest reductions that exceed community expectations and lead to a sense of betrayal and the loss of hope.

Option 9 was not developed in time for thorough analysis. It is our judgment based on available information that, although it will result in an allowable sale quantity less than in recent years, the adaptive management areas associated with it will provide management flexibility and help redefine relationships between communities and agencies. The presence of the adaptive management areas is an important distinction of Option 9 as compared to the other options. However, timber-dependent communities are not likely to benefit from Option 9 significantly more than from other options with similar timber harvest levels in the short term.

The negative social and economic effects associated with declining harvest levels have already begun. As panelists indicated, a number of communities have already felt and been grappling with the effects of reduced harvest levels. Because the reductions in harvest levels are the result of court injunction and not the result of official policy, there has been inadequate recognition of these effects and no mitigation measures have been established to address them. Policy makers must therefore address the social and economic consequences of this decision and the social and economic consequences of previous harvest reductions.

The development of a solution to the "forest crisis" in the owl region has offered hope to many that the selected option will reverse this decline. Policy makers must make clear that improving local conditions involves concerted action on the part of locals and not just the selection of a single option or increase in harvest levels. Policy makers must also realize that a government partnership with local communities is vital for achieving this goal.

The variability in capacity and consequences found in this assessment reinforces the need for policies and programs geared to the specific conditions found within communities, rather than any uniform and regional approach. This is particularly important, given the highly complex and multi-faceted nature of capacity, involving not only financial aspects, but also such diverse components as leadership, community attitude, and infrastructure.

Any generalizations about the social impacts of these options, therefore, must be carefully framed. It also suggests that collaboration between biologists and social scientists might produce management actions that minimize negative biological and social effects.

Selecting an option should be viewed as a starting point for involvement of communities in discussions of forest management, not decisions to be imposed from above. As Louise Fortmann noted at the Forest Conference,

> *... we need healthy forest communities...that can take responsibility for successfully solving their own problems...we need locally based planning processes that enable local people to develop and implement diverse policy options...and we need state and federal policies that will facilitate these local processes.*

Implications for Community Policy

Land management policies must be sensitive to the dynamic properties of both biological and social communities and the complex ways in which they are interwoven. More than jobs are at stake. Communities are more than collections of workers; they are complex social systems as fragile, resilient, complex, and elegant as the region's biological systems. This document has described some of the complexity of the social factors that help determine how land management policies affect communities. The ability of communities to respond to changes in forest management in recent years and those likely to occur in the near future, will prove crucial to how they fare under any of the proposed options.

Workshop discussion and analysis by the social assessment team have shown that capacity influences how communities are affected by changes in forest management. Thus capacity can be an important factor in helping communities affected by management changes. However, capacity is multifaceted and differs among communities, contributing to the difference in consequences expected throughout the owl region. Panelists discussed how capacity can be enhanced or diminished by federal and state policies. Understanding capacity is thus critical to developing the most effective policy responses.

A number of key issues raised by panelists who participated in this process are discussed below. Each of the issues helps frame specific strategies and programs that might be undertaken. They also illustrate the relationship between capacity and policy and how they can influence outcomes.

1. The desire for stability, predictability, and certainty are key community concerns; attempts by communities to cope with change are greatly constrained by recent high levels of uncertainty.

2. There is a need for an improved, stable tax base to support such basic community services as schools, social services, and transportation. Adequate social services are prerequisite to responding effectively to displacement caused by changes in federal timber harvest policy. They are also centers of community life where local information is shared and feelings of belonging and social cohesiveness are fostered.

3. Communities residents want to be part of decisions that affect their well-being. They feel that resource agencies have historically been unresponsive to local needs and at times even patronizing to locals.

Overlapping jurisdictions and the lack of coordination in agency activities act as major barriers to agencies' ability to respond to community needs. These conditions make community involvement in resource decisionmaking difficult.

4. There was an overwhelming perception that communities desire to preserve their culture and, for some occupational groups (e.g., loggers), their culture and work are inseparable. Some communities feel themselves and their culture under siege from a hostile urban world that neither understands nor cares about them. This is aggravated in some communities by the cultural and political conflict with ex-urban migrants and the shift from local to absentee ownership of retail and industrial establishments.

5. Additional family and individual stresses result from job loss, declining incomes, and other economic factors. These stresses are aggravated by the in-migration of impoverished individuals from urban areas who are seeking lower housing and living costs. Unemployment, poverty, and family stress often act to diminish community capacity and thus limit the ability of a community to address these problems.

6. Rural communities often feel discounted by economic and social changes over which they have little or no control.

From these broad policy concerns, we can derive a number of specific strategies and programs.

1. There is a crucial need to make land-management-resource policies predictable, coordinated, and realistic in both the short- and long-term. Such policies will help reduce the uncertainty that communities experience today and improve their ability to work with managing agencies.

2. A means must be found by which local communities can expand their capacity to help themselves. In particular, there is need to focus priority attention on those communities having negative consequences and low capacity; these communities are "most at risk," because they have the highest costs to bear and the least capacity to pay.

A variety of actions might be undertaken. Once an option is selected for, for example, strong encouragement should be given to hosting workshops that involve a range of people with knowledge and expertise on the region's communities, and develop a more detailed assessment of likely community-level consequences.

The results of the workshops conducted for this social assessment report should be viewed as illustrative of what can be done, rather than as the source of definitive answers. They were organized and conducted within a very short time, the representation across and within states was not as adequate as we desired, and there was a lack of detail in the options that made precise assessments of community impacts difficult.

Despite such shortcomings, however, the workshops revealed considerable insight to the nature of consequences for communities facing changes in federal forest management policy. The specific nature of impacts results from a complex interaction of such things as age-class distribution on the Matrix, specific standards and guides for management and salvage, and the level of technology in local mills. Policies designed in the absence of such detailed information are not likely to prove useful or effective in responding to the consequences imposed on communities.

A component of the region-wide assessment suggested above should include a community self-assessment program. Community-based social assessment is the first step to determine an appropriate role for federal and state governments as communities respond to changes in forest management. Self-assessment is useful for understanding communities needs *and*, equally important, will enhance community capacity by stimulating local involvement, providing local residents experience in planning for the community, improving morale and, if assessments include county and state officials and resource agency personnel, making linkages with outside institutions. Providing a forum where communities can voice their concerns, collectively define their needs and become effective actors in determining their futures can help catalyze community-based improvement efforts that go well beyond forest management. Self-assessment is a logical part of any mitigation measure as it will reflect the values of the people living in the community, provide a vehicle for integrating local knowledge in policy decisions, and contribute to a sense of community-level ownership in the resulting recommendations.

If preliminary indications are accurate, more financial support is likely to be channeled through ecosystem restoration projects than through more direct means such as job training, grants, or loan guarantees. The contributions that these restoration contracts make to local economies will depend on a number of factors, many of which can be adjusted to increase community-level benefits.

Ecosystem restoration projects can have positive social effects that go beyond economic effects. For example, in one California community, a stream restoration project reduced erosion and improved fish habitat, and provided local jobs, increased civic involvement, and increased locals' pride. Restoration efforts focused at the local level offer a venue for people to work together on issues of mutual concern, and begin to restore not only the biological ecosystem, but the social system as well.

Restoration work needs to be organized and developed. Contracts should be shaped to encourage the involvement of small, local contractors. In these cases, contracts let by federal agencies cannot be too large (e.g., in excess of $30,000) or small contractors will be shut out. Contracting rules might also need to be modified to allow family or extended families to operate.

Ecosystem restoration is a particularly useful mitigation measure because the jobs skills required for it are often held by local workers; also, local knowledge is brought to bear on restoration work, and increased local involvement with the community can result.

3. There is a need to increase the community role in resource decisionmaking, including, but not limited to, the application of local skills and knowledge in the implementation of forest management plans and watershed restoration. This is not just another form of public involvement, but a fundamental change in the relationship between resource management agencies and communities.

The community role is also justified on the grounds that local citizens have a vested interest in the implementation of sound and sustainable resource management programs; they cannot afford to see the environment they ultimately depend on destroyed. A recent report by Ecotrust states it well:

> *Local people don't want to save the environment any more than they want to conquer it; what they want to do is to live in it. If they are to do this, they must concern themselves with conserving and restoring the natural resources on which their lives and livelihoods depend* (Ecotrust 1993, p. 7).

Paehlke and Torgerson (1990b) agree. Speaking of the role of local residents in working with environmental management agencies, they support the idea that residents can and want to play a major role, because citizens (unlike the agencies) have a direct personal interest in the consequences of the decisions that are made and because they often possess the knowledge of local terrain and infrastructure.

Public access to information is a key component of community empowerment. Strategies should be developed for providing increased access to a range of information (particularly geographically-based) related to land use, local ecosystem status and management, and demographics, as well as information related to economic development assistance and opportunities to exchange information with neighboring communities. It is also important that information be provided in an easily interpretable and non-intimidating format. Public information access programs can take advantage of new technological advancements in interactive information retrieval, display and exchange.

4. There is a recurring call for a collaborative relationship among governmental levels and agencies, and between government and private citizens. Such an approach must embrace the states, tribes, and private land managers to mutually create and implement a comprehensive strategy for forest ecosystem management that pays particular attention to the role of people.

There appears to be little coordination across the three states. The governors of the states, or their representatives, should meet with federal officials to identify the desirable level of coordination. This would ensure that each state is learning from the experiences of others, programs are not duplicated, and resources are allocated as efficiently and promptly as possible.

Cooperative learning programs should be encouraged that bring together resource agency policy-makers, university researchers, college and high school students, woodsworkers, environmentalists, local businesses and community organizations to examine resource questions and design long-term projects. Socio-ecological research programs could provide information on the relationship between forest and communities, can enhance community capacity, can improve relationships between institutions and communities, and can help break down the disciplinary boundaries that foster conflict between resource management policies and social needs. In the California community mentioned above, students have planted native vegetation along the stream banks and been involved in monitoring the stream for a local watershed restoration project and for a high school biology class. Students have taken greater interest in their community and some are considering going on to college to learn more about watershed monitoring and restoration. An ongoing socio-ecological program could build a database from year to year on sociological indicators of community well-being as well as biological indicators of ecosystem health.

5. There is a need to utilize the existing network of programs and expertise at local, state, and federal levels. There is a well-established infrastructure for supporting forest-dependent communities in the owl region. State timber teams, economic development departments, and extension services have long focused on the needs of these communities. There appears little need to create a new level of bureaucracy to respond to the forestry situation; it would be redundant, disrespectful of the efforts and people already working on these issues, and wasteful of money that might otherwise support specific programs.

There is a great deal of formal information available regarding local communities, supplemented by a large amount of informal information held by individuals. It is important to find ways to capture and integrate these various forms of knowledge into a single data source.

Even though the design of any policy response will rely on technical and demographic data (e.g., migration, employment rates), the personal expertise of local residents, and community support and development specialists should also play a role.

6. It is important to distinguish between short- and long-term needs. Short-term responses are designed to mitigate the immediate community impacts of harvest reductions (e.g., restoration contracts, replacement funding for schools) and long-term responses designed to enhance the capacity of communities so they are less vulnerable to any single external event. Examples of these long-term responses include local leadership training, planning support, technical assistance for evaluating projects, and cost-sharing programs to encourage economic diversification.

Policy responses should not focus on short-term consequences at the expense of long-term capacity. The proposed changes to federal land management are profound and constitute a fundamental shift in how society views federal forests. These reductions shift the context within which timber harvesting on federal lands occurs. Means must be found to allow federal land management to function effectively within the context of new dynamics. Nevertheless, there is no future in supporting firms or industries that are not competitive in a modern economy.

Short-term consequences can have long-term implications. Loss of cultural continuity, family disorganization, and lack of educational funding can create inter-generational difficulties that might prove more difficult and costly to solve than they would have been to prevent.

7. There is a need to assemble appropriate and comparable data. Because many community support programs are conducted at the state level, most of the data they need or generate is held at that level. Each state tends to gather different information in different ways, making cross-state comparisons difficult. The community assessment team's efforts to use community experts in workshops only partially overcame these problems. Both workshops produced differences between states in terms of patterns of community consequences, but there is no conclusive way to establish the cause for these patterns. More information flow among states, as well as increased involvement of local residents and other community experts, would improve the ability to assess communities across the region.

Related to this problem, there is a need to break down jurisdictional barriers to understanding and responding to social impacts. Just as biological processes ignore artificial boundaries, such as land ownership, social impacts cross most jurisdictional boundaries. Arbitrarily focusing on any one level of organization -- community, county, state -- limits the ability to respond to the social consequences of falling federal timber harvests. Conversely, data collected at any one level can mask important diversity within that category; for example, information reported only at county levels can disguise significant effects within and between communities in that county. Both our analyses and policy responses must focus on multiple levels of social organization so that patterns at all scales can be identified.

8. There is much discussion and interest in the role of job retraining. Discussions with community experts confirm its importance, but also highlight its limitations. Retraining can mitigate some impacts, but it can increase others if designed and implemented without adequate attention to broader community issues. For example, former timber workers might be retrained in a field such as electronics, because of the demand for workers and the potential for year-round family-wage jobs. However, if few of those jobs are located in rural areas, retrained workers will be forced to relocate to other areas to capitalize on their new skills. Community capacity is not improved at all and can be diminished, as workers leave the community for jobs elsewhere.

Workers who accept retraining might therefore have to accept relocation, if retraining is not tied to comprehensive programs of economic revitalization that create a demand for workers in communities affected by harvest reductions. **A pertinent policy question is how to help people through periods of rapid change in socially acceptable ways.**

It will be important to design any retraining programs with an eye to the social and economic characteristics of specific locations. Importing techniques that proved successful elsewhere does not ensure success at the local level.

Recent retraining program evaluations indicate that the strategy with the highest net return is job search assistance (Leigh 1990). The technique is most successful in large complex job markets where displaced workers need to find jobs appropriate to their skills. It's not yet certain that job search assistance would be as successful in the rural Pacific Northwest, because there might be fewer alternative career paths for displaced workers.

The concept of cultural continuity is closely linked to the concept of worker retraining and the subsequent possibility of a need to relocate. Occupation and place of residence can be major factors in individual and group identity. Because timber jobs are disappearing, many rural residents will have to change jobs and relocate. Asking people to change their occupation, residence, or both constitutes one of the most stress-inducing changes in their lives. In effect, it forces people to redefine themselves in fundamental ways (e.g., "I'm unable to support my family"). A portion of the current social discord in the region has arisen because the political rhetoric around the spotted owl and old growth controversy has not been sensitive to this point. If anything, workers in the various timber industries have been portrayed as villains, rather than supported (Lee 1991).

Social theory defines cultural continuity as an important ingredient in social well-being. It provides a sense of who is and where he or she comes from; it also allows some notion of where one is going, at both individual and collective levels. A remark by Buzz Eades' at the Forest Conference states the issue:

> *I cut trees for a living just like my father did before me and my grandfather...But I'm afraid of the future that faces my family.*

It might not be possible for all the sons and daughters of current woods workers to remain, if they choose, in similar jobs. This observation is based on trends in mechanization, harvest levels, and concern for forest ecosystems. However, if we are concerned with the social well-being of all citizens, policies should strive to maintain the idea of cultural continuity, to the maximum extent possible.

The Options May Lead to Many Consequences For Native American Peoples and Cultures

Native Americans have occupied the Pacific Northwest region for perhaps 35,000 years. They were active managers of the land; they used fire and otherwise managed it to create and maintain specific landscapes. Harvesting strategies and techniques were governed by a complex system of social, political, and cosmological mechanisms that served to regulate and distribute resources in a manner which ensured perpetuation of, and access to, culturally important plants and animals. Recent research indicates that certain plants may need to be managed in a traditional manner to maintain their vigor and distribution within the landscape (Blackburn and Anderson 1993).

Access to and use of certain plants (e.g., sedges), animals (e.g., deer), and locations (e.g., fishing sites) continues to be vital to the cultural survival of a number of Indian tribes and communities. Plants provide food, medicines, and materials for utilitarian and ceremonial uses. Certain plants are essential for items that play key roles in the renewal of the earth (Karuk), becoming an adult in society (Yurok), and ultimately are essential to being Indian.

Indian tribes and groups are governments and communities that are potentially affected by a natural resource policy. Federally recognized tribes possess legal status and, in Oregon and Washington, also possess off-reservation rights held in trust by the United States Government. The treaty boundaries in Oregon and Washington are shown in figure VII-7.

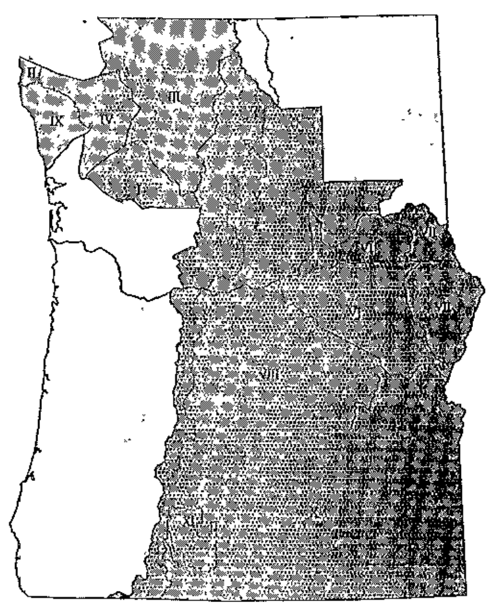
There are 25 federally recognized tribes in California and 36 in Oregon and Washington that are located, have cultural interest in, or have reserved treaty rights within the owl region. Twenty-five of these tribes have treaties and 10 have Executive Orders that affirm certain rights -- both on and off reservations -- for water, gathering, hunting, fishing (including the right to erect stations and temporary housing for curing fish), and other activities and resources.

An important legal principle is that the **off-reservation right to take fish at usual and accustomed places constitutes a property right**; it represents an encumbrance on the land to access the fishing site, irrespective of land ownership. This is the major principle of treaty law that elevates treaty tribes to a higher level than states when discussing relations and governmental matters with tribes. These rights are not granted to tribes, but are retained in their status as prior and continuing sovereigns.

There is a large body of judicial and legislative action that acknowledges these tribes as sovereign governments. As such, the tribes must be consulted on a government-by-government basis regarding policy development. Consultation means more than notification and coordination; it includes meaningful discussions and collaborations with tribal governments in policy development, planning design, and project formulation. Tribes must be consulted as legally constituted sovereign governments, as experts on treaty rights who have precedence over other uses, and as land owners potentially affected by natural resource policy changes.

Treaty rights include reserved rights for fishing, gathering, hunting, and grazing. Treaty reserved rights to gather roots and berries are also reserved by tribes on federal land. These rights have been interpreted through case law to have precedence over subsequent resource uses and must be accommodated by agencies. Only Congress can modify these rights; the federal courts have ruled that these rights must be respected and, if affected, compensation must be made.

Figure VII-7. Treaty boundaries for Oregon and Washington.



At present, there are no existing treaty rights recognized by California tribes within the owl habitat areas. However, there are 10 treaties that are applicable to Oregon and Washington tribes within the owl habitat area.

In addition to these treaty-based rights, **there are various cultural uses associated with natural resource products.** Cultural uses are traditional activities that, while not affirmed specifically in legal treaties, are essential to spiritual activities, cultural identity and continuity, and need to be addressed in decisionmaking.

For both legal and moral reasons, the impacts of management options on Native American uses and values are a key policy matter. There are constraints on direct consultation with the tribes in this exercise. As a result, our analysis of effects is necessarily limited, and it is difficult to determine all the ways that tribes might be affected by federal forest policy and practices.

However, given both traditional and contemporary linkages among Native Americans and forests, it is clear that tribal members have come to depend on public lands and resources for employment, subsistence, and cultural identity. The implementation of **standards and guides -- the specific rules that govern management within different management areas in the forests -- have a potential to either constrain or facilitate many of the practices and activities undertaken by Native Americans.** For example, standards and guidelines that prohibit or discourage the collection of certain plant materials could affect tribal rights and cultural subsistence practices. Habitat protection measures, such as controls on the use of fire, could also have substantial effects if these controls occur within traditional gathering areas (e.g., for grasses) that need to be burned. There was concern that prohibitions on the removal of Port Orford Cedar in old-growth areas on the Klamath National Forest would adversely affect Karuk Tribe members engaged in their rites of passage ceremonies. As with many rural residents (tribal and non-tribal), there was a concern by Native Americans with the constraints imposed on timber harvesting in all the options. The Karuk and Klamath Tribes have requested that specific areas which are managed for full yield be shown as reserves in both Options 1 and 3. Indeed, there appears to be little difference in consequences associated with Options 1 and 3.

Recommendation

- Initiate interagency consultation and collaboration with Tribes on programs sensitive to, and respective of, Native American spiritual beliefs.

The Options May Lead to Many Consequences For Recreation, Scenery, Amenities, and Subsistence

Recreation, scenic, and related amenity values in forests have been a central aspect of the popularity of forests, as well as a basis for much of the concern expressed in public involvement. Indeed, it was the burgeoning recreational use of National Forests and other public lands in the 1950's that foreshadowed much of the public awareness and concern for forest management that arose in the 1960's (Wondolleck 1988).

Subsistence activities on forest lands embrace a range of specific activities and levels of effort, ranging from the casual collection of firewood to significant economic enterprises, such as harvesting mushrooms, floral materials, and other forest products.

Collectively, **these activities represent a major source of values that people derive from forests.** It is understandable that forest management activities (e.g., timber harvesting, road construction) that are perceived to threaten or jeopardize such values are of great concern to the public. These activities and values have remained a consistent and central feature in much of the public input received in response to Bureau of Land Management and Forest Service plans over the past decade; a concern that forest management activities might negatively impact the values, activities, or places that are important to people.

In this section, we turn to an analysis of the potential effects of management options on selected amenity and subsistence values and activities.

Regional Survey of Social Value Information

As a first step in preparing this analysis, we undertook a regional survey of Bureau of Land Management and Forest Service units to determine the nature and relative availability of data on recreation, scenic allocations, and other public-use information. The availability of such data and the relative ease with which it can be accessed provides one measure for which the impact of forest management decisions on social values can be determined.

The eight Bureau of Land Management and 18 Forest Service field offices located within the range of the northern spotted owl were asked to provide information on the availability of data related to 24 types of uses and values. The information was coded as to relative availability (table VII-13):

AG: Readily available on geographic information system (GIS) maps
AH: Readily available on hardcopy maps
AN: Readily available but not on maps
NA: Not readily available
DNA: Does not apply

We have taken the existence of information stored in GIS files as the most desirable for our standard of performance. Increasingly, information regarding other resource values -- particularly commodity values -- is available in GIS. The growing importance of GIS systems (which provides an ability to display information in a rapid, graphic, and relational fashion) is that GIS has the potential for significantly improving management decisions, elevating community understanding of issues and consequences, and upgrading the attention given to a range of values. However, this will only be possible if all the relevant information is available in GIS, and can be processed and analyzed in comparable ways.

However, as table VII-13 shows, most of the social value information we inquired about is not in GIS. Those types of information available in GIS seem linked either to the political significance of the data (e.g., Wilderness or Wild and Scenic Rivers) or to a potential relation to conflicts with commodity values (e.g., roadless areas). For the information requested, there were only six data categories for which more than half the reporting units indicated they had GIS records.

Despite these concerns, the agencies maintain fairly complete data bases for recreation areas. Information on areas managed for scenic values (watchable wildlife, scenic byways, visually sensitive areas) are also generally well-documented in agency data files. In most cases, such data are available either in GIS or on hardcopy maps.

The generally complete databases for recreation, scenic areas, and specially designated areas indicates that the Bureau of Land Management and the Forest Service have a long-term concern for these values. Additionally, the values are reinforced by expressions of concern in public involvement forums and, of course, by the political attention they hold. Clearly, these are major social values for which the agencies must remain sensitive. The results of this survey suggest a relatively adequate data base exists for use in making informed decisions.

However, for other types of social values, data to support informed decisions are less adequate. For example, we found that information related to various Native American values -- historical cultural sites, contemporary cultural sites, and lands under treaty rights -- was variable. Although most units possessed information about historical cultural sites, 25 percent of the units indicated they lacked information in mapped form. Also, a significantly large proportion lacked mappable information for contemporary sites; only 30 percent had such information on GIS or hardcopy map. Only half of those reporting they had lands under treaty rights had this information in mapped form.

Information regarding Native American values can be affected by confidentiality and need-to-know considerations. It is possible that such information is purposely not maintained in readily accessible form so that it cannot be accessed improperly or illegally. However, the lack of site-specific knowledge also increases the likelihood of inadvertent impacts from other forest management activities (road building, logging) because of not knowing where these key values are located. The situation sets the stage for conflicts between Native Americans and managing agencies, making it difficult to promote collaborative relationships between the respective parties (see the related discussion on Native American Peoples and Cultures).

The data in table VII-13 also indicate a lack of GIS or hardcopy mapped information for a variety of other social-value categories. Some of these are surprising; for example, nearly 70 percent of the reporting units indicated a lack of information about special-use permits and other leases in mapped form. About 30 percent lack mapped information on utility rights-of-way and special places identified in cost-sharing grants. There are also surprisingly high figures for areas under land-tenure adjustments, and areas where mineral, oil, and gas leases have been granted.

We documented how poorly equipped the agencies are for dealing with issues such as recreation, scenery, special forest products, and subsistence. Information is collected and stored in different forms, even in neighboring units of the same agency. Relatively little of the information is readily accessible in GIS. Some information that would be useful for social assessment, for example community data) is not available in any form. Consequently, it was not possible to easily compare how the options affected the values society is very concerned about.

The lack of GIS-based information about most social values is disturbing. Informed decisions about forest management that consider the subsequent consequences to social values presupposes an understanding of their nature, location, and distribution. The ability to display this type of information quickly, accurately, and in a mapped format is critical in modern resource management. However, results of our review suggest that it is often not possible. In extreme cases, it appears the information is either totally absent or retrievable only through pain-staking efforts. This is not surprising because of the reliance on linear programs such as FORPLAN in forest planning. Spatial information regarding multiple values, although essential for solving conflicts over forest land use, has only been a priority of agencies in recent years. In summary, it seems impossible to have professional and responsible management of key social values in the absence of these data in GIS format. A major effort to remedy this situation is needed.

Recommendations

- The agencies should immediately and jointly begin to obtain comprehensive coverage of key social value information. Such information is essential for monitoring, evaluating, and assessing the tradeoffs in different management scenarios and actions. The information should be available in GIS to allow easy manipulation of data for analytical purposes.

- Agencies need to improve their systems of institutional memory and analytical ability to respond to growing public concerns that have a range of social values.

- Agencies should work closely with Native American groups to ensure that they possess adequate information regarding cultural values to prevent inadvertent loss of these values in the course of forest management activities. Special care to ensure privacy of this information is necessary.

- Agencies should explore opportunities to participate in joint fact- finding efforts including determination of what information is needed and it's acquisition and analysis.

Table VII-13. Bureau of Land Management and Forest Service combined data availability summary.

		Availability Status %				
	Resource Items	AG	AH	AN	NA	DNA
1	Developed Recreation Sites	42	54	0	0	4
2	Recreation Opportunity Spectrum Classes	31	38	4	4	23
3	Developed Trails and Trailheads	42	50	4	0	4
4	Roadless Areas	50	19	0	0	4
5	Special Recreation Management Areas	23	4	0	0	73
6	Nat'l BC Byways/Scenic Byways/TourRoutes	19	42	12	0	27
7	Watchable Wildlife Areas	4	31	31	12	22
8	Wild and Scenic Rivers	73	23	0	0	4
9	Wilderness (Designated/WSA's/ISA's)[1]	73	15	0	0	12
10	Wilderness (RNA's/ONA's/CAEC's/Other)[2]	88	8	0	4	0
11	Congressionally Designated Areas	58	15	0	0	27
12	Visually Sensitive Areas	72	12	4	12	0
13	Areas Under R & PP Lease[3]	15	8	12	8	57
14	Special Use Permits and Other Leases	8	19	42	27	4
15	Cultural Sites	19	54	19	8	0
16	Native American Contemp. Cultural Sites	8	22	12	54	4
17	Community Watersheds	31	27	12	15	15
18	Utility Rights-of-Way	19	47	15	19	0
19	Key Sites of Current Concern	15	19	31	31	4
20	Special Places ID'd in Cost Share Grants	0	4	15	15	66
21	Rural Interface Areas	23	0	0	8	69
22	Land Tenure Adjustments	19	31	15	31	4
23	Land Under Treaty Rights	8	15	12	12	53
24	Minerals/Coal/Gas/Geo. Leases/Permits/Claims	8	27	38	27	0

AG = readily available on GIS maps
AH = readily available on hardcopy maps
AN = readily available but not on maps
NA = not readily available
DNA = does not apply

1 Wilderness Study Area, Instant study area.
2 Research natural areas, outstanding natural areas, critical areas of environmental concern.
3. Recreation and public purposes.

The Case Study Workshop

The social assessment team conducted a workshop to supplement data collected in the regional survey and to provide a geographically specific understanding of how the options would affect social values.

It was not possible to survey all the Bureau of Land Management and Forest Service administrative units in the region because of the time constraints. The decision was made to select four sub-regional areas for an in-depth case study analysis. These four case studies provided a more detailed examination of the pattern of values and the possible consequences of management options.

Four criteria guided selection of case study locations: (1) each state should be represented; (2) lands administered by the Bureau of Land Management and Forest Service (representing a mix of rural- and urban-resident influences) should be included; (3) there should be wide geographical representation (e.g., coastal, Puget Sound, Willamette Valley); and (4) areas where the key endangered species (northern spotted owl, marbled murrelet, old growth, etc.) should be included. Based on these criteria, the following case studies and participating field units were selected:

Washington: (Seattle to east side of Cascade Range)

Mt. Baker-Snoqualmie National Forest
Wenatchee National Forest

Oregon

Mid-Willamette Valley

Bureau of Land Management
Salem District
Siuslaw National Forest
Willamette National Forest

Southwestern Oregon

Bureau of Land Management
Medford District
Bureau of Land Management
Klamath Falls Resource Area
Siskiyou National Forest

California (Klamath Mountains to Pacific Coast

Bureau of Land Management Ukiah District
Klamath National Forest
Six Rivers National Forest

The case studies were conducted during a 2-day workshop. Each group worked in a facilitated setting, with common guidelines for the exercise.

Because of the short timeframe that workshop participants had and the complexity of the seven management options being considered, it was decided to focus analysis on only three options. Option 1 (maximum reserve), Option 3 (a hybrid involving a diversity of management actions among the geographical regions), and Option 7 (representing the current Bureau of Land Management and Forest Service plans). This range of options also permitted us to bracket the range of possible consequences to determine if they were sensitive to changes in the options.

Participants were asked to provide their best estimate of the consequences to a range of social values that might result from the options. The participants were provided a background discussion on the concept of social values, to indicate that these were features, attributes, and qualities of the environment to which people ascribe worth and importance.

We stressed the identification of *consequences* rather than impacts. All management actions, including no action, lead to consequences. Some may be interpreted as positive, others as negative, and still others as a mix. The purpose of this exercise was to obtain the participant's best estimate of the nature, distribution, and significance of the various consequences: what would happen, where, why, and so what?

Participants were urged to be creative and not overwhelmed by the task. They were also asked to be explicit about assumptions and provide whatever documentation they has to back their judgments. It was stressed that the lack of information was information in itself; and our inability to describe consequences associated with the options helped us define areas of management that need attention and research.

There are Mixed Effects of the Options on Recreation and Scenic Values

National Forests and Bureau of Land Management Districts provided information on the land they currently have allocated to recreation and scenic purposes. From this baseline information, it was possible to examine how the allocations would be affected by the options. We specifically examined the changes associated with Option 1 (maximum reserve) and Option 7 (the Forest and Bureau of Land Management plans) to provide a measure of the likely range of effects.

For recreation, we were particularly interested in the extent that the options would affect the current allocations of primitive and semiprimitive nonmotorized recreation. To what extent would these allocations be located in the Matrix when compared to the Reserve classifications?

The information on recreation demand that is reported in both the Oregon and Washington State Comprehensive Outdoor Recreation Plans indicate there is a high and increasing demand for recreation settings with little development and management activity, relatively low use, and no motorized access permitted. For example, recent work by Swanson and Loomis (1993) indicates that although there are about 5.5 million acres in the region currently allocated to primitive and semiprimitive, nonmotorized recreation, the forecasted demand by the year 2000 will be nearly 13.5 million acres. It is clear that settings which cater to these forms of recreation are especially valuable. Decisions affecting these areas by increasing their accessibility or by modification (e.g., road building, timber harvesting) need to be carefully considered.

We examined the status of the current primitive and semiprimitive nonmotorized acres in the Matrix for Options 1 and 7. Areas within the Matrix will not automatically be subject to timber harvest or other developmental actions. However, given the constraints on development within the Reserves, these lands will be an obvious place where commodity demands may be met. Therefore, having an idea of how much recreation land would be in the Matrix provides an indication of how much recreational opportunities would be at risk to development.

Over half of the primitive and semiprimitive, nonmotorized acreage in each state would be in the Matrix, in both Options 1 and 7; nearly two-thirds of the acreage in California and Washington would be in the Matrix in Option 1 (table VII-14). In fact, Option 7 would actually result in there being slightly less acreage in the Matrix than in Option 1. Although the range between Options 1 and 7 for California and Oregon is only 6 percent, it represents over 100,000 acres for the two states. Combined with the distributional effects of the different options (which we were unable to fully capture in our analysis), the effects of the two options could be quite different.

It remains problematic as to what the implications of these effects will be because of the uncertainty of what specific management actions are permitted in either the Matrix or Reserves. For example, the fact that areas currently allocated to primitive or semiprimitive, nonmotorized recreation are located in the Matrix does not automatically mean these areas would become roaded or otherwise developed. Conversely, the fact that such areas are located within a Reserve does not automatically preclude the possibility of some developmental activity. However, given the conservation objectives and viability concerns associated with Reserves, their overlap with these primitive or semiprimitive, nonmotorized recreation areas will result in additional protection as well as an opportunity to provide a desired and demanded recreational setting.

The issue of standards and guidelines is crucial for recreation. The extensive reserve systems proposed in the options may offer a wide range of recreational opportunities, especially for nature-based activities such as camping, many styles of hunting and fishing, hiking and so forth. The creation of sensitive standards and guides represents an important way in which special places that embody much of the meaning forests hold for people can be protected for their continued enjoyment (Clark et al. 1984).

Standards and guidelines that allow for the construction of trails, recreation sites, and a variety of other low-level developments would make available the recreational values offered by the options. Such developments would not only result in the provision of desired opportunities, but they would also lead to significant economic values. Swanson and Loomis (1993) have calculated the annual recreation benefits that would accrue under selected options. They report that under Option 1, total yearly recreation benefits would be $825 million, less than that associated with the current situation ($842 million). However, by developing standards and guidelines that focused on the creation of additional semiprimitive nonmotorized and semiprimitive motorized recreational settings, this annual benefit could be increased to $910 million.

Rich opportunities exist to capture a range of values from the options -- they yield not only ecological and scientific values, but can also contribute to a variety of public uses and economic values. The development of standards and guidelines that promote opportunities to realize these values is a key issue; it represents one of the major ways in which the economic and social benefits of the options can be more fully captured.

With regard to scenic allocations, we examined two possible outcomes. First, we examined the extent to which areas currently managed for the retention and preservation visual quality objectives would be located in the Matrix. The preservation Visual Quality Objectives permits only ecological changes in the landscape; retention objectives require that management activities not be visually evident. Therefore, areas in the Matrix with these Visual Quality Objectives' represent another factor that might constrain developmental activities in the Matrix.

Over half these Visual Quality Objectives acres would lie within the Matrix for each state in Option 1. There are not large differences among the three states. In Option 7, the percentage rises in all three states, particularly in California (table VII-15).

We also examined the converse of the above: how much of the land with modification and maximum modification Visual Quality Objectives' would be located in Reserves? Modification permits management activities to be dominant in the foreground and middle ground of the visual landscape are as, but they must appear natural. Maximum modification is defined as where management activities are dominant, but appear natural because they are in the background (3 to 5 miles out, depending on slope).

Option 1 would result in between 30 and 60 percent of the modification and maximum modification landscapes occurring within Reserves. When Option 7 is considered, the figures drop sharply; only in Washington would a significant proportion of these areas be located within Reserves (table VII-16).

Table VII-14. Percentage of primitive and semiprimitive nonmotorized acreage located in the Matrix in Options 1 and 7 (by state).

	Current Acreage	*Option 1*	*Option 7*
California	816,340	65	65
Oregon	1,190,591	52	58
Washington	1,377,093	68	62

Table VII-15. Percentage of retention and preservation visual quality objective lands located in Matrix in Options 1 and 7 (by state).

	Current Acreage	*Option 1*	*Option 7*
California	1,575,770	58	79
Oregon	1,837,338	54	64
Washington	3,207,015	58	63

Table VII-16. Percentage of modification and maximum modification visual quality objective lands located in the Reserves in Options 1 and 7 (by state).

	Current Acreage	*Option 1*	*Option 7*
California	2,517,272	35	13
Oregon	4,858,015	40	28
Washington	1,903,733	61	45

Locating areas managed for modification and maximum modification Visual Quality Objectives' in the Reserves does not necessarily imply that changes in the Visual Quality Objectives would occur (e.g., from modification to retention). However, an opportunity does exist to re-examine the objectives and undertake steps to create landscapes with a more natural appearance landscape. Such a management direction is wholly consistent with research on preferred visual landscapes in forest settings (Ribe 1989), and complies with the strongly expressed preference for more naturally-looking landscapes revealed by public input. Driving for pleasure is the most demanded recreational activity on federal lands. Landscapes within Reserves would likely be more appealing for sightseeing as well as a more desirable backdrop for other recreational activities than areas subject to intensive timber harvesting, particularly near campsites (Clark et al. 1984).

The ability to create a more natural appearance for landscapes is also consistent with State Comprehensive Outdoor Recreation Plans results. To meet projected recreational demands by the year 2000, the Oregon and Washington State Comprehensive Outdoor Recreation Plans indicate that 18.6 million acres of natural landscapes would be needed, compared to only 4.7 million acres of heavily modified landscapes. If the amount of land needed to accommodate the demand for natural-appearing landscapes is not available in the future, associated economic benefits will not be realized.

For both recreation and scenic values, the options present opportunities to meet important public concerns and interests. The provision of primitive, nonmotorized recreational opportunities and the creation of more natural appearing landscapes are consistent in many ways with conservation objectives associated with the Reserves. The specific management of both the Matrix and Reserves will be guided by the standards and guides developed for these areas; the opportunity to increase the flow of human benefits to the community that this discussion reveals will be an important influence on the standards and guides.

Recommendations

- Agencies should develop comparable data collection systems that allow comparisons of recreation use and supply, scenic allocations, and related public uses.

- Information regarding various social values should be incorporated into GIS systems as soon as possible to enhance their value and use in decisionmaking.

- Standards and guides prepared for management of both Reserves and Matrix lands should attempt to accommodate the growing demand for natural-appearing landscapes and recreational opportunities featuring nonmotorized access.

Bureau of Land Management and U.S. Forest Service Field Staff Who Participated in the Workshop Brought High Levels of Expertise, Energy, Enthusiasm, and Creativity With Them

Their local knowledge was impressive and they were typically able to provide detailed and specific information about the nature and location of the values with which we were concerned, as well as trends and patterns in the uses of these resources. Clearly, the agencies have a rich, committed cadre of people upon whom they can call and who bring high levels of energy and enthusiasm to their work.

However, we were also struck by the idiosyncratic and anecdotal nature of much of this knowledge. Often the knowledge these individuals had to provide was the product of their own effort and concern, as opposed to that available through any systematic or routinized data collection system; there was little evidence of organized institutional memory. It was also apparent that little in the way of systematic data sharing among management units occurs; during group discussions, individuals were constantly "discovering" that others were also interested in, collecting, and concerned about, certain uses (e.g., mushroom collecting).

Finally, it was apparent that many of these values exist only as residual, secondary, and incidental to the primary job of timber management. The most obvious and explicit consideration of these values comes when their presence or use becomes a constraint on timber production or when mitigation measures are required. Despite the growing rhetoric calling for integrated resource management, we found little evidence of such practices. There was little in the discussions during the workshop that would lead us to change our view that the ability to integrate various forms of social values -- commodity, amenity, ecological, scientific -- into decisionmaking processes is limited by lack of knowledge and mechanisms for managers (Stankey and Clark 1992; Clark and Brown 1991).

Recommendations

- The professionalism underlying management of recreation, scenic values, subsistence, and related social values needs to be upgraded. This includes systematic data collection, "user friendly" data storage and retrieval systems, and integrative analytical frameworks.

- Functional and disciplinary structures and processes, including planning and budgeting, need to be replaced by multi-functional, interdisciplinary systems. Workshops, training sessions, and other forms of continuing education that address integrative approaches to planning and management should be given greater attention. .

- Educational curricula need to increase attention to formally incorporating interdisciplinary and integrative approaches into classroom teaching. If forestry and natural resource management programs fail to make these changes, it is likely other academic programs may take the initiative; if this should eventuate, foresters and other technically-trained individuals will find themselves increasingly removed from key decisionmaking positions. In particular, attention needs to be devoted to providing students with analytical frameworks that enhance integrative thinking and strengthen both problem-defining as well as problem-solving skills.

- Agencies should give priority attention to ways of encouraging and awarding integrative, interdisciplinary approaches to management, planning, and research.

Public Judgments of Acceptability Influence Management

What are the factors associated with effective resource management? Generally, three conditions are seen as necessary for any resource management program to succeed: (1) it must be ecologically sustainable or possible, (2) it must be economically feasible and (3) it must be culturally adoptable or socially acceptable (Firey 1960).

The first two conditions have attracted the most attention. The ecologically sustainable nature of any program is, in fact, what has brought recent attention to the question of forest management in the Pacific Northwest. There is also mounting evidence that many forest management programs, especially those related to timber management, are not economically feasible. Deficit timber sales, for example, have become a major political issue.

The issue of the social acceptability of forest management practices and conditions has attracted less systematic attention. Nonetheless, it is a crucial concern. Those forest management practices (e.g., specific timber management prescriptions) and conditions (e.g., clearcuts, road networks) that society judges unacceptable, by whatever criteria, simply cannot continue in the long-run. This is true, despite the fact that the given practice or condition might be based on sound science, or capable of producing significant economic returns. An example is the virtual foreclosure of large-scale clearcuts.

The social acceptability of forest management activities bears significantly on the current issue in the Pacific Northwest. Although the effect of public acceptable on management of Matrix lands is particularly a concern (largely because it is on the Matrix that timber harvesting would most likely be considered), it also will affect decisions for Reserves. For example, the question of the role of fire as a means of achieving conservation objectives, in these areas will need to consider public acceptability, irrespective of ecological or economic arguments.

Because there is a relatively large area committed to Reserve status in the options, the Matrix lands, which have a generally greater latitude for multiple-use management activities, will be the focus of much attention. However, Matrix lands also are seen as contributing to the viability of the owl population (because they serve as connections among Reserves); as a result, they have a dual role that will further intensify public scrutiny and concern.

In short, **the lands within the Matrix have been and will continue to be the source of a variety of other values** (e.g., recreation, scenic quality, special forest products, conservation objectives). To the extent that timber harvesting conflicts with these other values, it is likely to be further constrained by them. Public judgments of acceptability will play a major role in the form and extent of these constraints.

Public concerns about harvesting practices and associated conditions -- their impacts on scenic quality, biodiversity, wildlife -- represent a factor that further influences what proportion of the Matrix will be available for timber management. For example, comments received from the public on Forest Service and Bureau of Land Management plans reflects extensive concern about the impacts of timber harvesting and resulting conditions on a host of other values, special places, and concerns. In short, public judgments of acceptability can have profound impacts on what proportion of the Matrix is harvested.

Acceptability judgments can be influenced by public beliefs about ecological processes, agency motives, the importance of aesthetics, or the feasibility of achieving alternative forest conditions. It is important to understand the conditions under which acceptability judgments are formed and the factors that affect such judgments. Nevertheless, the concept of acceptability is complex. Even the definition is problematic; for example, that which is acceptable is not necessarily desirable. What is considered acceptable could be defined as a goal that managers strive for or, alternatively, a threshold of tolerance they dare not fall below. In short, do acceptable judgments reflect an optimal state or merely define that which is tolerable?

Managing the Matrix: Implications from the Acceptability Literature

Several important implications for management of the Matrix can be drawn from the literature and research on the issue of acceptability.

Knowledge is positively associated with acceptability judgments, a point consistent with conventional wisdom about the importance of "educating" the public. When people understand the rationale, basis, and purpose of a practice, judgments of acceptability normally arise. Judgments are based on not only what we see, but also on our understanding of how and why. For example, Brunson and Shelby (1992) reported that the acceptability of "new forestry" practices was positively related to the evaluators' knowledge about ecosystem management. The practice of new forestry (Franklin 1989) may indeed represent an acceptable practice for timber harvesting, especially in areas where traditional techniques (e.g., clearcutting) are not possible. However, this is most likely only if the public has an opportunity to learn about the technique and its relationship to an ecosystem-based approach to management (Brunson 1991).

Judgments of acceptability concern more than scenic impacts. Public dissatisfaction with timber harvesting in general and clearcutting in particular often is seen as based on an aesthetic concern. However, a growing number of researchers suggests there are other factors. Gobster (1992), Brunson (1991), Kusel and Fortmann (1991), and Fortmann and Kusel (1990) have discussed the priority assigned to such issues as biodiversity, species survival, and long-term site productivity in public judgments about acceptability.

The role of context has a major effect on public judgments of acceptability. A contextual issue that is especially relevant to judgments of a forest condition or practice is that of "special place"; specific areas to which people have attached a special meaning or memory (e.g., a favorite recreation site) (Mitchell et al. 1993). Practices or conditions generally judged to be acceptable may not be so in such places. Inventories that identify such sites can be valuable in forestalling actions that might otherwise have been undertaken.

A closely related issue is the question of scale. Specific forest prescriptions may find acceptance in the abstract, but when applied to the ground may be judged in terms of a larger spatial scale. For instance, Brunson (1992) describes a situation in which a particular prescription was criticized, not in terms of its appropriateness at a given site, but in terms of being yet another example of harvesting in a large landscape where overcutting had already occurred. The extensive acreage devoted to Reserves in the options might forestall some of this concern, but it is likely that the region's history of harvesting will still lead to concerns about future cutting in Matrix lands.

For some people, **the perceived risk associated with harvesting will remain an issue** that has two related dimensions. First, there will be a concern that the Reserves still are not adequate to ensure long-term viability of the species for which they have been designed. In such a view, harvesting in the Matrix will remain a threat to species survival. Second, harvesting methods in the Matrix that adopt non-traditional prescriptions (e.g., new forestry methods) are seen as untested and likely to have unknown consequences. In particular, when biological diversity and ecological integrity appear at risk, decreased acceptability will characterize the situation (Brunson 1993). When dealing with complex ecosystems where there are inherently high risks associated with little knowledge, we can expect relatively low levels of acceptability for practices that are problematic (best expressed by Jack Ward Thomas at the Forest Conference: "*ecosystems are not only more complex than we think, they're more complex than we can think*").

The risk associated with uncertainty and imperfect knowledge is exacerbated by the concerns held by many people about agency motives. In a survey of alternative conceptions of the Forest Service New Perspectives Program, Clark and Stankey (1991) reported that a significant number of respondents described the effort cynically. There remains uncertainty among the broader community, as well as resource management professionals, as to whether ecosystem management constitutes a real change or is simply another name for traditional forestry. In managing Matrix lands, as well as those options in which "special" silvicultural practices are used in portions of Reserves, this cynicism may be expected to cloud judgments of acceptability.

The importance of interpreting public acceptability within the proper spatial context cannot be over emphasized. The most obvious implication of this for the Matrix is that the production of multiple resources, including commodities, will be more acceptable in the Matrix if the area protected from harvesting is large. However, the influence of spatial scale on acceptability is more complex.

Just as different properties of a biophysical system emerge at different levels of resolution (e.g., from site to stand, from stand to landscape, etc.) so do properties of a sociopolitical system (from the individual to the community, from the community to the region, etc.). It is important to consider public acceptability at each of those scales. **Any ecosystem management solution must allow sufficient flexibility at smaller scales to allow for adjustments to meet the particular needs of the local public, as well as those of locally important plant and animal communities.** However, there must be sufficient structure to ensure that overall ecosystem objectives are met at the larger spatial scales and that the values of regional and national publics are protected.

There is mounting evidence of public support, in both rural and urban settings (Fortmann and Kusel 1990; Steel et al. 1993), for policies and programs that support environmental protection. This evidence suggests an *acceptable* ecosystem management solution will be one that clearly goes beyond the minimum Reserve system to ensure survival of currently listed threatened and endangered species. Moreover, biodiversity and ecosystem sustainability must also be given considerable weight in Matrix lands.

From Public Involvement to Public Participation

Although an array of legislative requirements exist for public involvement in resource management and planning, well-established programs and policies that integrate public input into decisionmaking remain elusive. The National Environmental Policy Act (and accompanying direction in the *Forest Service Manual*) calls for public input to agency decisionmaking as a means of identifying issues, concerns, and opportunities. When an Environmental Impact Statement is required, Forest Service policy calls for "*an early and open process to facilitate free and open communication with the public.*" The National Forest Management Act reaffirms this direction: public involvement is to play a central role in the forest planning process. The Federal Land Policy and Management Act of 1976 provides similar guidance to the Bureau of Land Management regarding public participation efforts.

Despite this legislative mandate and agency efforts to meet its requirements, there is substantial evidence that the goals underlying public involvement programs -- informing people, soliciting their ideas, integrating their concerns into decisions, and being responsive to those who own public lands -- are not met in practice (Shannon 1990, 1992b). For example, despite the massive public involvement effort undertaken in the preparation of Forest Plans as mandated by the National Forest Management Act, virtually all plans have been confronted by litigation, public dispute, and charges that the plans fail to be responsive to public concerns (Behan 1990b).

There are also claims that, at best, the Forest Service uses the results of public participation to make marginal changes in decisions: at worst, it uses them to sugarcoat decisions already made. Using data from the RARE II process, Mohai (1987) contends that statistical support is lacking for the agency's position that public comment was a factor in roadless area allocations. Based on his personal experiences as an environmental advocate in southern Oregon, Brittel (1991) argues that the Forest Service uses public participation, and indeed its entire National Forest Management Act and the National Environmental Protection Act planning processes, to rationalize and substantiate *faits accomplis.*

Such outcomes breed a cynicism toward agency efforts that can be crippling. Ironically, it often seems that agency public involvement programs exacerbate the problem: Wondolleck (1988) has noted that **programs are often designed in such ways that they promote adversarial relationships among various interests.** Moreover, there still remains little understanding and few mechanisms for integrating public input into the planning and decisionmaking process (Blahna and Yonts-Shepard 1989; Stankey and Clark 1992). As a result, public input often remains an outlier to the substantive planning process, and is treated in a consultative fashion rather than as a core aspect for consideration in decisionmaking.

Much of the concern with public involvement stems from its status as a legal requirement in key legislation under which federal resource agencies operate, including the National Environmental Policy Act, the National Forest Management Act (Forest Service), and the Federal Land Policy and Management Act (Bureau of Land Management). However, while such legislation provides a legal basis to public involvement, it also can lead to a procedural and mechanistic perception, more concerned with meeting the minimum legal requirement than with satisfying the intent and potential of these laws.

Such an approach severely constrains the potential value of public involvement and, ironically, contributes to the likelihood that the process of consulting with the public as a means of improving management will fail to do so. The following statement by Daniels et al. (1993) points out:

> *Finally, a "Catch-22" comes from agency personnel focusing on appeals/litigation. Fear of having decisions challenged or overturned creates a defensive stance, where the strategy becomes one of crafting "bulletproof" decisions. Unfortunately, this orientation is often perceived as suspicious by interest groups, in turn increasing the likelihood of adversarial relationships and ultimately the very appeals that motivated the Forest Service behavior initially.*

Three common reasons for public involvement are cited: (1) a means of informing the public of agency plans, (2) a way to obtain public views about these plans, and (3) collecting public information that might be of use in planning. However, there are other, more fundamental reasons why public input in the planning process is both appropriate and necessary.

People Should Have a Right to Influence Decisions that Affect Their Lives

There is the normative and populist view that people should have a chance to comment on those decisions that affect their lives. This is a central tenet of democratic governance: given the emerging importance of many of the values associated with forests (employment, recreation, scenery, and biodiversity), the opportunity to participate in decisions that affect these values is crucial.

People Have Much Knowledge to Contribute

In our highly technical society, we often assume that knowledge necessary to make things work is held only by those we call experts. However, expert knowledge is rarely sufficient for analysis, prediction, and management (Friedmann 1987; Schwarz and Thompson 1990), and experts are likely to disagree more often than not (Douglas and Wildavsky 1982). To fully understand the world, one needs knowledge that is a product of continuing interaction with the world. Often this knowledge can be found among citizens who live, work, and play in our forests. Robert Lee is currently working on a project examining knowledge that people who live in communities have about forests. The purpose of this research is to learn how to measure, preserve, extend, and enhance local knowledge about forests and forest management. Preliminary results suggest that the ways local forest managers think about forests varies with their experience in growing up and current responsibilities for managing the land.

In some cases, we find that citizens are the sole source of key technical information that is essential for effective decisionmaking. There is also mounting evidence that the quality of technical decisions is enhanced through the scrutiny that public involvement can bring (Paehlke and Torgerson 1990a).

Public involvement can provide increased understanding how the world works, how it might respond to changes, and how those changes would affect both people and forests. In this sense, public involvement is broadened to embrace the concept known as "social learning" (Reich 1985), "mutual learning" (Friedmann 1987), and "working through" (Yankelovich 1991), in which both the public and resource managers learn from one another.

Public Involvement Can Help Us Learn About One Another

One of the most disturbing, yet common, features of the debate over forest management is the increasingly shrill, acrimonious, and accusatory dialogue. Too often, the discussions become dominated by "us versus them" and "right versus wrong," which effectively precludes any chance of accommodation, compromise, or resolution. Unfortunately, many of the public involvement forums undertaken in the past have actually aggravated this situation, fostering an adversarial relationship among the public and between the public and the agencies (Wondolleck 1988; Daniels 1993).

There are examples, however, that demonstrate how thoughtfully constructed public involvement programs can help participants come to understand, and recognize as legitimate, the diverse perspectives and values held by others (examples of such efforts are provided later in this report). Understanding does not constitute agreement, nor should it, but it is an essential and necessary aspect of effective resource management.

What You Hear Depends on Who You Talk To

The means by which public comments are collected influences the nature of the constituency that participates and, as a consequence, the substance of the results. For example, we found that local environmental groups were not represented at the Forest Conference, but were participants in the subsequent input. Moreover, their comments tended to focus on specific places of concern. Conversely, considerable comment at the Forest Conference focused on conditions in rural communities and impacts on rural residents. The follow-up invitation resulted in input from outside the Pacific Northwest region, with a greater focus on extra-regional effects associated with any decision, such as effects on forests in Alaska, Canada, eastern Oregon, eastern Washington, and even Siberia.

This does not suggest that input from the Forest Conference, or any other forum, is not of value. It is simply that policymakers must be cognizant of how these forums, and associated rules of engagement affect the nature of what they hear: Is the input provided through oral statements, through written statements, and so forth?

This issue is especially important because it relates directly to the question of which interested and affected citizens have an opportunity to participate in decisions that affect their lives. Because not all people have equal access to various forums, or they find the forums alien, such biases can lead to the systematic exclusion of certain sectors of society, and the interests they represent. **It is important that planning efforts adopt a variety of mechanisms and forums through which public involvement efforts are conducted.**

What You Hear Depends on How You Listen

Our public involvement procedures can selectively screen what information we obtain. There is a tendency to look at public input as the source of technical, site-specific, and factual data; **information that conveys general attitudes, concerns, and opinions is often seen as having little value.** Failure to use comments in context can lead to a loss in the richness of information they contain. For example, in the course of our analysis of past public comments, we reviewed comments received in response to the Bureau of Land Management Final Environmental Impact Statement on timber management (1983). The summary reports of comments received suggests that people only commented on various silvicultural aspects. When we reviewed the actual letters, however, we found quite a range of information regarding other issues, such as recreation and scenic management. This finding is consistent with other comprehensive reviews of public involvement in federal decision processes (Force and Williams 1984, 1989; Blahna and Yonts-Shepard 1989; Shannon 1990, 1992a).

Public Input is Information on Public Values

Public input represents one of the major sources of information regarding the nature of societal values (Shannon 1991). Our understanding of public values, such as what they are, who holds them, and how they are affected by management actions, is typically limited (Stankey and Clark 1992). Although public input is not a systematic and representative measure of public values, it is one major way to gain an appreciation for a range of values and their distribution and importance across society. When we fail to capture the full richness of these data, or are unable to easily access and process what information we do have, we lose an important analytical capacity.

The view of public input as a major source of data, critical to any planning effort, rejects the view of public involvement as mere evidence of procedural compliance. Instead public input becomes crucial and central to the heart of any planning process. One related implication of this idea is the need to think of public involvement as an on-going process, one integrated into planning, providing different functions as the planning effort evolves. Often, public input is sought early in the planning effort (i.e., during the scoping phase), then again at the close to obtain reactions to the proposed decision. However, as one analysis of the Forest Service planning effort has reported, typically little public involvement is solicited during the middle stages of planning when many key decisions are made (Blahna and Yonts-Shepard 1989). In short, **at the time when the most important activities, those affecting the various forest values, were occurring, there was little or no systematic contact with the public who would be most directly affected by these decisions.**

Is Anybody Listening? We Told You This Before

The public input record that has been built over the past 25 years is an enormously important and rich data source. One implication that emerges when this lengthy record is examined is that many of the issues, concerns, and questions that the public has raised over this period are still with us. The fact that they are suggests, among other things, that the public does not perceive agencies as being responsive to their concerns. For example, in reviewing the public input record on one forest, we found that public expressions of concern about anadromous fish stocks had been received as early as 1974, and that recommendations for the protection of key roadless recreation sites had been made for over 2 decades.

The failure to demonstrate responsiveness carries significant costs, not the least of which is the promotion of a public cynicism that can be summed up as, "Why bother?" All too often, there is a public perception that their input disappears into some kind of black box and that the decisions eventually made (sometimes long after the input was provided) reflect little if any responsiveness to that input (Williams and Force 1985; Force and Williams 1984, 1989; Wondolleck 1988). Although it is impossible for everyone to get everything they want, there seems little justification for not providing people who have taken the time and trouble to provide their ideas with an indication of how their input was considered and used in the final decision (Force and Williams 1984, 1989; Blahna and Yonts-Shepard 1989).

Pay Me Now or Pay Me Later, But You Will Pay Me

There continues to be resistance to public involvement on the grounds that it is costly in terms of both finance and time. Although this may be true, the failure to engage the public early, honestly, and in an on-going fashion (Blahna and Yonts-Shepard 1989) will merely delay these costs. It will likely increase them as well not only in higher financial terms, but also in terms of increased cynicism, heightened frustrations and distrust, and increased public reliance on alternative decisionmaking venues, notably the courts and legislature. At the extreme, people may simply by-pass administrative agencies or pay them only perfunctory attention (Dunlap 1991), choosing instead to rely on the legislative or judicial branch to achieve satisfaction. In such a scenario, resource management professionals would become little more than technicians.

Barriers and Solutions to Interagency Collaboration

On April 2, President Clinton stated a vision wherein there will be "one government" focused on public service with respect to management of the federal forests. There seems wide concurrence that government is not working, at least not as it might or should. This, however, does not mean that government **can't** work; indeed, books such as *Reinventing Government* (Osborne and Gaelbler 1993) are based on the premise that government can serve the people, that it can achieve good things; but to do so, it has to find new ways of doing business.

Our workshop participants from the Bureau of Land Management and Forest Service agree. We posed two questions for them to consider as they thought about President Clinton's vision of "one government." First, we asked them to think about the barriers that impede working together (i.e., the two agencies). Second, we asked them to suggest steps to overcome these barriers.

Their responses, grouped into six broad categories, are presented below. Within each category, specific problems and proposed solutions are outlined.

MISSION AND VISION

Perception: Agencies lack a shared land management vision because of conflicting laws, regulations and policies.

Solutions:

1. Change legislation.
2. Consolidate agencies.
3. Create one internal "corporate board of directors" for the federal land management agencies.

Perception: Agency visions do not reflect contemporary societal values

Solution:

1. Develop a common mission embraced by agency management.

Perception: Two agencies are authorized to manage neighboring land bases differently.

Solutions:

1. Consolidate (block up) agency land holdings.
2. Implement a consistent delegation authority for both agencies.

COMMUNICATION

Perception: Agencies do not work well together as "sister" agencies

Solutions:

1. Co-locate offices.
2. Exchange and detail personnel between agencies.
3. Hold professional and management team meetings jointly.
4. Link agency communication networks.

Perception: Internal communication is cumbersome because of the three-tiered administrative structure

Solutions:

1. Validate and formalize existing field-to-office and office-to-field communication networks.
2. Develop a horizontal structure for communication.

Perception: Legal opinions, and the administrative field direction which follows, differ between agencies.

Solutions:

None given.

BUDGET

Perception: Budget processes and timing differ between agencies for both out- year and project-level planning and implementation.

Solutions:

1. Align the two processes.
2. Coordinate timing, particularly for jointly administered projects.

Perception: Current funding does not reflect agency needs.

Solutions:

1. Fund agency programs on some basis other than board-feet.
2. Fund agencies to adequately implement approved land use plans.

LAND-USE AND PROJECT-LEVEL PLANNING

Perception: Agencies are not coordinating land-use planning efforts

Solutions:

1. Use multi-agency interdisciplinary teams for joint planning efforts.
2. Coordinate timing and lead responsibility for joint project-level work.
3. Identify common issues that affect both agencies.
4. Conduct landscape-level planning between agencies.

INFORMATION

Perception: Agencies do not share common terminology, standards and informational databases

Solutions:

1. Develop common terminology.
2. Standardize and use common databases and informational systems (like GIS).
3. Create common inventory and monitoring methods.

Perception: Public information is independently developed and dispensed by agencies.

Solution:

1. Develop joint public information; for example, maps, brochures, etc.

AGENCY CULTURES

Perceptions:

1. "Turf" battles between agencies are prevalent with a pervasive mentality of "we do it better than you."
2. There is a lack of trust of the other agency's specialists', particularly between the Fish and Wildlife Service and the Forest Service.
3. A pervasive "watchdog" mentality exists between agencies. Agencies do not respect each others' views.
4. There is a feeling that public lands are managed as though they are agency owned. There is a pervasive mentality of "we've always done it this way."

Solutions:

None given, in a direct sense, because perceptions relating to an agency's culture change only after fundamental changes to other perceptions occur.

In reviewing these results, several key lessons emerge:

1. There is strong consensus among participants about the nature of the problems and the solutions needed.
2. Many of the solutions have been noted elsewhere. For example, in a recent report on science in the National Parks, the authors report that a major impediment to effective implementation of science findings can be traced to cultural barriers *within the organization, between managers and scientists.*
3. This group, in only slightly more than 1 day, showed its capacity to engage in collaborative, self-critical thinking. As Jack Ward Thomas commented to the President at the Forest Conference, "*You command incredibly talented people...they are highly skilled. They are incredibly motivated. They can do marvelous things...*" Within the organizations, there exists a rich body of creative, energetic, and innovative people who are capable of bringing about significant change.
4. There is wide recognition of the need for fundamental change, and there is an appreciation that marginal changes will not suffice.
5. A rich mix of ideas and suggestions range from the relatively simple (e.g., detailing personnel between agencies) to the fundamental and complex (e.g., consolidating agencies, drafting new legislation). We should not lose sight of the fact that much can be accomplished within current structures. A recent Forest Service Pilot Project reported that at least 75 percent of the changes called for could be achieved with no change in the law.
6. The ideas identified by this group are consistent with many of the findings that we have discovered in the course of the social assessment. There is strong support for collaborative decisionmaking processes that involve local communities and the full range of interests; there is concern with the inadequate data bases from which critical decisions must be made; and there is a recognition that the loss of trust must be overcome.

Effective Agency and Citizen Collaboration is Occurring

Criticizing government agencies often seems to be a national sport. Resource management agencies have been severely criticized for their seeming failure to be responsive to citizen concerns (e.g., see Wondolleck 1988). Such criticisms have considerable foundation and represent a major barrier to regaining public trust.

It would be a mistake to assume that important progress has not occurred. **There are a variety of examples of successful collaboration between land management agencies and citizens.** This is particularly true in efforts to establish innovative, collaborative links between federal agencies and their constituents. There are an increasing number of examples, many in the Pacific Northwest, showing that the contentious, adversarial nature of agency-public deliberations are not inevitable.

As a key part of our findings, we examined examples of successful undertakings that demonstrate productive links between resource managers and the community. A progress report provided to the social assessment team by Professors Julia Wondolleck and Steven Yaffee, School of Natural Resources, University of Michigan, summarized an on-going project entitled, "In Search of Excellence in the United States Forest Service: A Preliminary Assessment."

The Wondolleck-Yaffee study focused on innovative mechanisms undertaken by the Forest Service with various individuals, groups, and organizations. The study was purposely framed in terms broader than "public involvement" for three reasons: (1) the concept of public participation is narrowly defined by many in the Forest Service, often limited to a view of satisfying procedural guidelines; (2) there is a much larger social and political environment that affects the Forest Service and is affected it, but this is a relation often ignored by agency officials; and (3) much of the recent turmoil in public forest management has been caused by an inadequate appreciation of the importance of understanding, working with, and influencing the external environment.

The study focused on four key questions: (1) How do agency and nonagency respondents define success? (2)) Why was success possible? (3) What barriers did agency and nonagency individuals face? (4) What are the overall lessons?

A summary of key findings include the following:

What is Success?

Success is a problematic term. The literature in dispute resolution suggests widely different views of what the term constitutes and, consequently, widely different reports on the relative incidence of success. Daniels et al. (1993) suggest three conceptions of success: substantive (issues involving observable, definable, and measurable questions), procedural (what rules guide decisions), and relational (issues stemming from intangible, often emotional matters that involve power, authority, responsibility, and control).

Success, like beauty, is often in the mind of the beholder. Wondolleck and Yaffee relied on a self-definition of success. What in the view of the respondents, constituted success?

Their results suggest some situations were successful because they accomplished the following:

- Led to tangible action or benefits.
- Overcame bureaucracy.
- Provided better stewardship of resources.
- Generated administrative resources.
- Generated knowledge.
- Built understanding.
- Improved relationships.
- Resolved short-term disputes; managed long-term conflict.
- Provided for dynamic and flexible working arrangements.

Why was Success Possible?

Wondolleck and Yaffee next turned to discerning what facilitated these successes. What were the specific factors that led to successful outcomes? What did the individuals or agencies do that led to success? A summary of results included the following:

- One motivated individual made it happen.
- The individuals involved had a broad conception of their role and responsibilities.
- Support from agency superiors was present.
- Individuals were given explicit responsibility to build bridges.
- Agency-wide incentive programs encouraged or allowed i interaction.
- The activity built symbolically on the capabilities of both Forest Service and nonagency partners.
- Agency representatives paid attention to process.
- An open-minded, creative approach was used.
- Ownership was fostered of the problem and its solution.
- Forest Service staff evidenced flexibility, receptiveness, and responsiveness.
- Cultural differences were recognized and pre-existing social networks were used.

- Relationships were established.

- Forest Service employees were patient.

What Barriers Face Agency and Nonagency Individuals?

The success stories uncovered in this work are important, but raise the question: Why weren't more successes found? Wondolleck and Yaffee conducted an examination of the factors that constrain effective, innovative programs between agency and community. Results suggest that the following explain failures:

- A lack of time, money, staff, and energy.

- Individual and organizational biases, fears, and skepticism.

- Agency standard operating procedures.

- Tradition-bound superiors.

- Lack of pre-existing interagency bridges and relations to build on.

- Lack of leadership in the community to draw from.

- Counterproductive public perceptions.

- Lack of experiences and skills and, therefore, lack of confidence.

- Lack of a role model or an image to emulate.

- Lack of continuity because of the transiency of Forest Service employees.

How Can the Agencies Increase the Quantity and Quality of Interactions with its External Environment?

What are the key lessons that emerge from this analysis? How and what can be learned by others from the positive experiences reported in this study? The authors suggest that serendipity often seems important and raise the question of how this might be fostered. Several conclusions emerge:

- Make bridging more of a priority.

- Enhance the ability of Forest Service staff's to develop and utilize links.

- Deal with the nonagency world honestly, effectively, and durably.

- Recognize that success begets success.

Daniels et al. (1993) examined 56 natural resource management issues in the western United States to determine what lessons might emerge to enhance efforts at collaborative decisionmaking. A wide range of authorities were involved, including the federal government, states, counties, private corporations, and numerous citizen organizations. The results of their analysis are similar to the work by Wondolleck and Yaffee, as well as other authors.

For example, efforts to implement ecosystem management must transcend organizational boundaries. Collaborative approaches are essential to the success of the management direction currently being promoted by both the Bureau of Land Management and Forest Service. Daniels and his group also conclude, in concurrence with Wondolleck and Yaffee and Blahna and Yonts-Shepard (1989), that the public participation model is insufficiently rich and rigorous to accomplish collaborative management. At its heart, public involvement has been bound too closely to procedures to succeed. The core difference between collaboration and public participation lies in the former's central tenet of shared implementation responsibility.

The role of incentives is key to successful collaborative behavior for organizations and the public. At present, the structural characteristics of participation programs and internal reward systems give only limited support and endorsement to collaborative behavior; without changes in the incentive structures, it is unlikely that collaboration can be achieved at any significant scale.

Finally, returning to the notion of success, **it is important to appreciate that most innovations and collaborations create some progress, even when the full potential (the maximum possible gain) is not reached.** However, the failure to reach the maximum potential (e.g., a written accord signed by all interests) does not mean that improvement has not occurred. If a perspective can be encouraged whereby every thoughtful, sincere effort is perceived to produce some improvement (and therefore constitute at least a partial success), the fear of failure from rigid definitions of success can be overcome.

The results of Wondolleck and Yaffee, and Daniels et al. provide clear evidence that useful examples of collaborative management exist and that contain important lessons. The resource management lessons reported here are consistent with experiences and lessons reported in Osborne and Gaebler's *Reinventing Government* (1993), suggesting they may constitute powerful principles that transcend any given situation.

Recommendations

- Institute a multi-agency review of what does and does not work with respect to agency-citizen collaboration.

- Encourage agencies to more aggressively use available approaches and systems.

Ecosystem Management Includes People

With changing perceptions of forests come changing conceptions of appropriate management. For the better part of a century, the notions of multiple use and sustained yield have framed the basic approach to forestry in this country. Increasingly, however, these basic concepts have been found wanting. Multiple use, for example, was envisioned as a way to achieve "harmonious and coordinated management of the various resources, each with the other", but in reality, what occurred was multiple use by adjacency, with timber harvested in one place, recreation provided in another, and so on (Behan 1990a).

Similarly, the concept of sustained yield has come under increasing criticism. Typically, the emphasis of sustained yield was on the maintenance of a single component or species, not on what is required to sustain either the biological or human system or on the sustained yield of the multiple values people have for forests. For example, the assumption that sustaining timber supply would lead to the sustainability of communities is in error. As Dixon and Fallon (1989) have noted, there are many ways in which sustainability can be defined; its most useful definition is one in which the entire ecosystem is taken into account.

Such concerns have led to the search for "new" ways of doing business. The Forest Service programmatic effort called "New Perspectives" is an example. Today, however, there is growing interest in the concept of "ecosystem management" and recent policy statements have called for such an approach as an underlying feature of federal forest management. But when searching for new approaches and paradigms, it is important to understand what the shortcomings of previous approaches were before adopting new solutions. Although much of the attention to date in forestry has focused on variations in silvicultural prescriptions and other aspects of biological management, the underlying forces that have led to a re-examination of how forestry does business are socio-political in nature.

An essential feature of ecosystem management then has to be a view in which people are a fundamental part of the system. People are a part of forest ecosystems; they derive material and non-material goods and services from them, they live, work, and play in forests, and their attitudes, behavior, and knowledge of the forest system affect it in both direct and indirect ways. Thus, forest management systems that alter the structure and processes of the biological component will alter the human system that interacts with it. Conversely, the way in which people are organized and the processes through which they make decisions will lead to alterations in the forest ecosystem. This perspective is consistent with a rich tradition in social ecology that concerns itself with "the reciprocal influences between natural ecosystem structures and processes, and social system structures and processes" (Field and Burch 1988, p.95).

Three key elements can be identified that link forests with society. These include **people** (including their distribution, values, organization, and behavior), **places** (both the geographic and symbolic dimension), and **processes** (the ecological processes and human activities and institutions that affect people, places, and their interaction). It is in the overlap among these three elements that an ecosystem approach becomes essential to understanding the effects of changes in any one area, such as a shift in forest policy.

For example, the concern with people includes an understanding of their attitudes and behavior and how different levels of organization, from individuals to communities or entire populations, affect the kinds of questions that need to be considered. In this assessment, we have focused particular attention on how changes in forest management might affect people in rural communities. However, we have also seen how broad structural changes in society (e.g., growing urbanization) have led to major changes in attitudes about forest management and the growth of support for environmental protection..

We could also examine how changing perceptions of place can lead to significant impacts on how they might be managed. Places involve not only an objective set of geographic attributes, but a host of subjective and emotional attachments as well. Mitchell et al. (1993), for example, explore the consequences of such attachments for land planners; as they point out, many of the planning processes currently in use ignore the social meanings of place and thereby aggravate land use conflicts.

Managing across the intersection of these elements is the heart of ecosystem management. It is also an inherently complex and difficult undertaking. It will need to be characterized by being comprehensive, integrated, and unified (Mitchell 1990). However, current institutions, educational curricula, and legal structures often operate to thwart these qualities from being achieved. For example, despite considerable interest in integrated approaches to resource management (e.g., Lang 1990), we find there exists only limited ability to integrate multiple values into resource decisionmaking processes (Stankey and Clark 1992). Clark and Brown (1990) suggest that several fundamental conditions to achieve integration must be met, including a clear and comprehensive definition of what integrated resource management is and is not, that professionals become more open to new ways to manage for diverse values and share decisionmaking power, and that desired futures are visualized and communicated in such a manner that people from diverse social and cultural backgrounds can understand where and when changes affecting them will occur.

Thus, achieving ecosystem management will not be easy. It will require fundamentally new ways of approaching how forests are managed; a perspective that transcends administrative, political, and disciplinary boundaries, one that engages the public as a full partner in decisionmaking, and one that acknowledges the social-political nature of forest management.

Lessons Learned

Some key lessons that emerged from our experience in conducting the social assessment follow.

The Current Situation (Gridlock) is a Result of Many Failures

Contributing to the gridlock are fragmented land management, unresponsive forest management practices, inadequate monitoring and evaluation of the conditions of both federal and nonfederal lands, fears (often well-founded) about the effects of changes on community health and stability, and lack of a shared vision about the future. Fundamental to successfully resolving the situation are clarity of vision, inclusion of all potentially affected parties, and consistency of action.

We Must Work to Minimize the Negative Effects of Polarization of Political Agendas

Valid concerns exist on both sides of the issues at stake in the ongoing debate. There are many who do not share the extreme views of either. One of the most disturbing characteristics of the debate over natural resources in the United States is the shrillness of the dialogue and the perception of villainy by people of opposing values. Loggers, foresters, urbanites, scientists, bureaucrats, and environmentalists have all been painted as villains, depending on the point of view. Such tactics nullify the claim by the same people that a middle ground or common ground is needed.

Processes must be developed that contribute to an understanding of all the values at stake, regardless of who holds them. This means examining the extent to which current institutions and agency programs and processes increase, rather than alleviate, conflict and polarization. Development of decision making processes that fairly consider all values of concern to society is vitally needed. Failure to choose an appropriate course of action will leave the same polarized extremes at the table. Ending the gridlock is unlikely if this occurs. We must honor diversity; it's what makes us strong.

Recognize that Distrust is a Symptom of Underlying Problems

Although many reasons underlie the conflicts that characterize forest management today, distrust seems to be the central concern. Distrust exists for many reasons and at a variety of levels: between agencies (regulatory versus management), within agencies (line managers versus staff, management versus research), between agencies and citizens, and among various citizen groups. Distrust will undermine even the best plans. One strategy to build trust is to work together to solve common problems (Wondolleck 1988).

Put Science in its Proper Role

Many issues and problems facing forest policymakers and managers are social and political in nature. Resolution of these issues requires more than scientific knowledge and technical solutions. The role of science is to inform those who are in the business of making social choices. Failure to clearly define the role of science and scientists, and politicians and policymakers, likely will lead to inappropriate or incomplete solutions and further gridlock. Such failure might result in scientists viewed as scapegoats for failed policy.

Advocates for a Particular Group, Resource, Point of View, Pet Theory, or Policy are Not Functioning as Scientists

Credible scientists will affirm weaknesses as well as strengths in alternatives, and will facilitate the policymaker's and the public's understanding of the implications of choosing one approach over another. The scientist who espouses a personal position, under the mantle of objective science, is dangerous, particularly when the decisions being made have profound consequences on the natural resources and the people whose livelihoods and lifestyles may be in jeopardy. Scientists who become policy advocates are not villains, but they are miscast. A clear distinction between the roles of policymakers and scientists must be made to ensure that controversial decisions are founded on the best knowledge available, not on how articulate the advocates may be. As a nation that must make controversial decisions about natural resources, we need advocates who champion important causes. We need scientists who dispassionately inform and clarify what we do and do not know. We need to know who is in what role. In the absence of clear labels, let the buyer beware.

Avoid the Paralysis and Myopia Fostered by Boundaries

The issues under consideration are not possible to solve within any one institution or within federal forests. Appropriate boundaries must account for both physical and biological resources and other considerations important to society. It became clear during this assessment that a complete solution (or even an adequate understanding of the issues) cannot occur without including nonfederal lands (e.g., state, tribal, private).

People Will Not Support What They Do Not Understand and Cannot Understand That In Which They are Not Involved

Many professionals bemoan the seeming lack of understanding the public has for natural resource issues. In some respects, this may be well founded, but often professionals lack similar understanding of the public. To change the situation will require that public and agency education and involvement processes become truly participatory. The public must become an active partner, involved in mutual learning, understanding, and action. Scientists, managers, and citizens all have knowledge important to understanding and resolving issues. Mutual respect for the people who have information and an environment for mutual learning are critical to future success. A lack of these elements will probably lead to further polarization.

Walk the Talk

In the United States and abroad, there is considerable distrust of institutions, government, and professions. Skepticism and cynical views mean that actions will be evaluated, not slogans or labels. Saying so does not make it so; actions must be consistent with declarations. We need to address the implications of proposed initiatives and applications, and learn from the results of our actions. Observers will quickly determine if pronouncements are real, or mere window-dressing for business as usual.

Questions Come before Answers, Problems before Solutions, and Why before How

Thought must go into clarifying and agreeing on the problem before we design solutions. The focus frequently tends to be on a technical fix on how to rather than why. People will not be able to deal with details of how to solve a problem until they understand the problem that needs solving. The problem needs to be clearly defined before people will buy off on a solution, and the solution people are most interested in is the end product, not the tools used to achieve it. Tools are means to ends; we need to understand and agree on the ends desired before selecting the appropriate means for achieving them.

Panaceas Do Not Exist for Wicked Problems

Today, many of the environmental conflicts confronting society represent what Weinburg (1972) has called "trans-scientific" and Allen and Gould (1986) refer to as "wicked problems." They are trans-scientific in that their nature transcends scientific explanation. They are wicked because they defy answer; in fact, a basic quality of such problems is that they have no answer, only more or less useful solutions. For such problems, models of scientific inquiry are of limited utility. What is needed then?

The Process Must Be Open and Fair

Not only must we avoid confusing the means with the ends, and inputs with outputs, but we must focus on the process as well as the end result. For example, the process of planning is often more important than the plan itself. The process we use to make decisions can be the key to whether the decision itself is understood and accepted. Sometimes, what we learn along the way may lead us to a previously unknown destination. For the success of any new approach to forest management an open process is required that fairly considers all points of view and fosters mutual learning; an adaptive management must be developed, utilized, and carefully monitored.

Change is the Only Constant: Accept It

People seeking stability in the relation between natural resources and societal values, uses, and demands are likely to be disappointed if the past (and present) is prologue to the future. The rate of change may increase, the nature of the pressures faced may vary. Unless we learn along the way, we may find that what is a new approach today may be part of the problem tomorrow. We must continuously and carefully monitor the situation and adapt as is necessary and appropriate. We hope an evolutionary process, where people have adequate time to adjust, may preclude a revolution.

Solutions Must be Founded on the Principles of Inclusion, Leadership, and Vision

Top-down social engineering, particularly targeted at the community level, is a thing of the past. Leadership, both within the agencies and at various levels within the broader society, is essential to breaking gridlock and finding innovative solutions. A variety of opportunities exist to increase the quantity and quality of interactions among agencies and citizens: (1) deal with the nonagency world honestly, effectively, and durably; (2) provide incentives to encourage innovation, creativity, and risk- taking; (3) legitimize, sanction, and reward efforts to build effective links to the nonagency world; (4) make it easier for nonagency groups and individuals to interact with the agency; and (5) encourage management agencies to see communities and interested citizens as equal partners in management of public lands.

Major Recommendations

Based on our assessment, a wide range of specific recommendations are possible. We focus here on recommendations central to resolving key concerns documented in the assessment.

Recognize that Ecosystem Management will Require Collaboration by all People across all Forests

The President stated at the Forest Conference a vision wherein all the federal agencies would act in concert to serve the American people. Our findings validate this need, but there is more. We recommend that federal agencies be encouraged to provide leadership by moving *beyond* the limits of federal jurisdictions to engage states, tribes, forest industries, and other private forest managers as equal and essential partners in discussing their relative roles in sustaining the region's forests and communities.

Collaboration (not simply coordination) between federal, state, tribal, and private lands must commence now. A common vision, a shared framework for action, and an interactive process for creating both are central to successful resolution of the political gridlock (Clark et al. 1992; Shannon 1992c). Continuing to bow to those interested in delay and inaction will inevitably put our biological and human communities at further risk.

Fundamentally Change Federal Land Management Planning Processes to Provide the Leadership for Effective Collaboration

Preoccupation with the technical aspects of federal land management planning processes led to little attention to the reasons society was concerned about federal land management (Wondolleck 1988). Federal land and resource management plans are now inadequate mostly because of the reluctance of agencies to recognize public issues that led to the current gridlock.

In our judgment, marginal changes in the current plans are not sufficient. A fundamental reformation, founded on collaboration, powersharing, and mutual learning, is called for. Land and resource management plans must begin from a regional perspective and place federal lands into a landscape of forest lands, including both urban centers and rural communities. Information regarding forests must be developed from a regional perspective and should include a comprehensive assessment of societal values and uses, as well as ecological processes. Clear indications of who benefits and who loses need to be identified by social and economic assessments.

As part of the planning process, a new way of incorporating the wide array of societal values is required. Considerable attention must be paid to the relation between local, regional, and national values. Which takes precedence, where, and why? The relationship between the agency and citizens in reaching decisions must be clearly defined.

Current institutional arrangements are based on divided jurisdiction and authority. Collaborative planning will begin a process of building new arrangements. Part of the planning process must be the invention of new incentive-based implementation approaches for both federal and other lands. Information will be the basis for developing trust and common vision, because it can play an innovative role in creating new governance arrangements between agencies and the citizens they serve.

Changes in institutional responsibilities will necessarily address conflicts embedded in relations between values. Recognition of these relations, and inclusion of all affected and interested stakeholders in interactive assessment processes that generate information will undoubtedly be beneficial in building the basis for new institutional frameworks.

Immediately Develop a Comprehensive, Regionwide Assessment of the Effects of the Selected Option for Federal Land Management on Communities, Tribal Rights and Values, Recreational Opportunities, and Amenity Values

This social assessment is just a beginning. Crisis-oriented policy analysis (of which this current report is an example) is not a substitute for comprehensive assessment and adequate research. A full assessment of effects on communities, important resource values, future opportunities, and economic costs and benefits is essential to implementing new federal direction for land and resource management.

The complexity of issues and the significance of the values affected necessitates that all parties have a role in gathering information and deliberating the expected consequences. It is vital that those who will carry out new policies be part of the assessment of their implications and formulation.

Attend to the Short-Term Consequences from shifts in Federal Policy

While information is gathered, effects are analyzed, and collaborative relations are built, some communities are being immediately impacted by loss of federal timber supply because some jobs will be eliminated. These short-term effects can be mitigated by public policy programs. The communities and jobs that are immediately dependent on near-term federal timber sales can be identified. Specific policy relief can be accorded to both communities and occupational groups.

Federal programs might first seek opportunities to enhance and augment local and state programs focused on communities and workers. Sometimes, the limiting resource will be access to finances; other times, it may be access to technical expertise in effectively competing for existing programs.

Declining federal timber harvests will, however, immediately impact specific communities and jobs. In some instances, new federal programs may be appropriate. State and local governments should be included in deciding how and where scarce resources are allocated. Communities, in particular, must continue to evaluate and self-determine their future.

Future Forests for Society: Where to Next?

Some may ask why we bother to respond to threats confronting endangered species such as the owl ("species go extinct all the time") or put rural communities at risk because of changes in forest policy ("communities will adapt to change"). Isn't change inevitable, and isn't any effort to intervene through policy pointless and futile?

One response to these questions is that **the forest management issue is fundamentally a moral question.** This would suggest that a society which fails to take care of its environment or its people risks collapse; history is replete with examples. The focus on the survival of the northern spotted owl has deflected attention from the more fundamental concern: the declining status of the owl reflects an overall decline in the health of the environment we all depend on, whether for economic or psychic sustenance. Likewise, the denigration and dismissal of a sector of our society (e.g., timber workers) as not worthy of our concern and support has the familiar but ugly ring of intolerance, prejudice, and arrogance. To be dismissive of one group of citizenry raises the possibility of being dismissive of others.

Unfortunately, **the range of options for responding to the many demands on our resources is increasingly becoming very limited.** This shrinking decision space provides little latitude for choice, if the requirements of current legislation (e.g., National Forest Management Act, Federal Land Policy and Management Act, Endangered Species Act) are to be met. Our shrinking latitude is a legacy of the failure to come to grips adequately with a range of problems – social, economic, and ecological -- over the past decades and constitutes a damning indictment of our institutions: management, research, and education. The legacy includes the inability of resource management institutions to be responsive to change and, as a result, the court room has become the forum for debate and resolution about forest management.

Responsive Administrative Decisionmaking Structures are Required, with a Central Element of Participative Management

Shared decisionmaking is critical if people are to be part of the solutions rather than adding to or becoming the problem. Tapping into the rich body of knowledge held by the citizenry, working in collaboration with citizens to formulate alternative conceptions of the future, helping people understand the consequences of alternatives, and enhancing our awareness of the distribution of costs and benefits associated with alternative management all represent features of participatory management. **Natural resource professionals from multiple jurisdictions need to take the lead collectively in interacting with members of the public when addressing complex problems.** New ways of doing business are needed if we hope to achieve the idea of one government. Ultimately, the institutions of government serve only at the sufferance of the governed. If these institutions are perceived as dysfunctional, they will be replaced.

Research Institutions need to Focus on the Key Questions Confronting Society and how to make the Resulting Knowledge Available to a Wide Range of Constituents

Scientists and researchers must confine their role to addressing the complex social choices that confront society by defining the range of possibilities, the stream of consequences, costs and benefits associated with choices, and the means by which these choices can be achieved. Society is the ultimate beneficiary and consumer of research. The incapacity of research institutions to be responsive to the major concerns of society will diminish their long-term relevance and support.

Educational Institutions need to Refocus and Become Responsive to Changing Public Perceptions and Values of Forests and Forestry

Natural resource professionals need to be educated as citizens, as individuals who have a capacity to teach as well as to learn, and as people who can foster a sense of understanding, awareness, and appreciation among those around them. Above all, they need to be adept at asking the right questions and being critical thinkers. Like the institutions of management and research, educational institutions must help us understand today's problems and prepare for tomorrow's; conceptions of relevance change and there is growing concern that educational programs and curricula have not adjusted to face the priority issues facing society. Educational institutions must be more aggressive in demonstrating their responsibility and responsiveness to the wider society; failure to do so will diminish their value to (and therefore their support from) society.

Toward Breaking the Gridlock

At the Forest Conference in Portland, President Clinton asked participants to help break the gridlock that paralyzes forest management. To respond constructively, it is essential that we acknowledge the fundamental nature of the problem that confronts us. There is a growing sense of disenfranchisement between citizens and government (a problem not limited to forest management); a perception that the institutions designed to serve society have lost their sense of responsibility. One result of this perception is the increased reliance on the judicial and legislative branches to resolve issues with which the executive agencies are unable or unwilling to deal (Dunlap 1991).

Any successful effort to break the gridlock must address the question of the diverse values held by society: what they are, how they are distributed across the population, their associated benefits and costs, and how they are affected by management decisions. In this assessment, we have attempted to determine how the various options will affect a range of values held by the citizens of the region and beyond.

In the face of intense conflict and acrimony that surrounds the forest management issue, it may be tempting to not make any decisions to avoid offending some interest. It is not possible, however, to do nothing; "no decision" is a decision. The failure to act proactively defaults to a decision to act passively. Events overtake us and outcomes unfold without deliberation and thought. In such an event, the consequences will fall without reflection and without the possibility of appropriate mitigative action. Moreover, failure to act will only further shrink the range of choice before us; the status quo will prevail, with all its acrimony. As Ted Strong, one of those representing Native American interests at the Forest Conference remarked "*...we must understand that status quo management is completely unacceptable. We must go on.*"

There is nothing permanent except change.
Hereaclitus (540-475 BC)

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Appendix VII-A

President Clinton's Forest Conference, April 2, 1993 Proceedings: A Content Summary

Prepared by Catherine Woods Richardson

May 28, 1993

President Clinton's Forest Conference

April 2, 1993

Proceedings: A Content Summary

Prepared by Catherine Woods Richardson

for the Interagency Social Assessment Team

I. Introduction

A. The Forest Conference

On April 2, 1993, President Clinton convened a day-long conference in Portland, Oregon, to discuss the state of the forests, economy, and people of the Pacific Northwest. The conference was organized into three panel presentations/round-table discussions, with additional opening and closing remarks by the President, Vice-President Gore, Oregon Governor Roberts, Portland Mayor Katz, and Historian Kimbark MacColl. Seven members of the Cabinet also participated: Interior Secretary Babbitt, Agriculture Secretary Espy, Labor Secretary Reich, Commerce Secretary Brown, Environmental Protection Agency Administrator Browner, Deputy Budget Director Rivlin, and Science and Technology Advisor Gibbons.

Those invited to participate in the conference represented a variety of interests and areas of expertise related to Northwest forests. Members of the first panel addressed the question "Who is affected and how?"; natural and social scientists discussed biological, economic, and sociological dimensions of Northwest forests in the second panel; the third panel spoke to "Where do we go from here?". The conference focused on the region west of the crest of the Cascade Range in Washington, Oregon, and northern California, but forests on the eastern side of the Cascades were also discussed, as were national and international issues that affected or were affected by events in the Pacific Northwest.

B. The Content Analysis

The purpose of this content analysis is to provide a summary of the issues raised during the conference, to identify who said what about each issue, and to locate areas of consensus and disagreement. To do the analysis, I worked from a typed transcript of the public comments made during the conference. I first read the transcript to gain a general overview of the issues discussed at the conference, then assigned each comment to a category that I had determined from my initial reading of the transcript. After this organizational task, I again reviewed the categories of issues I had chosen and reassigned comments as appropriate before writing the analysis. In all stages of the process, I worked to include every statement of fact or opinion.

The citation convention that I use refers to the typed transcript, listing page number(s) followed by line number(s), e.g., 231:5-12 would refer to page 231, lines 5 through 12.

II. The Issues

A. The conference and process of reaching a solution

1. Gridlock of past few years: why conference is needed

a. Who says what

i. Government

Gore: "The status quo cannot continue. We must break the gridlock and move forward (12:6-8)." See also 122:16-21.

Clinton: "Thank you very much, all of you, for your endurance today. One person said that she'd been waiting for years to get something done, a few more hours would be well worth it (169:11-14)."

"One of the things that has come out of this meeting to me loud and clear is that you want us to try to break the paralysis that presently controls the situation... I was mortified when I began to review the legal documents surrounding this controversy to see how often the departments were at odds with each other, so there was no voice of the United States (251:4-252:16)."

"In the past politics seemed to matter more than people or the environment (4:7-8)." See also 4:24-5:7, 253:10-18, 255:5-10.

Katz (Portland): "Thank you for doing to gridlock in the Northwest what you are doing for gridlock in Washington, D.C. (9:6-7)."

Strauger (Hoquiam, WA): "And it just seems to me that surely, surely this planet is big enough to support the wildlife species and the human species, and I just want to wish you all of the cooperation and all of the help from all of the people at this table to bring about a solution to what has become a regular log jam (83:4-9)."

ii. Forest Workers & Communities

Coates (International Woodworkers of America): "And I hope that you and Congress can come to some agreement, break the gridlock, and just give us some help, please (241:12-14)."

Draper (Western Council of Industrial Workers): "...if we don't break this gridlock the next official endangered species will be the timber family of the Northwest... I have seen families destroyed, towns bulldozed, the very fabric of the rural communities torn by a long period of government inaction and contradiction (28:25-26:7)."

Bailey (Logger's Wife): "...you said the other day that you didn't think that there was -- that nobody would be happy. We will be happy with a solution. We want to roll up our sleeves and get to work (46:9-12)."

iii. Forest Industries

Tomascheski (Sierra Pacific Industries): "We think a key element to all of that scheme is to recognize that the federal lands are in a real box right now. There's the gridlock (118:17-19)."

Geisinger (Northwest Forestry Association): "First step is to break the legal gridlock that has essentially kept our federal forest agencies from selling any timber during the last two years (174:5-7)."

iv. Environmentalists

Sher (Sierra Club Legal Defense Fund): "And we've been in court because, for the last 12 years, we could find no other level playing field where the issues of biology and economics and federal law could be debated and decided in an objective setting, and the record from that courtroom experience is clear. Case after case has found what one federal judge called in 1991 a remarkable series of violations of the federal laws, repeated, systematic, deliberate, and political in nature (90:9-16)."

Kerr (Oregon Natural Resources Council): "It was said earlier that these laws haven't been followed, and that's the problem (199:8-10)."

Arthur (Sierra Club): "I empathize and understand the frustration and the anger that the communities feel. We do need to break the gridlock (51:18-20)."

v. Tribes

Powell: "When we first heard the rumblings of endangered species issues and other environmental issues, we immediately began to learn and understand what limitations could be imposed on us, and we began to manage for them instead of simply allowing them to control us because of our inaction. Unfortunately, this is a process that is virtually nonexistent in the federal management and regulatory management scheme. Federal agencies...have been plagued by multi-levels of decision making and overly bureaucratic and fractionated approval and appeal procedures (86:16-87:2)." See also 85:20-24, 88:4-14.

vi. Social Scientists

MacColl (Historian): "We see today longstanding misguided federal policies with little coordination between the federal agencies and between the federal and the state agencies (21:22-24)."

vii. Biologists

Thomas (USFS): "We can't go back now. We have to go on, and there should be no looking back now except to learn from the past, because in the past there's blame enough for all of us, but by golly in the future, there's credit for all of us too, and let's get on with it. A decision is imperative (210:21-211:1)."

Gordon (Yale): "Maybe it's time to bite the bullet and say, "We're going to do it now," because if we continue to fight and continue to think that one side is going to get it all that's left, there isn't going to be anything there for anybody (133:23-134:3)."

b. Consensus

Gridlock exists; consists of conflicting policies among federal agencies, court cases and injunctions, government inaction; breaking gridlock is a desirable and primary goal of the conference. Biologists (Thomas and Gordon) who have worked on previous plans and reports addressing Northwest forest issues sound especially anxious for action, not more assessment and discussion.

c. Disagreement

Environmentalists who have successfully used the courts to delay or stop federal actions have contributed to overall gridlock, which other groups might not support, but from environmentalists' point of view, the courts were the only effective means of trying to make the federal government accountable for its actions.

d. Places mentioned

Northwest; need for cohesive policy at national level

e. Time periods mentioned

Court cases and injunctions of past few years, past 12 years [past three administrations], last 2 years, long-term inconsistencies in federal policy. Need to break gridlock in short-term future (Clinton: "I will direct the Cabinet to report back to me within 60 days to have a plan to end this stalemate [251:23-25].")

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2. What is the conference about?

a. Who says what

i. Government

Clinton: "We're here to begin a process that will help ensure that you will be able to work together in your communities for the good of your businesses, your jobs and your natural environment. The process we begin today will not be easy. Its outcome cannot possibly make everyone happy. Perhaps it won't make anyone completely happy. But the worse thing we can do is nothing (5:15-21)."

"When [Meslow] said you didn't want me to come out here to do this 480 more times, I thought that was about the best onesentence encapsulation of our mission that I had heard (108:1-4)."

Gore: "Because at its very heart this debate is about people. It is about all of you here today and many others who are watching and listening to this Forest Conference. It is about people who care deeply about their communities and about a way of life passed from one generation to the next, rich in traditions, strengthened over time. It is about people who care about the forests, wildlife, water and fish. It is about proud, hard-working people worried about losing their jobs and their dreams, worried about a future now uncertain for their children. It is about people tired of confusion and controversy who are ready to work together for solutions (12:20-21:7)."

"President Clinton has made clear his commitment to reviving our economy and creating jobs, to investing in America, to ensure our long-term economic strength. That's what his economic package is all about. And that's what this Forest Conference is about too (14:19-23)."

Roberts (Oregon): "This conference is not just about the northern spotted owl, but about the whole spectrum of concerns we have with our Northwest forest ecosystems, the economic role of the forests in this region, and how they relate to national interests (10:9-16)."

ii. Social Scientists

MacColl (Historian): "Forty-three years ago, Fortune Magazine proclaimed that, quote, "Happiness is pursued in the Northwest with a certain calm simplicity that is rare in America," end quote. I doubt if such words would be repeated today, given the heated and complex problems this region is currently facing, not the least of which is the quintessential environmental issue of the 1990's, the old growth debate (15:20-14:1)."

iii. Forest Workers & Communities

Draper (Western Council of Industrial Workers): "This is not just an argument over the remaining ancient forest. That's a buzz word. We're getting back into the same rhetoric. And it's not about the industry, the wood products industry, and the workers destroying our environment...We are not just talking about ancient forest. We're talking about second growth forests that are under injunction. We're talking about society (62:20-63:17)."

iv. Biologists

Gordon (Yale): "When we talk about vision, foresters and other professionals can't do a good job unless we have a clear idea of what our clients want, and you're helping us with that here today. What does society want for and from their forests? How do they want to make a living? How do they want the Pacific Northwest to look? How much assurance do they want that endangered species will survive and flourish?...there will be no final solution to the old growth or any conflict over forest uses and values because times and people and knowledge continually change. The best we can hope for are improved processes and the leadership to use them. You've given us the opportunity to have these beginning here today and now (99:5-21)."

Thomas (USFS): "Well, the question was not owls then [when Thomas and others were completing owl report], and it's not owls now. It's a larger question. It's always been more complex than that (210:18-20)."

v. Commercial Fishermen

N. Bingham (Fisherman): "On behalf of the commercial salmon fishing industry and the recreational fishing industry, California, Oregon and Washington, I would like to express the gratitude that all of us feel that you have recognized that this problem is more than just spotted owls, but that there is another industry which is dependent on a healthy forest, the salmon fishing industry (54:12-18).

b. Consensus

The conference is not about spotted owls or forests, but about people and the many values that society wants from its forests, both in the Pacific Northwest and the nation.

c. Disagreement

None.

d. Places mentioned

America, Northwest

e. Time periods mentioned

43 years ago, present, rhetoric of past few years, writing of owl report, short- and long-term future

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3. Endangered Species Act

a. Who says what

i. Biologists

Thomas (USFS): States that the Endangered Species Act and National Forest Management Act are tough laws that create a de facto policy of protecting biodiversity, especially on federal lands. Government needs to state clearly in policy or law whether protecting biodiversity is or is not an objective of management (208:5-20).

Meslow (Fish & Wildlife Service): Documents listing of northern spotted owl, marbled murrelet, notes many other plants and animals associated with old growth and 200 stocks of fish are also at risk, states at least 480 other species may be following in wake of owl and murrelet. "Mr. President, we look forward to having you revisit the Northwest, but not 480 times, especially to review contentious endangered species issues like this one. What most scientists are advocating is an ecosystem approach to the management of all old forest resources (106:7-107:16)."

ii. Environmentalists

Wales (Audubon Society): "The environmental protection laws we have, such as the Endangered Species Act, are like the red idiot lights going on simultaneous with something terrible happening to your car. The spotted owl, marbled murrelet, and numerous wild fish stocks now at risk are equivalent of all the lights coming on at once. When that happens, it's too late to think about a tune-up, you simply have to stop (32:21-33:2)."

Kerr (Oregon Natural Resources Council): Don't change the laws, despite any pressure to do so; follow them (199:2-10).

Sher (Sierra Club Legal Defense Fund): "The laws are good laws. They are this nation's commitment to the future and a covenant with the people that we will not squander our resources in this generation and deprive future generations and not violate our trust responsibilities to the other species with which we share the planet (90:18-23)."

iii. Forest Industries

Irvine (Home Builder): "I think that we do need to review the Endangered Species Act and look at finding a way to balance it (229:16-18)."

Hicks (Plum Creek Timber Co.): "In the western states, federal and private lands are often intermingled in a checkerboard pattern such as you see here. That land configuration alone presents a tremendous challenge to forest and wildlife management. However, when 111 owl circles at 6600 acres each are added, as has happened on Plum Creek land, forest management and habitat protection for the spotted owl become exceeding difficult. Because of the presence of the owl, I currently have 12 biologists working for me full time doing nothing but searching for owls on this intermingled ownership." Describes owl research, habitat use (100:17-101:17).

iv. Tribes

Powell: Notes that spotted owls have moved onto the reservation because of poor off-reservation timber management, and the tribe is now obliged to manage their lands for these new owls (85:24-86:4; 88:15-89:3).

b. Consensus

The Endangered Species Act is a powerful piece of legislation. Powell and Hicks agree that its impact through the spotted owl listing has greatly complicated their forest management operations.

c. Disagreement

The environmentalists like it as it is, industry would like to see its power reduced, biologists question its effectiveness and efficiency in protecting ecosystems and biodiversity, not just single species.

d. Places mentioned

Range of northern spotted owl, owl and murrelet habitat, Plum Creek Timber Co. land, Hoopa Reservation land, lands adjacent to the reservation, Northwest, western states

e. Time periods mentioned

"Nation's commitment to the future" (Sher), time since the owl was listed, present, future listings of other species

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4. Need for a balanced solution and/or compromise on all sides

a. Who says what

i. Government

Roberts (Oregon): "We look forward in the coming months to forging a balanced solution that reflects the long-term interests of the Northwest and of the nation (11:14-16)."

Gore: "The days when this debate was defined by either/or choices are over. This isn't about saving jobs or saving the environment. It's about saving jobs and saving the environment. We can't do one without doing the other; certainly not in the long term (13:17-21)." See also 11:17-23, 13:25-14:9.

Clinton: "So when you leave here today, I ask you to keep working for a balanced policy that promotes the economy, preserves jobs and protects the environment even as you may disagree, as Mr. Thomas said, over how the word 'balance' should be defined (254:5-9)." See also 4:16-5:22, 7:3-11.

Ron Brown (Commerce): "The comment...caused me to wonder about all the range of delicate balances we have to strike, and how we have to consider the impact on workers in all sectors of our economy... (61:18-62:4)."

Nafziger (Washington): "We need to preserve both our forests and our communities, and all of us are going to have to be willing to take some risks and make some changes if we're going to do that...(190:20-23)." See also 193:2-14.

Schmidt (Linn County, OR): "The counties believe that we certainly need to be sensitive to biodiversity needs, all the environmental considerations, but we believe that we must be managing the forest, not locking it up (242:20-23)."

ii. Forest Industries

Irvine (Home Builder): "Home builders across America truly love the environment...but we've got to be able to make sure there's an adequate wood supply today and into the future to meet the demand for housing in America (229:20-230:8)."

Spence (Sawmill Owner): "Solutions exist. Solutions that can balance the need for preservation of jobs, preservation of communities, preservation of wildlife (36:15-17)."

C. Bingham (Weyerhaeuser): "We need to have a sensitive balance of people and land (195:16-17)."

Marson (Lumber Dealer): "I really feel in my area -- I live right on the back door of the Alpine Lakes Wilderness Area and close to the North Cascades Wilderness Area -- and I know there has to be a compromise, because I'd be the first one out there if they destroyed the view that's out my window of my office and my home, because it's a beautiful place to live and that's why I live there. But I've also seen families devastated by two mills shutting down in my area (40:9-17)."

Hicks (Plum Creek Timber Co.): "I'm here to discuss research on spotted owl management and explain innovative forest management practices using new forestry techniques. Both, I hope, will be useful as you develop your balanced solution to the timber crisis in the Pacific Northwest (100:12-16)."

iii. Forest Workers & Communities

Draper (Western Council of Industrial Workers): "The forest product workers understand the importance of protecting the forest ecosystem... We don't ask that people be placed above wildlife. We only ask that you remember people count too (30:16-22)." See also 30:23-25.

Lang: "Your challenge at this point is to move us forward, to put people first, to put people back to work and -- in the immediate sense, and in the long term, put us on the road to a solution that puts the forest and people walking -- working hand in hand together (79:10-14)." See also 78:16-79:1.

iv. Biologists

Thomas (USFS): "All sides in the issue including elected leaders easily speak the word 'balance.' They all mean different things.... I think it means obey the law with a high probability of success and then minimize the social and economic cost or maximize the social and economic benefits, whichever way you choose to put it (208:21-209:4)."

Gordon (Yale): "We did a report in '84 that said there ought to be an old growth reserve that protected some of these species, and then maybe we could go ahead and harvest some of the rest of it. It was resoundingly unpopular and nothing came of it." Clinton: "Unpopular with whom? With everybody?" Gordon: "Everybody. Everybody I knew. Everybody who spoke to me about it...But, again, now it's ten years later, and I hear the same thing over again, "Yeah, we ought to do it, but it's not popular enough with either side to do it."(133:9-134:20)."

v. Tribes

Powell: "...it will take a cooperative effort on the part of the management agencies, the timber industry, and environmental groups to achieve the balance that everyone is striving to achieve (87:17-20)."

vi. Environmentalists

P. Lee (Oregon Trout): "I would like to thank you...for the initiative that has been shown in trying to reach a compromise or to find that middle ground in the controversy that we have in front of us (37:2-6)."

Arthur (Sierra Club): "Balance is important, and that's something that we should strive for. But balance means saving the 10 percent we have left, that change is inevitable, that we need your help to prepare for the future, to invest in our Northwest; that our northwest rivers, our northwest forests are part of our infrastructure to prepare for the future. We don't hunt buffalo. We no longer kill whales. And we can't sacrifice the last ten percent of our remaining ancient forest for the future (53:24-54:7).

Kerr (Oregon Natural Resources Council): "I want to suggest that what the solution is not, and that is environmentalists such as myself were very wary about this event today, because in a situation like this, all the parties are often called to compromise a little and give and take and something like that like a labor management negotiation, and then everybody splits the difference and says there's a deal. But when so little of the virgin forest is left, the 10 percent, environmentalists are not in a position to compromise the forest any further (196:17-197:1)."

vii. Church

Murphy: "I believe that only through dialogue and full participation of all concerned parties can we achieve a balanced solution that serves the common good (28:1-3)."

viii. **Social Scientists**

MacColl (Historian): "... I am encouraged that sensible solutions to the present impasses will be forthcoming. History does show that logging can coexist with environmental protection as has occurred in Germany (22:24-23:2)." See also 23:3-10.

b. Consensus

All who mentioned the need for a balanced solution agreed that the elements to be balanced were environment and people (also economy/jobs).

c. Disagreement

As Thomas and Clinton noted, disagreement exists over the definition of 'balance', especially between environmentalists and other groups: see old growth issues (Section II.G.3.) for more environmentalists' refusals to compromise remaining old growth forests. Biologists Thomas and Gordon are much less optimistic than others on the possibility of reaching a compromise: they've tried to do this before.

d. Places mentioned

North Cascades and Alpine Lakes Wilderness Areas; Northwest; America/nation; Germany (as example)

e. Time periods mentioned

Past (in Germany as example), coming months, long-term future

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5. Need for all groups to participate in crafting solutions

a. Who says what

i. Government

Clinton: "This conference has established a dialogue... And it's got to continue, between us and you, and among yourselves. You have got to be part of this solution. Even if we make the most enlightened possible decisions under the circumstances, they will be all the more resented if they seem to be imposed without a continuing mechanism for people whose lives will be affected here to be involved (253:19-254:4)." See also 7:8-11, 254:5-255:11.

Gore: "It is because we care about you, the people in these communities, about your jobs, your future and your families that we are here to listen and learn from your experience... We're encouraged by the eagerness of all involved to seek common ground and comprehensive long-term answers (13:8-16)." See also 13:25-14:4.

Schmidt (Linn County, OR): "The counties have been a partner in all the consequences, and we want to continue to be a partner in the solutions... And if there's any way the counties can support you in accomplishing our goals, we want to be a part of it (244:15-21)."

Katz (Portland): "But if democracy is about finding solutions to problems unsolved, if it's about finding the core of common agreement, then this conference will be a step forward in that direction. If you call upon us to try the different approach, the unlikely alliance, the untried alternative, we will respond. This conference is our chance to prove that we have the wisdom, the imagination, and the courage to find solutions (8:20-9:2)."

Roberts (Oregon): "On behalf of Oregonians and Northwesterners, I thank you for coming here to listen and to work with us... (9:21-22)."

ii. Environmentalists

Kerr (Oregon Natural Resources Council): "[Environmentalists] stand ready to support, with all our resources, a program that you and your administration craft... (197:15-17)."

iii. Forest Workers & Communities

Draper (Western Council of Industrial Workers): "On behalf of workers everywhere, I pledge our commitment to work with this administration. Together we can find a solution that protects the forests of God and the families of man (31:7-10)."

Mason (Western Commercial Forest Action Committee): "One of the big problems we've had in the past is we've wanted to seek simplistic solutions based on public relations programs and legislative expediency, and very rarely crafted by people who live and work on the land, sir. We need to be there with you (76:3-8)." See also 76:9-20.

Eades (Logger): "When these decisions are made, science deserves a very prominent role, but it should be only one ingredient in this solution... Keep people like me in this equation. And I'd like to declare myself your friend in this and tell you to call upon me anytime you want, and you'll hear the truth from me (50:1-10)."

Bailey (Logger's Wife): "We can solve these problems if we just continue to do what we're doing here today, and that's join together and find a solution that involves the local people (47:7-10)."

iv. Forest Industries

Hicks (Plum Creek Timber Co.): "Mr. President, if there's anything I or my company can do, please do not hesitate to ask (104:15-17)."

Tomascheski (Sierra Pacific Industries): "There will be working groups coming out of this session, scientists, that will be looking at this approach, and some of us have extensive experience in attempting to implement this kind of thing on the ground, which is where the real work gets done, and we would ask that some of us be allowed to participate in that process (120:23-121:3)."

Irvine (Home Builder): "We want to work with you (229:2)."

v. Tribes

Powell: "It will take a cooperative effort on the part of the management agencies, the timber industry, and environmental groups to achieve the balance that everyone is striving to achieve. It will not be acceptable for one group or agency to stop the work or efforts of the others (87:17-22)."

Strong: "I was asked to consider, for the purposes of this roundtable, where do we go from here. And, Mr. President, there are an estimated five million American Indians, some watching here today, and they may be tempted to quote an old Hollywood Indian named Tonto and say, "What do you mean 'we,' Kimosabe?" (249:10-15)."

"We come here because we believe your administration represents the redeeming quality of government-to-government relationships between American Indians and the United States of America... (248:15-18)."

vi. Church

Murphy: "I believe that only through dialogue and full participation of all concerned parties can we achieve a balanced solution that serves the common good (28:1-3)."

vii. Social Scientists

MacColl (Historian): "Thus has there been a progressive tradition in Oregon buttressed by an ethos of egalitarianism with a strong populist influence. This record is why I am encouraged that some sensible solutions to the present impasses will be forthcoming (22:22-23:1)."

viii.Commercial Fishermen

N. Bingham (Fisherman): "...there's a lot of people out there that want to work with us to solve this problem. The fishing industry has been working for years developing model programs...We know how to do the job, but we need your help (56:18-24)."

ix. Biologists

Thomas (USFS): "I also find that there is a large confusion in the body politic about what science is. Science is a process. It's not a product. Scientists propose; elected officials and others dispose. Now, I've found in these three crash efforts to develop information that you -- something else that's very encouraging. You command natural resource agencies that have incredibly talented people in your employ. They are highly skilled. They are incredibly motivated. They can do marvelous things when they understand their mission and it's clear and it's concise and all of them move forward together (209:21-210:6)."

Oliver (U Washington): "You'll never have a species completely out of risk. What we're really looking at is how much risk are we willing to accept, and if you list all the trade-offs, risks for the different species, the relation of that to the cost of the local communities, plus the cost that the American public is willing to put forward, either in encouraging private landowners to put these in and money pay in lieu for various forms of welfare or job transfer. You have to look at various levels of set-asides relative to ranking all of these risks. Now, the scientist's point of view is to try to come up with the best idea of what those risk rankings are, but then what level the public is willing to expect becomes a choice of the people, which is -- I'm sorry -- that's your job, but we could come up with probably an agreement looking at everything including the global environment, the local economy, the risk to the spotted owl, the risk to other species (130:21-131:13)."

Franklin (U Washington): "I agree completely with Professor Oliver...you have a document of that sort already available to you in the Gang of Four report where we lay out many alternatives, identify the risks associated with each of those alternatives, and then leave it to you folks to make your choices about what level of risks we want to deal with (131:16-23)."

b. Consensus

All parties want to participate in crafting a solution; none state that they wish to exclude any other parties from the discussion. Clinton and Gore support/promise participation of all. Only group that does not request inclusion is natural and social scientists, i.e., those who are already a part of the process.

c. Disagreement

Rather than requesting inclusion in the process (which they already have), biologists seek to define and limit their role in developing a solution. They do not want to be responsible for making policy decisions, but for assembling and presenting the best knowledge possible to policy makers.

Strong speaks for American Indians on where the real responsibility for remedying current conditions lies.

d. Places mentioned

Northwesterners as source of solutions

e. Time periods mentioned

Past: exclusion of some groups, gridlock over issue in short term; long-term populist/egalitarian tradition in Oregon;

present/short-term future: time during/after conference when administration will be crafting solutions

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6. Need for reconciliation among groups

a. Who says what

i. Government

Clinton: "The rhetoric from Washington has often exaggerated and exacerbated the tensions between those who speak about the economy and those who speak about the environment (5:4-7)."

"When you hit an impasse, I plead with you not to give up, and don't turn against your neighbors... I don't want this situation to go back to posturing, positioning, to the politics of division that has characterized this difficult issue in the past (254:10-25)."

Gore: "For far too long bitter fighting and confused policy making have scarred this debate... It is time we moved beyond argument and confusion to a new approach that replaces fear with hope and stalemate with progress (11:24-12:5)."

ii. Environmentalists

P. Lee (Oregon Trout): "I believe education is a key to the beginning of the healing process... (38:5-6)." Describes environmental education center she is starting in her community (38:6-39:10).

iii. Church

Murphy: "I, the members of my church and the members of many other churches, stand ready to assist your efforts toward resolution and reconciliation (28:8-11)."

iv. Tribes

Strong: "...where we go from here...In actuality, tomorrow, we go out and we build coalitions across all ideological lines (251:21-24)."

v. Social Scientists

MacColl (Historian): "Forty-three years ago, Fortune Magazine proclaimed that, quote 'Happiness is pursued in the Northwest with a certain calm simplicity that is rare in America,' end quote. I doubt if such words would be repeated today... (15:20-23)."

"Hopefully, this conference will show the way and start the process, that calmness and happiness may again reign throughout the Northwest (23:25-24:2)."

b. Consensus

Division and polarization have typified forest issues in past few years; this needs to change.

c. Disagreement

None.

d. Places mentioned

Northwest; Washington, D.C.; P. Lee's education center in Douglas County, OR

e. Time periods mentioned

Short-term past: debates and divisions; long-term past (43 years ago): calmness and happiness. Future: tomorrow (Strong) to future generations (P. Lee)

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7. Hope generated by the conference

a. Who says what

i. Forest Workers & Communities

Eades (Logger): "Thank you for giving my people hope, sir (50:12)."

Bailey (Logger's Wife): "I don't know if you've realized what you've done for millions of families or thousands of families like mine that are dependent on the forests. You've given us new hope and we desperately need that (46:3-6)."

Ollivier (Longshoreman/Eureka Harbor Commissioner): "You have energized -- both of you have energized our country. You know? I was always positive. But now I can smile, you know (247:23-25)."

ii. Forest Industries

Irvine (Home Builder): "The confidence that you bring by being here at this table today alone has lowered the price of lumber today... (229:11-13)."

iii. Government

Roberts (Oregon): "...your presence here today, Mr. President and Mr. Vice President, stand as a powerful symbol of change and of hope for this region (11:7-9)."

b. Consensus

Apparent agreement among forest workers and communities (those who had been most disenfranchised from previous discussions).

c. Disagreement

None apparent, but most groups are silent on this issue.

d. Places mentioned

People in forest-dependent towns, the region, the country

e. Time periods mentioned

Present

8. Appreciation of President's initiative/leadership in convening conference

a. Who says what

i. Forest Workers & Communities

Eades (Logger): "Words can't describe my gratitude for your coming here to help us end the gridlock that is crushing my people (47:23-25)."

ii. Environmentalists

P. Lee (Oregon Trout): "I would like to thank you...for the initiative that has been shown in trying to reach a compromise or to find that middle ground in the controversy that we have in front of us (37:2-6)."

Wales (Audubon Society): "I want to particularly thank you and Vice President Gore for the personal interest you are taking in fashioning a long-range comprehensive strategy for management of the federal forests (31:17-21)."

Rick Brown (National Wildlife Federation): "As someone who's worked on these issues for quite a while and someone who's spent a few years working for one of your recent predecessors, this level of coordinated high-level involvement from the administration is more than a breath of fresh air to me (125:11-16)."

Sher (Sierra Club Legal Defense Fund): "Thank you both for bringing to the country and to the Northwest an administration which is willing to confront and grapple with these issues as stewards of our public lands rather than as litigants in court (89:18-21)."

Arthur (Sierra Club): "We very much appreciate your leadership in this important issue (50:24-25)."

iii. Forest Industries

Irvine (Home Builder): "Mr. Vice President and Mr. President, we're really pleased that you have shown the leadership and demonstrated the commitment to resolve this great debate (225:9-11)."

C. Bingham (Weyerhaeuser): "...every single large-scale change in this great company has begun with leadership at the top, and we now have leadership in the form of the President and the Vice President of the United States...(195:25-196:3)."

iv. Church

Murphy: "Again, Mr. President and Vice President, your willingness to listen, to have people continue what has begun here, and to be open to understanding the issues involved and to look for ways -- and I think especially within the church community, that we can be of help and assistance in bringing people together, and we hope to, and we will because of your initiative, and we are grateful (92:16-22)."

v. Tribes

Strong: "And as disciplined followers we are eager to follow your lead and hope that we can all see a better future for our children (250:17-19)."

vi. Social Scientists

MacColl (Historian): "I may be wrong, but I believe this is the first time in Oregon history that the President, Vice President and five cabinet members have all visited the state at one time and in the same place, and we are honored (15:16-19)."

vii. Commercial Fishermen

N. Bingham (Fisherman): "On behalf of the commercial salmon fishing industry and the recreational fishing industry, California, Oregon and Washington, I would like to express the gratitude that all of us feel that you have recognized that this problem is more than just spotted owls, but that there is another industry which is dependent on a healthy forest, the salmon fishing industry (54:12-18).

b. Consensus

All appreciate the interest and attention of the President and his Administration, including environmentalists, who had much less to say on other issues related to conference such as need for compromise, for all groups to participate in crafting a solution, and hope generated by the conference.

c. Disagreement

None.

d. Places mentioned

Federal lands/public forests; Oregon; California; Washington; Northwest; the nation

e. Time periods mentioned

Oregon history, previous administrations; present; long-range future

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9. Requests for continued Presidential involvement

a. Who says what

i. Government

Nafziger (Washington): "Mr. President, we need your help. We need you to help us come together and build a new paradigm for sustainable communities and a sustainable environment (193:15-18)."

Schmidt (Linn County, OR): "We're asking for your help (242:15)."

ii. Forest Workers & Communities

Coates (International Woodworkers of America): "I hope that you, Mr. President, will be committed to keep your hands on this matter personally. We're talking about a lot of human beings. They're not just statistics. They're names (241:6-11)."

Ollivier (Longshoreman/Eureka Harbor Commissioner): "We're fighting for our lives, Mr. President, in northern California. And we're going to make it. With your help we're going to make it (246:15-17)."

Draper (Western Council of Industrial Workers): "I have the utmost trust in you and the Vice President and your administration to resolve this issue (63:18-19)."

Lang: "We were all so pleased, during your campaign, Mr. President, to hear you talk about putting people first, and we couldn't support you on that front more. Your challenge at this point is to move us forward...(79:7-10)."

iii. Environmentalists

Kerr (Oregon Natural Resources Council): "So environmentalists urge you to save the last of the big trees, deal with log exports, and help these communities move in order to the 21st Century economy (199:11-13)."

Arthur (Sierra Club): "The past administration was frankly mired in the past and we need your help to move towards the future (51:1-2).

iv. Tribes

Strong: "Mr. President Clinton, you have been chosen to write one page on the book of American history. American Indians, natives to this land, hope and pray that the pen that you wield will be guided by the Sacred Beings who created and authored the perfect laws of nature by which all mankind have existed since the beginning of time (250:6-11)."

v. **Commercial Fishermen**

N. Bingham (Fisherman): "We know how to do the job but we need your help (56:23-24)."

b. **Consensus**

All groups look to the President and his Administration for continued involvement and assistance in resolving the current situation and in providing aid to people who are suffering.

c. **Disagreement**

Strong directs a prayer for guidance for the President to higher authorities, compared with direct requests to the President by other groups. This is more a difference in form than disagreement over issues, but it does reflect a different sense of time and authority than that of American politics. Archbishop Murphy's comparable appeal was "May the blessings of a good and gracious God be with all of us and grant us the wisdom to find solutions (28:11-13)." Mayors Katz and Strauger also wish Clinton "God speed" and "God bless."

d. **Places mentioned**

Northern California

e. **Time periods mentioned**

"Since the beginning of time," present, future: Clinton's term and 21st Century

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10. **Responsibility to future generations**

a. **Who says what**

i. **Government**

Clinton: "...we need to protect the long-term health of our forests, of our wildlife, and our waterways. They are, as the last speaker said, a gift from God, and we hold them in trust for future generations (252:25-253:3)."

Gore: Old growth forests "if once destroyed will be gone forever for every generation that follows (14:7-9)."

Roberts (Oregon): "...our economic and environmental stewardship of these resources will in no small part determine the heritage we leave for our children and our grandchildren (10:17-11:1)."

ii. **Environmentalists**

Wales (Audubon Society): "The bottom line is that those most affected by environmental decisions of this decade will be the grandchildren of our grandchildren (33:17-19)."

Arthur (Sierra Club): "These great forests do define the character and the culture of the Northwest. They are part of our heritage, but they also ought to be a part of our legacy, the legacy that we leave to our children and grandchildren so that they have choices to make, they have opportunities to experience and enjoy what we have, but also to reap the economic rewards and the economic benefits these forests can provide if we sustain them, protect them, and manage them well (52:7-15)."

Lee (Oregon Trout): Discusses need to teach children about forests and forest processes and "how to enjoy those gifts while ensuring that their grandchildren's grandchildren will also enjoy those gifts (39:2-10)."

Sher (Sierra Club Legal Defense Fund): "The laws are good laws. They are this nation's commitment to the future and a covenant with the people that we will not squander our resources in this generation and deprive future generations and not violate our trust responsibilities to the other species with which we share the planet (90:18-23)."

Wawona (New Growth Forestry): "We have a chance to go down in history as people who learned from their mistakes and created a new way forward. Let's do the right thing for our grandchildren (60:21-24)."

iii. Tribes

Strong: "...where we go from here...we unite as family, and we begin to do the work that lets us leave behind a legacy of love for our natural resources to be enjoyed in perpetuity by all humans yet to walk this earth (249:21-250:2)."

b. Consensus

Environmentalists are the strongest voice on this issue; all who speak of responsibility to future generations do so in terms of preserving forests and environment.

c. Disagreement

None here, but see rural community issues (especially sections II.B.1. and II.B.7) for responsibilities to present generations, especially children now living in rural areas.

d. Places mentioned

Northwest; only one mentions place at all

e. Time periods mentioned

Present; short-term future actions; future generations: children, grandchildren, grandchildrens' grandchildren; "in perpetuity"

B. Rural communities

1. Value of rural culture, way of life

a. Who says what

i. Forest Workers & Communities

Lang: "Are all of our children in the Northwest supposed to grow up and work for multinational corporations because they're the only ones who can survive? I hope not. The roots of this country are in small businesses and in small community. And if we are serious about respecting the cultural integrity of those small communities then our long-term solution, how we deal with this problem right now, has to respect those cultures (78:8-15)."

Hollenbeck (Logger/Sawmill Owner): "When I stared working in the woods at 14, I learned our heritage, and our heritage is a proud heritage. One of the speakers at the first table today said it in a nutshell. He said that we were problem solvers by heritage, and that's absolutely correct, and that spirit is alive and well today (219:14-19)."

Eades (Logger): "My two sons, Corey and Kevin, work with me every day in the woods. Like I said, we cut down trees, and I have a daughter that's a wildlife biologist and a forester. We work on some of the same ground our grandfather worked on every year. Mr. President, my people, my family are forest people. We love the beauty of the forest; we respect it. It's part of what we are. We have a heritage in the forest (48:20-49:2)."

Mason (Western Commercial Forest Action Committee): "...I brought with me letters from the school children in my community...These are the children that we need to manage the forests in the future. We can't send them to the city to be retrained. These are the rural heritage. These are who we are...(77:14-24)."

Ollivier (Longshoreman/Eureka Harbor Commissioner): "We're fighting for our lives, Mr. President, in northern California. And we're going to make it (246:15-16)."

ii. Government

Clinton: "As I've spoken with people who work in the timber industry, I've been impressed by their love of the land. As one worker told me...'I care about Oregon a lot, the beauty of the country.' (4:11-15)."

"I remember the families from the timber industry whom I met last September in Max Grossbeck's back yard in Eugene, Oregon. I was moved beyond words by the stories that people told me there and by their determination to fight for their communities and their companies and their families (3:16-21)."

"I cannot repeal the laws of change...But what we have to find a way to do is to try to make it possible for more people to be faithful to their cultural roots and their way of life and to work through this process in a human way (94:13-24)."

Compares processes in rural Northwest to collapses of agriculture and rural communities along the Mississippi River after the Depression and in the early 80s, also to defense workers laid off in southern California (93:3-95:7).

Gore: "At its very heart this debate is about people...It is about people who care deeply about their communities and about a way of life passed from one generation to the next, rich in traditions, strengthened over time. It is about people who care about the forests, wildlife, water and fish. It is about proud, hard-working people worried about losing their jobs and their dreams, worried about a future now uncertain for their children. (12:20-21:7)."

Strauger (Hoquiam, WA): "When I hear people start to talk about putting these good workers back to work building picnic tables and cutting trails, it's unacceptable to me because we are a proud people, a proud community, and they deserve full-time family wage jobs (81:1-5)."

iii. Church

Murphy: "A culture, a way of life, prized and reverenced in our timber communities is dying (27:17-18)."

iv. Environmentalists

Kerr (Oregon Natural Resources Council): "I was born in a mill town, Creswell, Oregon, and I could have dropped out of high school and went to work in the woods, but I had a chance and a choice that many of my high schoolmates did not have, and I -- so I feel for those people in those timber towns. I grew up with them (196:6-11).

Wales (Audubon Society): "I was born and raised in Klamath Falls, Oregon, and have lived in Roseburg for the last 15 years...Being an environmentalist in Douglas County is not easy. Views that would be considered moderate elsewhere are blasphemy in Roseburg. I am married to a life-long resident of Douglas County whose father was part owner of a small mill that was absorbed by Roseburg Forest Products. Cliff put himself through college and through law school working in mills, and his older brother still works in a mill just north of Roseburg...My clients come from all walks of life in Douglas County, and my business is as dependent as any other small business on the economic health of my community. I am deeply committed to my community's long-term economic and environmental well-being (31:22-32:13)."

b. Consensus

The culture and heritage of timber-dependent communities are a valuable part of American culture. They include a love of the land and natural beauty passed from one generation to the next through working the land; independent, proud spirits; practical problem-solving abilities.

c. Disagreement

None here, but many groups are silent on this issue and speak strongly for the value of old growth, especially environmentalists. Environmentalists who speak here relate personal histories that show they are linked to rural communities and feel for the people there, but they do not express concerns for the traditional culture and heritage of those communities.

d. Places mentioned

Roots of the country; Northwest; Oregon; timber communities; Mason's community (Forks); woods where Eades, his children and grandfather work; northern California; southern California; Eugene, OR; Creswell, OR; Klamath Falls, OR; Roseburg, OR; Douglas County, OR; Mississippi River

e. Time periods mentioned

Past: heritage of working in woods from grandparents, the Depression, early 80s. Present: what is happening to rural cultures now. Future: what will happen to children. People's lives in rural towns (Hollenbeck, Eades, Kerr, Wales)

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2. Uncertainty/fear in rural communities

a. Who says what

i. Forest Workers & Communities

Eades (Logger): "Mr. President, I'm here today because I'm scared... I'm afraid of the future that faces my family. I represent thousands and thousands of timber workers just like me, ordinary, everyday, hardworking people who face a fearful future, and I have friends just like have been described to you, modern Paul Bunyans who are hiding in the car while their wife buys groceries with food stamps. These people have hopes and dreams just like all of us (49:8-17)."

Kostopulos (Woodnet): "There's a fear on the Olympic Peninsula, a climate of fear, Mr. President, and part of the reason that people are afraid up there is that they know that we are ill prepared to meet the challenges that we need to face right now (177:20-24)."

ii. Forest Industries

Spence (Sawmill Owner): "Pacific Lumber and Shipping is a third-generation, family-owned company started by my grandfather in 1932... Since we began operating, our mills have never shut down. We have done everything we can to uphold our commitment to our employees and to our communities. Now we find ourselves in the position where that commitment is threatened. The trust and faith that our employees have placed in our company has been shaken. The story I have to tell you could be told by just about any lumberman in the West. We are all in the same precarious position (34:7-22)."

iii. Government

Schmidt (Linn County, OR): "We need to find a level of stability. We have such a stake, and of course we are close to the people that are affected (242:12-15)."

Roberts (Oregon): "The citizens of this region know that change is coming, and they are preparing for change. But as they adapt to these changes, they also seek predictability as we plan together for our communities, our industries, and our workers (11:3-7)."

iv. Environmentalists

P. Lee (Oregon Trout): "My first thoughts about how the timber crisis has affected my community is the economic uncertainty, the polarization and fear it has engendered, all elements of our community from the timber worker to the cafe owner, to the banker has been affected (37:13-17)."

Arthur (Sierra Club): "I grew up in rural northwest Montana and in Eastern Washington. My family ran a logging and Christmas tree operation. I partly put myself through college logging as well. I empathize and understand the frustration and the anger that the communities feel (51:15-20)."

v. Social Scientists

MacColl (Historian): "Timber workers especially feel helpless because they, like the rest of us, cannot control our own destinies. They have seen their livelihoods threatened just like the forests are threatened. There appears to be little that the individual can do to make the Oregon dream a reality (18:9-14)."

b. Consensus

Timber and wood product workers, employers, and communities are afraid of what will happen to them economically, and how economic changes will change their livelihoods and ability to provide for their families, their communities, and themselves. This fear of not being able to provide is linked to losing that aspect of self-identity and self-respect. These people have little feeling of control over their lives.

c. Disagreement

None.

d. Places mentioned

Olympic Peninsula (Kostopulos); Southwest Washington, the West (Spence); this region (Roberts); my community (in Douglas County, OR: P. Lee); rural nw Montana, e. Washington (Arthur); Oregon (MacColl); timber communities (several)

e. Time periods mentioned

Since 1932; time growing up; experience of fear in recent past and present; fear of what future brings

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3. Breakdown of community ties

a. Who says what

i. Forest Workers & Communities

Draper (Western Council of Industrial Workers): "I have seen families destroyed, towns bulldozed, the very fabric of the rural communities torn by a long period of government inaction and contradiction (29:5-7)."

ii. Environmentalists

P. Lee (Oregon Trout): "A friend I've known for 20 years avoids me now because I suggested there are limits to what we can take from the environment. The business that I manage has suffered harassment because we have been labeled as just a bunch of environmentalists (37:25-38:4)."

iii. Church

Murphy: "But I do know that this man's tragedy has been repeated thousands of times by workers who have lost their livelihoods in our forests. These are not only personal experiences; they are community tragedies. The man who lives in his pickup truck has lost the wherewithal and the self-worth that builds community. He does not vote. He does not belong to the Rotary Club or Kiwanis. He doesn't show up for coffee at the diner or McDonald's (27:2-9)."

iv. Social Scientists

R. Lee (U Washington): "In the most recent assessment that I have made in the health of our communities, we're moving into a process which looks an awful lot like what happened to the inner city. We're seeing...disintegration of communities...(148:5-10)."

b. Consensus

Not many people talk directly about the breakdown in friendships, business networks, community participation, and other informal relationships that bind a community together, but those who do see these relationships note their importance and their loss.

c. Disagreement

None apparent, but lack of comment on this subject by most could mean that many groups do not consider this an important issue.

d. Places mentioned

Timber communities, meeting places in those communities, P. Lee's community and business (Steamboat, OR)

e. Time periods mentioned

Friendship of 20 years, recent past (past few years), present conditions

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4. Unemployment

a. Who says what

i. Government

Strauger (Hoquiam, WA): "My city got hit on November the 12th with the closure of a three-unit mill, and our unemployment is now 19.5 percent and climbing. We expect it to go over 20 percent." Describes impact of closure on city budget, probability of having to lay off 22 city employees. "But I cannot describe to you the feeling that I have in the pit of my stomach when I know that I have to add to this unemployment. I've never had to lay people off before in my whole life (79:19-80:10)."

ii. Forest Workers & Communities

Coates (International Woodworkers of America): "I closed 39 mills between March of 1990 and March of 1991 just in Gray's Harbor. The 650 who now have lost their jobs as of January 1 have not impacted to date. That impact, I feel, will probably hit around June, and we will feel another three times that many because of the indirect and the induced (240:25-241:5)."

Bailey (Logger's Wife): I live in Trinity County...and in January our unemployment rate was 21 percent. In February it was 23. We still have two mills left that have probably approximately eight to twelve months' worth of logs to ply (46:14-19)."

Draper (Western Council of Industrial Workers): Lists the types of people who have lost, are losing jobs: people who construct homes, carpenters, woodworkers, millworkers, paperworkers. Gives example of one family in which both parents lost jobs in the same veneer mill in Colburg, OR, when it closed in December..."Sadly, they are not unique. Thousands of men and women have lost their jobs. Thousands more are at risk due to a dwindling timber supply (29:14-30:4)."

iii. Forest Industries

Spence (Sawmill Owner): "If the Gifford-Pinchot timber sale program is not reinstated soon companies will have no choice but to curtail production and to begin laying off workers. Employers who depend on the timber from private and state lands are also being damaged...the pulp and paper industry in this region also faces devastation. They depend on wood chips produced by sawmills for their raw material (35:18-36:9)."

b. Consensus

Unemployment is bad, is getting worse, and many more are at risk in the next few months. Workers in many economic sectors are affected, both in a variety of forest and wood product industries and in jobs that are funded indirectly by timber production.

c. Disagreement

None.

d. Places mentioned

Hoquiam, WA; Gray's Harbor, WA; Colburg, OR; Trinity County, CA; Gifford-Pinchot National Forest

e. Time periods mentioned

March 1990-March 1991; November-December 1992; January-February 1993; June 1993; next 8-12 months

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5. Poverty

a. Who says what

i. Government

Strauger (Hoquiam, WA): "I think probably the instances that hurt me the most are the time that a mill worker came into my office not too long ago, and he told me what it was like to stand in his first food line, and he said, 'Mrs. Strauger, I made it back to the car,' and then he said, 'I sat there and I cried.' (81:13-17)."

"92 percent of our kindergarten children are on free and reduced lunches...it goes down to 50 percent by the time they get to high school because the high school kids don't like to sign up for it (80:14-19)."

Tallerico (Siskiyou County, CA): "What I have observed in our county, and I think it's indicative of the region, is the constant increase in the aid for dependent children. Over the last 5 years we have steadily increased to a high of 28 percent of our school population being recipients of aid to dependent families...in the last year, our free and reduced meals have increased to 41 percent of the total school population of 8500 children. We feed also breakfast and lunch. So we're feeding about 7200 meals a day simply because these children's parents no longer have the resources to provide those lunches (43:4-16)."

ii. Forest Workers & Communities

Bailey (Logger's Wife): "The average median income for a person living in Trinity County is $13,900. We don't have much to compromise at that rate. There's not much left to give...60

percent of our children in our public schools are on free and reduced lunches. This means that they also live at or below poverty level (46:20-47:5)."

Coates (International Woodworkers of America): "I have a distribution warehouse that last year we put out 730,000 pounds of free food from. We're currently feeding 10,660 people in two counties (240:10-12)."

iii. Social Scientists

Fortmann (UC Berkeley): "Poverty is a long-standing and persistent feature of these communities. In 1989 nearly a fifth of California's forest-dependent communities had poverty rates that were equal to or greater than inner city rates. In the decade between 1979 and 1980, forest counties in California that experienced increases in timber cuts did not experience decreases in their poverty rates. The lesson is that at least in California, large timber harvests will not automatically resolve the poverty problem, particularly when profits are not reinvested in the communities or counties to any significant extent (143:2-12)."

iv. Church

Murphy: "The loss of that man and those like him is evident in the empty storefronts in downtown Hoquiam and other timber communities. The loss is evident in the lines at the soup kitchens and the welfare office...(27:10-13)."

b. Consensus

There are a lot of poor people in timber communities and their numbers are increasing, as measured through soup kitchen and welfare lines, use of food banks, school lunch programs, and other such services.

c. Disagreement

Fortmann's statement that large timber harvests will not automatically reduce poverty is a novel point in discussion of this issue, as is her description of long-term poverty independent of recent events; don't know whether other groups would agree with her or not on this.

d. Places mentioned

Hoquiam, WA; Trinity County, CA; forest-dependent counties and communities in California; Siskiyou County, CA

e. Time periods mentioned

1979, 1980, 1989, "long-standing problem", last year, present.

6. Homelessness

a. Who says what

i. Government

Strauger (Hoquiam, WA): "Another man came and told me -- he's 50 years old -- how he was going to lose his house... A friend of mine went up the Wynoochee River and found two families camping in a tent with little children, and in order to keep their kids in school, they had gone to the nearest community and had bought a post office box because that gave them an address, but they didn't want those kids to tell anybody where they were, and they were cautioned not to do that at school because they were afraid that somebody would take the children away from them when they found them living like that (81:18-82:13)."

ii. Forest Communities & Workers

Coates (International Woodworkers of America): "I hear Andy and some of the others talking about the beauty of the forests. When I go into the beauty of the forest, in the capital forest, and in the park service and in some of the rock quarries, we have people living there. They have no home. They have no water. And they have no power. If I was to divulge where these people were, they wouldn't have their children either (240:12-19)."

Draper (Western Council of Industrial Workers): "I speak on behalf of Tia, a young mother living homeless and jobless with three children in a tent community in Amiter County Park, Oregon. She lost her job in Dillard, Oregon, due to this gridlock. Separated from her husband, she has since gone from job to job looking for the steady work to support her family. These are the faces behind the statistics, Mr. President (30:8-14)."

iii. Church

Murphy: "...I arrive in Hoquiam...here I meet a burly strapping fellow in the prime of life. He has worked most of the 40 some years in the woods felling trees. He has been without work for months, stretching into years. He has lost his home, and his ties to family and friends are tenuous. 'Archbishop,' he asks me, 'do you know what it's like to work for 20 years and then end up sleeping in your pickup at the side of the road?' (26:16-25)."

iv. Social Scientists

R. Lee (U Washington): Mentions homelessness as one symptom of poor community health (148:10).

b. Consensus

Job loss leads to homelessness for some people; personal stories discuss impacts on families and children, feelings of helplessness.

c. **Disagreement**

None.

d. **Places mentioned**

Hoquiam, WA; Wynoochee River; Amiter County Park, OR; Dillard, OR; National Forests and Parks; quarries

e. **Time periods mentioned**

Past couple of years, present

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7. **Condition of children and families**

See also poverty and homelessness sections 5 and 6 above.

a. **Who says what**

i. **Government**

Strauger (Hoquiam, WA): "There was a young couple up in the Quinault area...They got laid off. They were down to the point where the only food they had was out of the food bank, and that was it. She became pregnant and had her baby, and the baby died, and afterwards they learned that for three days before that baby was born, that mother had not had anything to eat. Anything she'd had, she had given to the two little kids they already had (82:14-22)."

Tallerico (Siskiyou County, CA): "What I have discovered, is that when Dad or Mom comes home in the evening and addresses the issue that we are looking at mill closure and/or layoff...that youngster's life is now changed, because what this youngster's going to focus on is what's happening to me and my family and my friends, will my father and mother be here tomorrow, or do we have to pick up and move?" Notes that in their region, father often leaves for timber jobs in other parts of California or the Northwest, leaving mother at home with the children. "We are de facto-ly creating single-parent families. And if you have a youngster that's in those middle teens that requires a lot of parental guidance, we are finding that to become very important for us to react to that." Notes increasing numbers of young men in juvenile hall.

"And that's why we need a reasonable solution to this problem. And we need it soon, or we're going to lose a whole generation of young people (44:17-45:8)."

ii. **Forest Workers & Communities**

Mason (Western Commercial Forest Action Committee): "I brought with me letters from the school children in my community...if you would read those letters which I gave to your staff, you will have a new understanding of the depth of the psychological legacy that we are handing on in rural America...it's a tragedy of great consequence (77:12-19)."

Draper (Western Council of Industrial Workers): "I speak on behalf of the thousands of children at risk, their happiness, their hope, their dream imperiled by an uncertain future (30:5-7).

Fletcher (AFL-CIO): "We have people on the abyss who cannot wait, some have gone over the abyss. Divorce, suicides, child abuse is in endemic [sic: epidemic?] in timber communities that have lost mills (201:1-4)."

Lang: "The future is our children, and in fact much of my concern I share with a lot of the mothers in the Oregon community is for our kids. When I was holding my one-year-old son this morning, I was feeling sad that in the short time that he's been on this earth his choices have already diminished considerably (78:2-7)."

iii. Forest Industries

Marson (Lumber Dealer): "I've also seen families devastated by two mills shutting down in my area (40:15-16)."

iv. Church

Murphy: "...and the loss is evident in the homes where unemployed workers, anxious, depressed, sunk in despair, lash out at their loved ones or find solace in alcohol or drugs (27:13-16).

v. Social Scientists

R. Lee (U Washington): "...we're moving into a process which looks an awful lot like what happened to the inner city. We're seeing the collapse of families, disintegration of families, disintegration of communities, loss of morale, homelessness, stranded elderly people, people whose lives are in disarray because of substance abuse...(147:7-12)."

b. Consensus

There are serious and lasting effects on children and families in timber dependent communities with high unemployment. Children are being physically harmed through poverty and abuse by distressed parents. They are being psychologically harmed through family and community disintegration and their loss of hope and dreams for the future. Symptoms of family breakdown include physical abuse, substance abuse, divorce, single-parent households, juvenile delinquency.

c. Disagreement

None.

d. Places mentioned

Quinault area; Siskiyou County, CA; California; Mason's community (Forks); Lang's community (OR); Marson's area (WA); timber dependent communities in general

e. Time periods mentioned

Recent past and present conditions; future of children

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8. Need for local control in rural communities

a. Who says what

i. Social Scientists

Fortmann (UC Berkeley): "Local people are angered by outside influences on their communities. The decisions that affect the well-being of these communities are often taken or influenced by timber corporations with out-of-country or out-of-state headquarters, by the staff of state and national natural resource agencies, and by the urban-based staffs of national environmental organizations. These are people who are not personally affected by the adverse consequences of their decisions."

Fortmann calls for locally based management and planning processes that tap local peoples' creativity and knowledge of their communities and ecosystems, citing The Plumas Corporation and Trinity Alps Botanicals in northern California, also Matole Watershed Alliance and Westwood Concerned Citizens... "I think that the success of these and other community-based experiments in change tell us that facilitating local process is going to be the most important product of this conference (143:13-145:18)."

R. Lee (U Washington): Argues that the root of the issue is in federal land tenure arrangements...the U.S. Forest Service had an early record of community building that was purged during the 1950s, leaving it vulnerable to political interests--first timber, then preservation, both of which are destabilizing to communities.

"What I'd like to suggest is that we look at the experience of the rest of the world and the things that we recommend to other countries in books such as <u>Caring for the Earth</u>, where we say we want fundamental security in land tenure arrangements, security in communities, rights of political participation... I don't see that being done under our land tenure arrangements... we may need to move toward a system of community trust or something else that brings people together in legal authorities which cannot be easily interfered with by national interest groups, bureaucracies, big capital, big environment, whatever." Cites Association of O&C Counties as an example (147:8-150:21).

ii. Forest Workers & Communities

See also A.4.iii: Need for all groups to participate in crafting solutions--Forest Workers & Communities.

Eades (Logger): "Today you're going to hear a lot about science from some of those people over there... the science of ecosystems and the science of economics. People like me are caught in between those sciences... (49:18-25)."

Ollivier (Longshoreman/Eureka Harbor Commissioner): "Our major producer of pulp in the area has just moved to Chile. With the World Bank financing that mill and it's very efficient, and they just laid off 262 of our workers, which is 44 percent of my work (246:23-247:2)."

iii. Forest Industries

C. Bingham (Weyerhaeuser): "We need to empower people. Empowered people, research, and operations have to work together...(195:17-19)."

iv. Commercial Fishermen

N. Bingham (Fisherman): "We want to get together with the forest people, with the Indian tribes and the farmers, and work on a watershed base to empower local communities to go to work to solve this problem (56:24-57:2)."

Robinson (Oregon Salmon Commission): Calls for management reform that includes "local people involved designing their destinies (206:19-22)."

b. Consensus

Fortmann and Lee agree on need for local management and planning. See also section II.H.5. on institutions and processes for ecosystem management.

c. Disagreement

No disagreement in this section; most groups are silent on this issue. I do find two types of argument for local control and planning processes: the people included in this section seem to have a social interest in these issues, i.e., local control is an issue of human rights and dignity and an end in itself. The people I included in the ecosystem management section (II.H.5) who also argue for local processes seem to do so out of an interest in managing unique, local ecosystems rather than general, regional ecosystems. For them, including local people seems to be a means to their end of healthy ecosystems, not a goal in itself. If other, simpler means to healthy environments could be found, they might well toss out local process and participation as a tool.

d. Places mentioned

Examples of grass-roots groups in northern California and Oregon; mill near Eureka, CA, moved to Chile

e. Time periods mentioned

Lee discusses history of USFS relationships with communities in this century; others discuss recent past (e.g., mill closure), present, prospects for short and long-term future

9. Community and forest sustainability

a. Who says what

i. Government

Nafziger (Washington): "We need to help us come together and build a new paradigm for sustainable communities and a sustainable environment (193:15-17)."

Gore: "The days when this debate was defined by either/or choices are over. This isn't about saving jobs or saving the environment. It's about saving jobs and saving the environment. We can't do one without doing the other; certainly not in the long term (13:17-21)."

Clinton: "A healthy economy and a healthy environment are not at odds with each other. They are essential to each other. Here in the Northwest, as in my own home state, people understand that healthy forests are important for a healthy forest-based economy (6:13-14)."

ii. Environmentalists

Norman (Headwaters): "A healthy ecosystem is the economic infrastructure for communities with a natural resource base. By working for sustainable communities as well as sustainable forests, we hope to ensure the well-being of both (173:8-11)."

iii. Forest Workers & Communities

Lang: "How about taking a step back and concentrating on overall forest health? How do the forest ecosystems work best together while we're integrating and responding to the needs of people? That's the comprehensive approach that will take us to a road where the future will be more stable (79:2-6)."

Mason (Western Commercial Forest Action Committee): "Our membership includes a broad spectrum of individuals from all occupations who perceive that their future is connected to the sustainable and responsible management of our forests (73:13-16)."

b. Consensus

A direct connection exists between the health and sustainability of human and natural communities.

c. Disagreement

I suspect Larry Mason and Julie Norman would not agree on what constitutes 'sustainable forest management.' More generally, not many people comment on this interconnection: the content of much of the conference still is one of either/or, in the short term, at least: saving jobs or saving old growth.

d. **Places mentioned**

Northwest, Arkansas

e. **Time periods mentioned**

Present, future

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10. Fishing communities

a. Who says what

i. Commercial Fishermen

N. Bingham (Fisherman): "For 30 years I've been privileged to participate in that [salmon] fishery industry. It was a wonderful way of life. I can't tell you how rewarding it is to go out on the ocean and work all day out there and come back with a catch of fish and sell them and be a provider for your family. That way of life is fast disappearing. We are now faced with almost an identical situation that the timber harvesting families are. Next week the Federal Pacific Fisheries Management Council which Mr. Brown administers will decide whether we are going to be allowed to fish at all on the Pacific Coast this coming season. Last year 500 miles of the West Coast was closed to commercial salmon fishing, including my home port in Fort Bragg, California (54:19-55:7)."

Estimates that with support industry, around 65,000 jobs involved in commercial fishing industry in Oregon, California, and Washington (57:4-8).

Robinson (Oregon Salmon Commission): "Everything that you've heard about forest workers' jobs being lost and the effects on our communities is every bit as true when you look at what happens now with salmon fishermen. It's the same. I don't want to compare one family to another family. It's the same story (205:18-23)."

b. Consensus

Salmon fishermen and their communities are facing the same level and kinds of difficulties that forest workers and their communities are: loss of culture and self-identity, economic and social stresses that accompany job loss.

c. Disagreement

None, but only one group commenting.

d. Places mentioned

West Coast; California; Oregon; Washington; Fort Bragg, CA; coastal communities

e. Time periods mentioned

Last year; now; next week; coming season; 30 years as a fisherman

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C. Opportunities for displaced workers

1. Retraining/employment in non-forest work

a. Who says what

i. Government

Clinton: "I was also inspired by Frank Henderson who had lost his job as a timber worker and had gone through retraining to learn thermoplastic welding and now owns a plastics welding building of his own (3:22-25)."

Nafziger (Washington): "We must develop a coherent national retraining policy to help workers who have lost their jobs (192:20-21)."

Reich (Labor): Asks whether people are being trained for jobs that are in demand, that they can easily find work in (221:11-222:18).

ii. Forest Workers & Communities

Ollivier (Longshoreman/Eureka Harbor Commissioner): Asks for retraining and for an educational program like the GI Bill (245:10-25).

Hollenbeck (Logger/Sawmill Owner): "My wife and I feel so strongly about this right now that we are terminating the manufacturing at our facility, and we're going to start -- we're starting right now a school, a school to train people in our community that are out of work and the young people in our community how to make a product, how to market it, and how to get out there and do it (220:24-221:5)."

Heffner (Vocational Counselor): Finds that formal schooling, even in community colleges, does not work well for most timber workers who haven't been in classes for years, are used to working outdoors and using mechanical skills. If they finish formal schooling programs, they often have problems competing against others who already have related work experience. Heffner recommends on-the-job training, tax credits and/or help with worker comp costs for employers who take on displaced workers for training and employment (187:3-189:10).

Also notes that timber workers have skills that are readily transferable to other sorts of work without extensive retraining, e.g., operating heavy machinery in construction work, working in a machine shop or operating a forklift. Individual's hobbies are another source of skills for reemployment, e.g., knowledge of photography (184:19-186:11; 189:11-190:8).

Coates (International Woodworkers of America): "You hear from some of the others on training and retraining. You're talking about a lot of people with some very few selective jobs to retrain to. You have to break the gridlock on this thing and put people -- at least a portion of people back to work -- within the industry (240:20-24)."

b. Consensus

Retraining is an important element in placing displaced timber workers in new jobs.

c. Disagreement

People put different qualifiers on value of retraining: e.g., are people trained for jobs in which they can readily find work? Ollivier advocates formal education; Heffner says that often doesn't work well. "Retraining" seems to mean different things to different people, and some have thought out what sorts of retraining would work best while others give retraining a blanket recommendation without distinguishing different approaches. Heffner also notes that many workers have skills that are transferable to non-timber work without any formal retraining program; identifying these skills may require personal knowledge of individual's work and education history and outside interests.

d. Places mentioned

School in Hollenbeck's community; Oregon preferred worker program (Heffner)

e. Time periods mentioned

Post World War II programs for employing, educating returning servicemen (Ollivier); recent past: successful retraining; present efforts; need for programs in short-term future

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2. Environmental restoration/New Forestry

a. Who says what

i. Government

Clinton: "I'd like to know what you think the realistic prospects are for harvesting second growth forests, how it's affected by the way the Endangered Species Act has been interpreted? So I'd just like to hear you talk a little bit about to what extent some of the jobs and the human problems we've heard might be solved over the long run with aggressive replanting and responsible managing of the second growth forests (63:25-64:10)."

Schmidt (Linn County, OR): "It was mentioned here a few minutes ago about taking some wood out of the many, many thousands of acres of dead and dying timber, particularly in Eastern Oregon, but we've got the problem coming over in Western Oregon as well. It's a disaster, but it's also an opportunity to extract a lot of fiber, to put some people to work, and to do some of the long-term help that those stands need, reducing of densities that have come on since fire has been controlled by man; to modify the species in the stands to more correctly assimilate the stands as they used to be 150 years ago, things like this (242:5-15)."

"We think that investing in these forests is a very good idea: thinning, road maintenance, brush control on young plantations, and certainly stream and riparian enhancement could be done (244:3-6)."

ii. Environmentalists

Norman (Headwaters): "The future of both [federal agencies and local communities] obviously lies in restoration and second growth, given the fact that old growth will soon be gone if not protected...As an example, the Applegate partnership seeks to find common ground with the local timber industry in designing sustainable forestry and restoration projects (172:21-173:5)."

Doppelt (Pacific Rivers Council): Discusses a "comprehensive region-wide watershed protection and restoration program" that his organization has been developing..."the first two steps will create income stream for 15 to 25,000 person-years of employment. The entire program, if implemented over a ten-year period or so, would create the income stream for 50,000 person-years of employment. These would be primarily jobs back up in the woods doing things that many of the rural community people have done in the past like use bulldozers and excavators to treat road systems. So a program that we feel is absolutely vital for the future of our river systems and fisheries will also provide one piece to the short-term transition needs for rural communities (202:14-25)."

Wawona (New Growth Forestry): Answering question on skills and jobs in sustainable forestry from L. Mason: "Many years ago I was on the California Future Timber Supply Task Force to the State Board of Forestry where we learned that there were millions of acres in California that need -- that are in understock condition, need planting or thinning or a number of different types of treatment. The skills are use of chainsaw, surveying, forestry principles, controlled burning. There's a number of different types of skills. I couldn't say what the amount of jobs that would be created (61:1-16)."

iii. Social Scientists

Hanus (Oregon Department of Forestry): Clinton: "What else could be done that would enable each local community to devise opportunities to put people to work?" Hanus: "There's an opportunity in Oregon as well as in other states. We have about 500,000 acres of underproductive land that are nonindustrial private forest land...These could be converted and planted to full stocking, in other words, restored to their natural condition...Some other possibilities are on federal lands where you could do some restoration work (151:4-153:3)."

iv. **Biologists**

Oliver (U Washington): "[To create stands with old-growth structure] What we could do would be using the creativity of the local people...to do the thinning, the pruning, the creating the snags, the creating the openings (115:4-9)."

Franklin (U Washington): "One of the aspects of [the experimental approach of New Forestry] that's very important is that we begin to monitor seriously our management activities...And this, incidentally, is one place for a potential link with the rural populations. Because it's very clear to me that as we develop this work force for the monetary activity, the rural resident populations are an obvious place to draw (109:12-20)."

v. **Forest Industries**

Hampton (Willamina Lumber): Responding to Clinton's question on employment in harvesting second growth: "I do have experience in second growth forests. My father bought a peckerwood sawmill at Willamina, Oregon in 1942 at which time virtually all the old growth in that area had been harvested, what little there was, because the bulk of the timber in the area had been burned over years ago, and we had a very vigorous crop of second growth Douglas fir coming on. The Siuslaw National Forest on which we depend is almost exclusively second growth Douglas fir. Our company hasn't cut an old growth log since 1950. We have high technology. We have highly trained workers, highly educated workers, highly paid workers. Our average worker last year, Dr. Reich, received $39,000. These are not small-potatoes jobs (64:11-25)."

Irvine (Home Builder): Mentions salvage sales as short-term source of timber (228:7-13).

b. Consensus

Restoration and New Forestry projects are a potential source of employment for rural communities, and would require skills that timber workers already have. Hanus and Doppelt both say that funding restoration work would be costly, discuss how this might be accomplished. Harvesting second growth forests has long been a source of employment in the PNW.

c. Disagreement

Each person who discusses restoration/New Forestry has different sorts of projects in mind: salvage and restoration on public lands, watershed restoration, restoration of private non-industrial forests, silvicultural treatment of existing stands, monitoring efforts. None of these are mutually exclusive, but if financial resources are limited, disagreement could occur over which ones should get priority.

d. Places mentioned

Forests in eastern and western Oregon; Applegate partnership (in Medford BLM District, OR); Pacific Northwest watersheds; nonindustrial private forests in Oregon; federal lands; private lands; California forest lands; forests in Western Washington; Willamina, OR; Siuslaw National Forest

e. Time periods mentioned

Lands harvested before 1971 Reforestation Act (Hanus); time since humans have controlled fire, 150 years ago (Schmidt); present conditions; short-term, up front costs; long-term benefits; Doppelt's ten-year program, 1942, since 1950

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3. Value-added manufacturing/new wood products and technologies/manufacturing networks

a. Who says what

i. Government

Clinton: Discusses idea of small scale manufacturing networks as dating back to medieval guilds... income gain in Northern Italy in 1980s due in part to use of such manufacturing networks...gives example of a small metalworking manufacturing network in southern Arkansas...considers such networks to have potential for generating income in small communities (182:12-183:9).

Ron Brown (Commerce): "...the other thing we're trying to do also as part of the stimulus and investment package is this whole concept of manufacturing technology centers. And a lot of what we've heard today would speak to bringing new technology. It's not necessarily high technology. It's just new technologies to an industry in transition so that you can keep mills open, you can create employment situations in that local community, and we've got to see -- we've got to think very carefully about how we place them. They don't all need to be in urban areas. Some of them need to be in rural areas with a good spread around the country to bring the possibility of technology transfer to some of these small and medium-size companies (167:2-15)."

Reich (Labor): "I was actually visiting a mill yesterday, a fairly high technology mill, and they were adding employees. I mean they kept on reinvesting in that manufacturing process... Technology was not replacing workers. Technology was creating more employment (156:25-157:6)."

ii. Forest Workers & Communities

Kostopulos (Woodnet): Discusses Woodnet, started two years ago on the Olympic Peninsula, "a network of over 300 very independent wood products manufacturers." Lists myriad products that member firms of 1-40 people produce. Network activities include attending trade shows, learning about new technologies, advertising and marketing, coming up with ways to use what was waste from mill production. Woodnet is looking to develop a manufacturing technology center [in Forks?] (178:4-182:11).

Mason (Western Commercial Forest Action Committee): "Now you hear about the opportunities in employment and how levels of employment would have automatically declined in the timber industry, and I contend that that's not so, and our mill was an example of that. We use a very small volume of wood and employ 40 local people. And the way we were able to do that was by having a value-add process in our mill...And what you see naturally as resource access becomes restricted the value of fiber increases, and when the value of fiber increases, you can afford to put more investment into labor...[Discusses manufacturing boards from industrial by-products to replace old-growth sawn boards.] That was the transition that I envisioned for my family when in the '80's we invested a million dollars in modernizing our sawmill [to make the transition from milling old growth to milling second growth] (74:10-75:21)."

Hollenbeck (Logger/Sawmill Owner): "We have learned to do more with less, too. In fact, for the last 21 years, we've gotten to be masters at existing on air. We're a Victorian mill work firm. We make all the fancy Victorian trim work and ship it all over the United States. Let me give you a little history of our company, and I think that you can see what can happen to the displaced timber workers today. I'm one of those kids that started working when I was 15 years old in the woods. I worked up until I was 24, and then I quit and started this company. I started it first as a logging company. We logged dead and diseased trees from the Forest Service and made a good living doing that...Then that was stopped, and it wasn't stopped by the government. It was stopped by market, and you couldn't give your logs away. All of a sudden in the mid-70's, the timber industry ran into a recession and nobody wanted the logs...So I went and found in the local sawmill's boneyard, and I dug out parts from there, and I built my own sawmill to try and keep money flowing somehow. I had the logs, so then I started selling fence boards and then we began manufacturing little buildings out of that, and then I began accumulating one piece of machinery at a time. The facility that we have today sits on two and a half acres (218:2-219:8)."

iii. Forest Industries

Spence (Sawmill Owner): "The great bulk of the old growth product goes into the door and window market, not only here in the United States but in foreign markets such as Italy, Germany, and Japan. And we are in the process, now, of transitioning from those types of products into what we refer to as engineered wood products. And as we make the transition we will be able to make that adjustment, but to do that in a short period of time would cause an overwhelming burden on a huge employee base throughout this country (69:17-70:1)."

Minnick (TJ International): "What we've done is we've worked very hard on these reconstituted wood products. [Shows and describes an example.]...the wood fiber can come out of second growth trees, and because it's got a high labor content, probably creates twice as many jobs as sawing a round log into rectangular lumber (223:1-16)."

Mater (Mater Engineering): "We are clearly learning how to make more with less, and I'll give you some examples of how we do that relative to value-added manufacturing." Mater gives examples of products, states interest of Japanese in purchasing some of these products, not raw logs...describes a microthin veneer technology in which 60-75 employees could work an eight-hour shift using only 14 logs...thinks many of these new technologies have worldwide market potential (212:18-214:22).

Irvine (Home Builder): "The new technology issues which several have talked about around this table, I think there's a grand opportunity there. Our national research center in Maryland spends a great deal of time working at new technologies... (228:14-18)."

Hampton (Willamina Lumber): "Last year at our Tillamook Lumber Company Plant alone we invested five million private dollars in the renovation of that plant which is in pretty good shape before that to get the highest value and quality and volume out of those second growth logs. It's laser technology. It's scanning. It's computerized positioning, all run by skilled workers who make this average wage that I identified as $39,000 a year (71:1-8)."

iv. Environmentalists

Kerr (Oregon Natural Resources Council): "And so we need to talk about secondary manufacturing, the future of the timber industry in Oregon, making more with less, and higher value products (198:4-6)."

Norman (Headwaters): "We believe the answer lies in adding value to forest products and investing in new community-based market opportunities...the Rogue Institute for Ecology and Economy is promoting value-added wood products (172:25-173:7)."

Wawona (New Growth Forestry): Wawona: "We have a sawmill also that uses old growth and makes those very products [windows and doors]." Reich: "Can you make the transition?" Wawona: "I don't think that they could, no. For one thing, retooling is a tremendous expense, several million dollars (70:2-7)."

v. Social Scientists

Greber (Oregon State U): "The thing I want to emphasize here is that technological change can do a lot of things to the way we use labor in the wood products industry. A lot of people talk about the technological change and its impact on labor displacement. And if we look in that time period from 1980 to 1986, we did see that there's a large displacement of labor due to technological change. Twenty-five percent of jobs were displaced in that time period due to technological change. But if you look back in the 70's, technological change actually added jobs to the economy of the region. What happened was in the 70's, the industry was focusing on mill recovery, residue utilization, and secondary wood products. You can see that as we head into the 90's, our labor use per million board foot has started to step up once again, perhaps due to scrambling for that raw material recovery (140:12-141:3)."

Discusses composites technology in wood products as example of new (expensive) value-added process that could generate employment and income: 161:1-162:5.

Response to Secretary Brown's comment on manufacturing technology centers: "I think that is a point of great concern in the Pacific Northwest right now. We have this large network of small secondary wood products firms ranging from furniture to cabinet to small molding and mill work and specialty firms that are really at a loss for some of the new technology that's out there in wood products. And they can be a great contributor to a number of the rural economies and capitalize on a lot of the skills of the work force that is out there, but they really don't know how to proceed in marketing or manufacturing (167:16-25)."

Whitelaw (U Oregon): Notes that new wood products technologies can both displace workers and create new employment opportunities, but new employment opportunities in both high-tech wood products and other sectors may not be open to "the 50-year-old dislocated worker with a GED or junior in high school dropout (156:11-157:10)."

b. Consensus

New value-added technologies are an important potential source of employment; though technology has displaced workers in the past, the present trend appears to be one of technology creating jobs. These technologies permit the wood products industries to make "more with less," and thus could mitigate reductions in employment due to reductions in timber supply.

New technologies must be available to manufacturers to do any good. Technology transfer centers and manufacturing networks are two mechanisms that could aid in this. The latter can also assist small manufacturers with much-needed assistance and advice in marketing their products.

c. **Disagreement**

Some, e.g., Kerr (Environmentalist) seem to view value-added technologies as an easy panacea to unemployment in the woods product sector. Others consider that relationship between technology and employment to be more complex. Spence (Industry) and Wawona (Environmentalist) note that adoption of new technologies cannot happen overnight, even though the industry is moving in that direction. Small mills, in particular, would have problems with the costs. Whitelaw (Economist) notes that a job in a high-tech mill might not employ the same worker laid off from an older mill. Disagreements or differing emphases seem as common within groups as among them for this set of issues.

d. **Places mentioned**

Northern Italy, southern Arkansas, local communities, urban & rural areas, Olympic Peninsula, mill that Reich visited, Mason's mill, mill in Wawona's community, United States, Germany, Japan, Maryland research center, Oregon, Pacific Northwest

e. **Time periods mentioned**

Middle Ages, 1970s, 1980s, 1980-1986, two years ago, now, 1990s, short-term future, generalized future

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4. **Non-timber forest products**

a. **Who says what**

i. **Forest Industry**

Mater (Mater Engineering): Mater describes economic diversification through tourism and special forest products processing, e.g., mushrooms, food, pharmaceuticals, botanicals, florals. "And the neat thing about these kinds of products, they're in abundance. You can harvest these products on an environmentally sound two-year rotation. If you do it right, that species can come up in even higher volume than the index volume that you cut, and secondly, we're talking about good family wage job development." Mentions Willamette National Forest study, conceptual plan that would employ 134 people...global market potential (215:24-217:22).

ii. **Environmentalists**

Kerr (Oregon Natural Resources Council): "We need to look at ways to make money off of forests...people do make money off of forests without cutting them down. Our organization has appealed a few timber sales in its days, and one of the timber sales that we appealed is a sale where we tried to show the Forest Service that the annual value, the annual harvest of gourmet mushrooms from that stand of trees each year was worth more than the standing value of that timber (198:7-17)."

iii. Social Scientists

Fortmann (UC Berkeley): "Let me stress that forest dependence is not synonymous with timber dependence (142:24-25)." Mentions Trinity Alps Botanicals, which produces non-timber forest products for export as an example of local community effort in Northern California (145:7-12).

iv. Government

Clinton: "If we destroy our old growth forest we will lose jobs and salmon fishing and tourism...recreational opportunities and hunting and fishing for all...(6:17-21)."

Gore: "If we destroy the old growth forests we lose jobs and threaten entire communities. Jobs in tourism and fishing, recreational activities like hunting and hiking and fishing...(14:11-14)."

Espy (Agriculture): Asks about tourism as one alternative to timber production for rural economies (83:16-18).

Strauger (Hoquiam, WA): In response to Espy, notes "Tourism is something we had been working on even before this hit (83:20-21)."

v. Forest Workers & Communities

Bailey (Logger's Wife): "Let us work. We need those jobs. We need that pride...Let us continue to provide recreation and opportunities for wilderness experiences which we've done (47:13-18)."

b. Consensus

Mater and Kerr agree that special forest products can provide substantial income to families and communities. Mater, Espy, and Strauger also identify tourism as an avenue for community economic diversification.

c. Disagreement

Fortmann makes a unique point in the conference in noting difference between forest and timber dependence, though others may not disagree with her. Mater, Kerr, and Fortmann see non-timber forest products as potential sources of economic growth. Clinton, Gore, and Bailey, in contrast, seem more concerned with not losing existing jobs in commercial fishing, tourism and recreation; they do not identify these activities as job opportunities for displaced timber workers.

d. Places mentioned

Willamette National Forest; Northern California; Hoquiam, WA

e. Time periods mentioned

Past timber sales appeals; two-year rotations; present activities; development or maintenance of these opportunities in the future

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5. Need for family-wage jobs, work not welfare

a. Who says what

i. Government

Clinton: "We need to do our best to offer new economic opportunities for year-round, high-wage, high-skill jobs (251:22-24)."

Schmidt (Linn County, OR): "We need to be thinking about family-wage jobs, not entry-level wages (244:13-14)."

Strauger (Hoquiam, WA): "I've often heard you say that you are a child of the '60's. Mr. President, I'm a child of the Depression. The stock market crashed creating the Depression the year after I was born, and I never knew anything else growing up except the poverty of the Depression, and quite frankly, I had all of the WP programs I want. And when I hear people start to talk about putting these good workers back to work building picnic tables and cutting trails, it's unacceptable to me because we are a proud people, a proud community, and they deserve full-time family wage jobs (80:20-81:5)."

Reich (Labor): Asks about quality of jobs in timber, forest, wood product employment: where are best salaries and benefits? (145:22-6).

ii. Forest Workers & Communities

Bailey (Logger's Wife): "...don't send us money. Let us work. We need those jobs. We need that pride. Let us work towards the solution that will benefit not only us. Let us continue to provide a product to this country that the country desperately needs. Let us continue to provide recreation and opportunities for wilderness experiences which we've done. Let us continue to do what we've done, which is grow trees better than anybody else in the world so that we can have not only a healthy forest in the future, but a healthy economy also (47:12-21)."

Ollivier (Longshoreman/Eureka Harbor Commissioner): Discussing possible employment, retraining, education programs for displaced workers: "You know, people want dignity. You know. We want dignity in this world (245:24-25)."

Heffner (Vocational Counselor): Asks that job placements and tax credits, training for displaced workers not be allocated according to what they have in savings or whether their wife works..."If it's a displaced worker, then let's have the job... (188:1-9)."

iii. Social Scientists

Greber (Oregon State U): Answering Reich, Greber states the highest wages are in pulp and paper; then sawmill and logging jobs; then secondary manufacturing, which tends to have lower-than-average-wages. "So you can talk wages when it comes to quality of the jobs. That's a subjective judgment that I wouldn't want to venture into saying whether my job's better than a logger's job, or a logger's job is better than a mill worker's job (146:7-21)."

Fortmann (UC Berkeley): Answering Reich, "When I was interviewing loggers and their wives, the logger's wife said to me, 'Every day at 3:00, I thank God he's alive,' because she knew if he made it to 3:00 that day, he hadn't been killed. And I believe it was 1976 -- these are very old data -- deaths in the logging and the forestry industry in California, Oregon, Washington, and British Columbia exceeded deaths among policemen and fire fighters in those same areas. It is a very, very dangerous occupation for certain occupations (146:23-147:7)."

b. Consensus

Displaced workers want and should get family wage jobs.

c. Disagreement

Several people discuss job quality, but have different criteria for 'quality'... Reich, Greber, Clinton, Schmidt focus on wages; Fortmann mentions safety; people closer to workers themselves (Strauger, Bailey, Ollivier) talk about need for a job that maintains workers' dignity and pride. See also section II.C.1.a.i for comments from forest workers on the value they find in their work.

d. Places mentioned

The country, Oregon, Washington, California, British Columbia

e. Time periods mentioned

Depression, 1976, present, future

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6. Federal unemployment policies

a. Who says what

i. Government

Clinton: "A lot of these battles we're all fighting are big-idea battles...it is astonishing the number of people who would literally -- in the Congress -- who would not sleep until the unemployment extension is passed, you know, to pay people who they feel sorry for who are unemployed. Then turn around and say that we're wasting money if we want to have a huge increase in the Labor Department's ability to retrain people on a continuous basis to keep them from getting on unemployment in the first place...We've got to change our attitudes and start all in government thinking about how government can work with the private sector to make good things happen instead of just be there when bad things occur...(164:24-165:22)."

Gore: "...the kind of federal-state partnership or stewardship programs that were referred to earlier to take a proactive approach, money for that is in the stimulus package that is being considered -- excuse me for the commercial just for a moment -- that is being considered on the floor of the United States Senate right now, and people who want to see a proactive approach to create jobs and start getting serious about helping working people, should encourage the senators who are voting gridlock in holding that up, to let it come for a vote and start getting these kinds of stewardship programs enacted...(164:11-21)."

ii. Forest Workers & Communities

Fletcher (AFL-CIO): Offers support for Clinton's economic stimulus and deficit reduction packages, suggesting a similar short-term/long-term approach to current problems, noting in the short term "we need adequate assistance for displaced workers, because we know they're going to be displaced workers, both wood products and those workers who are going to be displaced because of the wood products jobs that are gone (199:16-200:17)."

Ollivier (Longshoreman/Eureka Harbor Commissioner): "...the best social program that the President can give all of us here is a job (247:18-20)."

iii. Social Scientists

Whitelaw (U Oregon): "...when you're talking about what federal policies, if we could shift to -- or from this passive labor market policy where we sort of wait till the tragedy occurs and then kick in with certain number of weeks of unemployment compensation, if we could anticipate and plan to facilitate that transition, it would relieve immensely the trauma, the tragedy that goes on (164:3-9)."

b. Consensus

Unemployment compensation is a stop-gap policy that does not address the underlying causes of unemployment or how people may become reemployed, both of which are of long-term importance. Proactive approaches that prevent job loss are needed.

c. Disagreement

None apparent among those commenting here, but Clinton and Gore mention political battles over unemployment policy in Congress.

d. Places mentioned

Oregon, not really place-specific

e. Time periods mentioned

Present efforts/packages before Congress, short-term and long-term future

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D. Opportunities for the federal government to assist rural economies

1. Economic diversification and community development

a. Who says what

i. Government

Clinton: "...one of the things that we're trying to is to set up a representative number of community development banks...and it may be that we ought to make sure we have one or two in the Pacific Northwest... (166:19-167:1)."

Schmidt (Linn County, OR): "Rural community development is also very important to us. If there is a way to cut some of the red tape, maybe get past some of the traditional ways of doing business that agencies responsible for delivering these packages to the communities -- that would be a big help. Our small communities do not have the sophistication and abilities to deal on and on with the programs when they're all changing, the goal posts are always moving, and if there's something that can be done with the agencies involved here, we would appreciate that (243:16-25)."

Nafziger (Washington): "We must attract capital to rural timber communities through the creation of community development banks. Redlining and uncertainty created by the timber crisis have cut off the lifeline of capital to these towns, and capital's essential if there's going to be any diversification or any value-added, and a government private partnership through community banks could leverage private capital (192:11-19)."

Espy (Agriculture): Asks Mayor Strauger how a town like hers fashions alternatives once it loses its principal timber-based industries, and how the federal government can assist in developing alternatives, e.g., tourism (83:12-19).

Strauger (Hoquiam, WA): Replying to Espy: "We are working on tourism, and we're doing everything we can to diversify, but our biggest problem with diversification is that we have no industrial park. We have no warehouses. I don't know how many times we get inquiries for warehouse space. All we have to market is an empty log truck and a rusty spar pole. The industry, our county has been 85 percent timber, and it just has never been necessary to have the kinds of things you need to diversify (83:20-84:7)."

ii. Environmentalists

Wales (Audubon Society): "Federal policies of the last half century have fostered the development and dependency of communities like mine. But diversification has already begun, and at this point a gradual transition to a nonextraction-based economy is possible (33:9-14)."

iii. Forest Communities & Workers

Ollivier (Longshoreman/Eureka Harbor Commissioner): Mentions needs for low-cost business loans and investment in infrastructure (246:1-14).

iv. Social Scientists

R. Lee (U Washington): Mentions community development corporations as possible legal mechanism for providing a more secure environment for the financial community in rural areas (166:7-11).

b. Consensus

Diversification of rural economies, so that they become less dependent on timber extraction or any single source of revenue, is desirable. Loans and community development banks are appropriate means for mobilizing diverse investments in rural communities.

c. Disagreement

Potential disagreement exists over how development programs should be implemented and which federal agencies should be responsible. Wales and Schmidt, who live in timber counties, mention past and potential involvement of federal natural resource agencies (USFS, BLM) in community economies, as does Lee (old sustained yield units 166:13). State and federal government officials (Clinton, Espy, Nafziger) seem to focus on bank and loan programs that are more likely to be administered by economic agencies from state capitols and Washington, D.C.

d. Places mentioned

Pacific Northwest; Hoquiam, WA; Strauger's county, rural communities

e. Time periods mentioned

Last half century, recent past, present, future

2. Assistance/incentives for non-industrial forest owners and forest industries

a. Who says what

i. Government

Clinton: "... Anne's citation here of the potential of second growth forests on privately owned timberlands that are presently not well-managed or well-planted, where the owners can't afford to do it. If there were a very close level of cooperation between the state and federal forestry agencies, the private timber owners, and the big companies who might contract to harvest the land, it seems to me you could get a whole lot more done more quickly than if you just hope that these individuals could come up with the cash from their local bank to do it. Is there anything that the federal government could do to change policy to facilitate that? (158:22-159:8)."

Schmidt (Linn County, OR): "We've heard a little bit about tax incentives on private lands. A lot can be done with the carrot rather than the stick (244:7-9)."

Nafziger (Washington): "We can strive to develop an entire landscape of natural forests... but we can't achieve this goal by ramming new regulations down private landowners...Everybody's got to contribute to this forest landscape, but we need to create market incentives like generous capital gains tax treatment for environmental sensitive forest investments so that protecting the earth can become a question of economic self-interest... Investment tax credits can help create an incentive for value-added investments (191:5-192:2)."

ii. Social Scientists

Greber (Oregon State U): Mentions his experience consulting with nonindustrial private forest landowners in the South, how forestry is done on private land there with consultants, state agents, industry landowner assistance and cooperative management programs. Thinks that public policy to encourage long-term industry-private landowner partnerships could be beneficial and cost-effective (160:3-25).

Hanus (Oregon Department of Forestry): "... there are substantial up-front costs of restoration. There are limited options for obtaining financing. For example, if you were to do reforestation on a hundred acres, it would cost approximately $50,000, which is a substantial investment for a small woodland owner. There are programs that could provide assistance that way. There are cost-sharing programs that are available, but in the state of Oregon, those federal cost-sharing programs that we receive through state and private forestry or the Forest Service, give us enough for about 7,000 acres a year. That's not clearly enough to help with those 500,000 acres. Plus there are some very innovative programs that have been talked about, a forest trust that would provide venture capital to provide some of that up-front funding (152:4-21)."

iii. Biologists

Oliver (U Washington): "Now, what you're asking is these private owners, industrial and otherwise, to provide a public value on their land [by restoring land or using new forestry techniques]... rather than looking at it in a regulatory approach, I encourage your incentives approach...you could do something similar to the soil bank program... (168:15-169:2)."

iv. Forest Industries

Minnick (TJ International): "...if you throw in some procurement incentives, if you would get out of the business of subsidizing low-cost timber sales and the other old way of doing things and let the market work, I think you'd be amazed by how successfully we can have both spotted owls and a very successful and vibrant growing forest products industry (224:20-225:1)."

Hampton (Willamina Lumber): Suggests raising the number of employees permitted under the SBA Act from 500 to 1000: "we have sold several businesses which were value-added businesses to stay under 500 personnel (66:22-67:16)."

v. Forest Workers & Communities

Hollenbeck (Logger/Sawmill Owner): "Small is okay, and we need to get that message out to the community that everybody starts someplace." Hollenbeck discusses difficulties for small businesses to compete under current USFS policies of cost-efficiency when the minimum bid for small business set-aside sales is $30,000. "You might as well make the minimum bid the national debt. Ninety percent of the small operators starting on this can't even go to the table. You want to see the hardwood market start up? Everybody's screaming hardwoods in our industry. Get the Forest Service to sell a couple of trees to the gypo loggers. You'll see hardwood cut. You'll see hardwood cut in a hot tick, and we'll experiment with it because it's something that we can afford. It's something that we can do and that we want to do (219:25-220:23)."

b. Consensus

Incentives and voluntary cooperation between private landowners, industry and/or government are the most appropriate means to increasing timber supply and other forest values on non-industrial private forest lands. Incentives are also favored for industrial private owners. No one spoke in support of more regulations on private forest owners.

c. Disagreement

Hollenbeck's point about institutional barriers to small forest businesses indicates potential conflicting interests between small and large forest businesses. Incentives or programs that favor one may exclude the other. Cost of programs and incentives could also become an issue among government officials when discussions of state and federal aid become more focused.

d. Places mentioned

The South, Oregon, private non-industrial lands

e. Time periods mentioned

General: present and future

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3. Stability in policy needed to promote investment

a. Who says what

i. Government

Reich (Labor): "I just wonder how much of the problem, or to what extent there is any problem, with lack of predictability? That is, does merely not knowing what the policy is going to be or likely to be have a chilling effect on investment and on business and on jobs? [See response by Hampton, below] (70:15-22)."

ii. Social Scientists

Greber (Oregon State U): "You've got an industry out here that a lot of times right now has a tough time going to the bank. You say you're going to develop something in forest products, you want to invest $500,000 in new equipment, people say, "Where's the timber supply going?" I think until we get some certainty in the timber supply picture, people are going to have a tough time coming up with the finances to move ahead in that technology, so some certainty in this public policy on timber will help...(161:6-17)."

R. Lee (U Washington): "I think there's some legal mechanisms for addressing the points that Dr. Greber raised about the security of both supply and then the security of the lending institutions, and legal mechanisms such as community development corporations or other vehicles by which jurisdictions can then enter into contractual relationships with the Federal Government for supply or provide a more secure environment for the financial community. And I think there's an enormous potential there for sort of relooking at what these old sustained yield units were, but doing it in a way which would bracket it and contain the flow of wealth...(166:4-17)."

Hanus (Oregon Department of Forestry): "With the type of uncertainty we have now, both federal and state regulatory, it is difficult for landowners to make investments...(152:6-8)."

iii. Forest Industries

Hampton (Willamina Lumber): Responding to Reich: "The cost of modern technology is extraordinary. It takes a leap of faith under these conditions to invest the kind of money that one does to modernize a plant." Hampton discusses the $5 million investment his company made in modernizing their Tillamook Lumber Co. plant last year (70:23-71:8).

C. Bingham (Weyerhaeuser): "From a private landowner's point of view...this region was fundamentally different than the Midwest and New England. In 1941 the private landowners said, "We are going to manage these lands on a continuous basis," and they began protecting them. They built the roads. They put the fire protection in. They paid the taxes on them now for -- since the Roosevelt administration now for 55 years...The folks who made those investments 50 years ago had confidence in only two things. One, 'Will I be able to harvest this?'...And two, that they could market it...we do need the confidence, the small private landowner as well as the industrial landowner, we need the confidence of two very simple things. Will we be able to harvest it? Seriously in doubt with the way the owl has been politicized and passed back and forth by regulatory agencies. And will we be able to market? [Discusses $400 million modernization of Longview facility.] We need assurance that there's going to be raw material...And we need assurance that we can compete in the international market [In context of policy on log exports from private lands.] (234:3-237:21)."

Minnick (TJ International): "And there are quite a number of these engineered lumber technologies. They're gaining in market share, and essentially what we need the government to do is get out of way, let the market system work, get some certainty into the west side timber supply because we don't know whether to build another plant here or to go to Canada or even whether we should be hiring folks for a month from now, because we can't be assured that our veneer suppliers are going to have the raw material we're going to need (223:17-25)."

iv. Forest Workers & Communities

Bailey (Logger's Wife): Commenting in discussion of economic/technological transition from milling old growth to milling second growth: "And it all comes back to access...how can you expect a company to invest billions of dollars if one day they're not going to have access. In our county the mills were 70 percent dependent or more on federal timberlands, on second -- and mainly it's land that's been used over and over again. If we don't have that access it's hard to get people to invest (70:8-14)."

v. Biologists

Oliver (U Washington): Discussing investment in silvicultural treatment of second growth: "I could show you stands that were begun thinning at age 40 that are now age 80 and 36, 37 inches in diameter have very many of the old growth structures. The problem is that this is on private lands, and people aren't doing that because they're scared stiff a spotted owl will fly into it, and then they've lost any economic advantage to their stands (112:13-19)."

b. Consensus

If the federal government expects people to invest in forestry and forest products technologies, they have to provide more of a climate of stability in forest policy than now exists.

c. Disagreement

Different people identify different aspects of stability (differences in comments, but not necessarily disagreements): of timber supply in general, of access to federal lands for harvest, of ability to harvest private lands, of ability to market forest products on the international market. Lee's suggestion of communities or others having legal contracts with the Forest Service to assure sustained supply is a novel point in the discussion.

d. Places mentioned

Old sustained yield units, Midwest, New England, this region, international markets, Longview facility, private industry lands, private nonindustrial lands, federal timber lands, Tillamook facility

e. Time periods mentioned

50 years ago, 1941, 1955 and on, last year, now, future

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4. Federal receipts to counties

a. Who says what

i. Government

Tallerico (Siskiyou County, CA): "I am a school superintendent in Siskiyou County, California, of which the land mass or land base of 6,400 square miles, sixty-three and a half percent is in federal jurisdiction. So as you know those federal receipts are very important to us, because that translates into numbers of positions and numbers of teachers, numbers of staff that we're able to provide (42:19-43:1)."

Schmidt (Linn County, OR): "The State of Oregon, 31 of our counties receive timber revenues, 18 of them from the O&C lands. Fifty-two percent of our state is in federal ownership; slightly lesser percentages in the states of California and Washington...County revenues are made up of some state revenue, some property taxes in the state of Oregon and other private fees, and about $200 million from federal lands go into providing our services, critical services such as public safety, human services, mental and public health, environmental services. These are services that the demand is increasing as we see the problems that we're discussing here today go on and on and on (241:17-242:11)."

ii. Forest Workers & Communities

Fletcher (AFL-CIO): "On a long-term basis, we also need some guaranteed level in place of the timber receipts because currently $136 million a year of that comes into Oregon in lieu of taxes...(200:18-21)."

iii. Environmentalists

Wales (Audubon Society): Mentions that husband's salary as Douglas County Counsel comes largely from O&C receipts (32:7-8).

iv. Social Scientists

MacColl (Historian): "One problem unique to Oregon relates to the Oregon and California railroad lands, or the O&C lands, which are the remainder of the public lands originally granted to the railroad in 1869. Somewhere between 25 and 50 percent of all timber receipts are distributed annually to 18 Oregon counties in lieu of property taxes the lands would earn. Now, these revenues have been crucial to balancing the budgets of many counties like Lane and Douglas. Lowered timber sale receipts mean less funds for county operations (20:7-17)."

b. Consensus

Loss or reduction of federal timber receipts to counties will reduce services counties can offer unless other sorts of revenue are found or provided. Focus on O&C counties, but counties throughout the PNW are affected, to varying degrees.

c. Disagreement

None.

d. Places mentioned

Siskiyou County, California, Oregon, Washington, Lane County, Douglas County, federal lands

e. Time periods mentioned

1869, present, future, long-term future

E. Regional and national economy

1. State of regional economy

a. Who says what

i. Social Scientists

Greber (Oregon State U): Discusses role of timber industries in the regional economy. For employment, every billion board feet is estimated to produce 11,000-14,000 jobs in the region. From 1988-1992, employment in timber industries went from 140,000 to 116,000 in the Western Oregon, Western Washington, and Northern California region, a reflection of changing harvest levels, driven by national and global economic trends as well as recent harvest restrictions.

"Timber industry's role in the regional economy is changing. As its share of employment fell from ten percent in the early 1970's to five percent in the late 1980's...The region is becoming less well-characterized as a timber economy, but still it contains many communities that are dependent upon timber...a lot of the communities are diversifying and have diversified in the last 20 years. But the other thing you'll notice is still in the late 1980's, there are 21 counties who had at least 15 percent of their employment directly in timber industry in the late 1980's. These counties are particularly concentrated in Southern Oregon and Northern California, which is an area which is very heavily federal timber reliant...Many of these counties that were heavily timber dependent in the late 1980's currently have unemployment rates much in excess of 10 percent. If you're to do a map of unemployment rates, it would mirror that timber dependency fairly heavily at this point in time. So we do have a healthy economy in aggregate, but there are some severe differences as you look across the landscape and the role that timber industry and other industries are playing (137:12-142:14)."

Whitelaw (U Oregon): "...in the early '80's in a three-year period from '79 to '82, Oregon and Washington's timber industry lost 27,000 jobs permanently. During the decade though, the two states added over 700,000 jobs. Now, that was a surprise to a lot of us. Jerry Franklin's talking about the mysteries of old growth forests that he encountered in the early '80's and the '70's. Well, there's some mysteries going on in the northwest economy. It wasn't clear what was happening. One thing that was clear was that timber was no longer driving the northwest economies. Something else was going on. And that mechanism -- and this is where the link comes back to the forests and the ecosystem. We have accumulated evidence, but not with a lot of rigorous study, that many of these jobs, including jobs in manufacturing that are paying substantially higher than the timber industry is paying, many of those jobs are quite sensitive to the environmental amenities here in the Northwest (154:22-156:10)."

MacColl (Historian): "The lumber industry has always been plagued by boom and bust cycles. It's also faced ruinous competition, overproduction, market chaos and dependence on railroads for shipments to market. During 1920's the problems of oversupply and low prices in a very fragmented industry initiated movements to merge the smaller timber companies in an effort to stabilize the industry. The merger movement culminated in the 1950's and '60's when corporations like Georgia Pacific and Champion Paper acquired many smaller companies from Arkansas to Oregon to Northern California as they added their extensive holdings. Financed by larger national banks and Wall Street they treated their region more like colonies. They came to cut and then departed, using their cash flow to liquidate their acquisition debts (20:18-21:6)."

ii. Forest Industries

Mater (Mater Engineering): "Let me preface my comments by giving you a little background on the engineering firm of Mater Engineering. This process of being a part of timber crisis is not new to us. We've been around for almost a half a century working in the wood products industry throughout the world. Needless to say, we've seen a lot of transition within the wood products industry. This is not the first time that we've been involved, and I suspect, Mr. President, won't be the last time that you'll be involved in these type of issues (211:18-212:2)."

C. Bingham (Weyerhaeuser): "I've worked for Weyerhaeuser now for over a third of its existence. It's been in business for 93 years. I think if there's one thing that we have learned, it is that we must be able to manage large-scale change." Discusses fire protection, Depression, Mt. St. Helens... "and now we have another one, which is the role of private lands in landscape ecology. What is their contribution? I would suggest that there are a half dozen things quickly that one needs to do. First, there has to be a recognition of the need to change, and every one of those we had to recognize that we had to change (194:10-195:3)."

iii. Environmentalists

Sher (Sierra Club Legal Defense Fund): "Contrary to some of the things that you've heard today, the industry problems are not unanticipated. Industry was predicting this a long time ago. In 1986 George Weyerhaeuser gave a speech in Longview, Washington in which he said that: "We are weathering a revolutionary restructuring that is shaking the forest products' industry in the Pacific Northwest... Forest products companies, both big and small, must learn to play by a new set of rules if they are to survive." This was long before the spotted owl flapped its wings (91:20-92:6)."

iv. Forest Communities & Workers

Draper (Western Council of Industrial Workers): "Our workers deserve and need a healthy forest products industry to maintain the economic stability and viability of this region (31:1-3)."

b. **Consensus**

There has been a great deal of change in the regional economy that is not tied to timber production in the past few years, and there has been a great deal of change in the forest industries that is not tied to spotted owl/environmental issues in the past few years. The region as a whole is not highly timber-dependent, and is becoming even less so, but some communities and counties still are. Large forest industries will weather current changes, as they have previous ones in this century.

c. **Disagreement**

Draper is the only one who claims a strong linkage between regional economic health and the health of forest industries. Whitelaw's hypothesis of the contribution of environmental amenities to a growing regional economy challenges traditional timber-based analyses of employment and income attributable to PNW forests.

d. **Places mentioned**

Western Washington; Western Oregon; Northern California; "the region"; Pacific Northwest; southern Oregon; Longview, WA; Mt. St. Helens; Oregon; Arkansas

e. **Time periods mentioned**

Past 93 years, past 50 years, past 20 years, first 20 years of the decade, the Depression, 1920s, 1929, 1931, 1941, 1950s and 1960s, eruption of Mt. St. Helens, 1970-1990, 1979-1982, 1986, 1988, 1992, 1970s, 1980s, 1990s, early 70s, early 80s, late 80s, future

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2. **International trade, log exports**

a. **Who says what**

i. **Government**

Gore: "...do any of you have a view on the present subsidy for the export of whole logs? I mean is it a significant factor in the percentage of logs that are exported and the percentage that remain here available for higher value added to jobs in the forest industries and if so, do any of you have views on that? (162:8-13)."

Clinton: [Continuing from Gore's question] "Well, before you answer it, let me ask the whole question. Also, if you repealed it, would you generate more jobs than you lose? (162:14-16)."

Nafziger (Washington): "We must adjust our trade policies. Landowners cannot be expected to stop exporting logs when our trading partners put up barriers to finished products but not to raw logs. The wood products industry in the U.S. cannot be expected to compete with foreign nations in finished product markets when we have higher environmental standards than our competitors. Trade policies must create a level playing field (192:3-10)."

ii. Forest Industries

Irvine (Home Builder): Recommends removing countervailing duty on Canadian timber and federal tax subsidy on export of raw logs (227:22-228:6).

C. Bingham (Weyerhaeuser): Notes that no federal logs are being exported, no state logs from Oregon and Washington, very few state logs from California. Logs from private lands that are being exported are predominantly second and third growth. In 1992, his company sent 72 percent of their volume in Oregon and Washington to domestic mills, 28 percent to the international market. In 1992, 70 percent of their export in dollar value was value-added, compared with 30 percent in the Japanese market 15 years ago. Bingham states that the tax incentive on log exports does not encourage export of logs over lumber because the incentive applies to all exports, but the incentive in general does help the industry be more competitive in international markets, and any amendment of it to exclude logs would reduce industry's competitiveness (234:3-239:25).

iii. Social Scientists

Whitelaw (U Oregon): "When I come to this issue on the exports, I always feel there's something fundamentally wrong if we're hauling items of that magnitude and weight across the Pacific. I mean there's something flawed in the trading arrangements, either at the buying end or the selling end (162:19-23)."

Greber (Oregon State U): Notes that 80 percent of logs harvested in the region go to domestic markets, 20 percent go overseas...from 13 percent of the harvest in the early 70s to 21 percent of the harvest by the end of the 80s..."the last three years the exports have started to decline, and that's due in large part to a global recession, but also because of increased competition for the logs within domestic mills in the region (139:9-21)."

iv. Environmentalists

Rick Brown (National Wildlife Federation): "We also need to be looking at creative options such as dealing with log exports as a way to work through a transition while some of these problems are worked out (129:25-130:2)."

Arthur (Sierra Club): "We export one out of every four trees that are cut in the Northwest. I'm not against log exports, but I'm in favor of exporting finished products: wood, lumber, and finished wood product materials, so that we can get both the jobs and the economic rewards here in the Northwest (53:4-8)." Arthur mentions dealing with exports as an opportunity for a short-term bridge to a long-term solution (71:23-72:1).

Kerr (Oregon Natural Resources Council): "I would urge that an important issue that has to be on the table here is log exports. Trying to talk about timber supply in the Pacific Northwest and talk around log exports is like trying to talk about the national deficit and not talk about the Defense Department (197:22-198:1)."

b. Consensus

Log exports are an important issue; environmentalists advocate reducing or eliminating exports to provide short-term supplies to domestic mills, as does one industry person (Irvine).

c. Disagreement

Little consensus appears on this issue, even within groups, and even on the volume of logs being exported (Arthur says 1 in 4 logs, Greber 1 in 5). Some call for a complete ban on exports, others for changes in trade incentives, others for no further restrictions. Bingham tries to show minimal environmental and economic effects of current exports, while others consider these effects to be quite serious.

d. Places mentioned

Pacific Northwest, U.S., Japan, Canada, foreign nations, global markets, Oregon, Washington, California, the Pacific

e. Time periods mentioned

15 years ago, early 70s, late 80s, 1992, short-term future

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3. Lumber prices

a. Who says what

i. Forest Industries

Geisinger (Northwest Forestry Association): States that as volume harvested in the Northwest has declined since 1990, lumber prices in the country have been going up "and it really doesn't take a genius to figure out that there's a cause-and-effect relationship that has driven up the price of lumber (231:3-232:1)."

Irvine (Home Builder): "My market [in Portland] is predominantly the first-time home buyer. And my homes six months ago were selling in the range of $95,000, and now I'm having to price the same homes at $98,500 just to cover the costs and the increase attributable to the lumber costs and to those homes. Nationally it's about a $5,000 increase over the last five months. So this is a significant increase and truly impacts housing affordability. And the best way to illustrate that is to just tell you a brief story about a family, and I know we've had a lot of stories about families this morning earlier, but think this one shows why this is more than a regional issue and is truly a national issue." Irvine describes a couple who were told they could not qualify for a loan to buy their first home when lumber prices increased the cost from the time they had decided to buy it.

"First-time home buyers everywhere are feeling the impacts of these increased costs, and why that's significant is that we're forecasting...1.3 million housing starts this year, and a ten-percent reduction in those starts could truly forestall the economic recovery. Instead of losing the 25,000 and 35,000 jobs that have been talked around this table, you could be talking 200,000 jobs across the country. (225:12-227:21)."

Marson (Lumber Dealer): "The lumber prices have gone up substantially since October, nearly have doubled. In a $5,000 increase or more in the cost of a house eliminates approximately 127,000 people from the housing market every year. In many cases, the increases in prices have gone up much more substantially than just $5,000. Housing, I know to you and Vice President Gore, is an essential component of the economic development and growth of this country, and we're really concerned that we're starting to see areas of the country have a slowdown in housing because the builders can't afford it, the homeowners are disqualified from loans and everything (39:22-40:8)."

On questioning from Gore, attributes rise in lumber prices to lack of supply, not other factors such as demand or Canadian tariff (41:5-42:12).

ii. Environmentalists

Norman (Headwaters): Responding to question from Gore on lumber prices: "From my perception, it is the scarcity that's been created due to the overcutting on the private lands. You know, the private lands were the primary source of supply in this country up until the 1950's because the private landowners didn't want the markets to be flooded with the public timber. And then in the '50's, the policies changed, and we began to cut off the federal lands to supplement the depletion that had occurred on the private lands. So I think it is just a growing depletion worldwide that we face (230:14-24)."

Wawona (New Growth Forestry): "Wood is simply too cheap, even at today's prices to afford to practice sustainable forestry. Lumber prices today, adjusted for inflation, are less than what they were in 1977. The usual glut of federal timber on the national wood market has kept log prices low (59:17-21)."

Kerr (Oregon Natural Resources Council): "If you compare the cost of dollars, you'll find that the prices are comparable to lumber in the 1970s (232:9-11)."

Pace (Klamath Forest Alliance): "The Congressional Research Service has looked at this, I believe, just recently, and always, if you look historically, in periods like this where we're coming out of a recession and demand is picking up for housing, lumber prices have gone up. And I think that we're looking at multiple factors here, but just the fact that two things are happening at the same time does not prove any causality behind them, and I think we have to take this longer perspective.

The analysis says that it's a combination of coming out of a recession and the situation down in Florida have both combined to produce those higher prices. And I might add to that, that the high price -- the high price that finally we're getting the true price of the log into the log, and in my county, in the rural areas, the small landowners, who in California, according to the state figures, are the only people that over the last two decades have been growing more wood than they've been harvesting, those people are now taking their logs to the market. And these are small farmers and small landowners, and they're getting a good price for them, and they're investing that money back into our communities, and that provides the incentive...to invest in those lands (232:13-233:11)."

b. Consensus

Consensus appears among forest industries that rising lumber prices negatively affect housing starts and thus the national economy, as well as causing distress among potential first-time home buyers. Consensus appears among environmentalists that, if anything, wood is too cheap.

c. Disagreement

Disagreement exists over the increase in lumber prices in the past six months: caused by lack of supply or other factors? Disagreement, noted above, over what price of lumber should be. Some of these disagreements reflect short-term/long-term viewpoints on the part of forest industries and environmentalists, respectively.

d. Places mentioned

Northwest, Portland, nation, private forest lands, public forest lands, worldwide, Florida, California

e. Time periods mentioned

In this country until the 1950s, 1950s, 1970s, 1977, since 1990, last 5 months, future

F. **Timber supply**

1. **Historical harvest levels**

a. **Who says what**

i. **Social Scientists**

MacColl (Historian): "Tree stumps symbolized prosperity to 19th Century Pacific Northwesterners because felling trees was often associated with activities that connoted growth and progress...To the lumbermen, most of whom came from the East and Midwest in the latter years of the 19th Century, after they had exhausted their homelands, here was a vast continent to be settled, limitless resources to be utilized and infinite wealth to be created. Thousands upon thousands of acres, the very cream of the timber claims in Oregon and Washington, were secured by these entrepreneurs. [MacColl documents railroad grants and forest land exchanges and purchases around the turn of the century.]

By 1910, Weyerhaeuser and his 90 affiliated companies owned 26 percent of all timberlands in Washington and 20 percent in Oregon. The fact that this ownership has helped to save the forests is one of the reasons, until recently, the federal presence has not been resented. It is also the reason that valuable federal holdings are now the center of the biggest battle ever fought between the environmentalists and the lumber industry...

The merger movement culminated in the 1950's and '60's when corporations like Georgia Pacific and Champion Paper acquired many smaller companies from Arkansas to Oregon to Northern California as they added their extensive holdings. Financed by larger national banks and Wall Street they treated their region more like colonies. They came to cut and then departed, using their cash flow to liquidate their acquisition debts. And many agree that this process led to excessive cutting of some of the most productive timberland in the world...

The historical record is not a pretty one, and all parties must bear some of the blame. From 1980 to 1985, some reported that timber harvests were 61 percent greater than growth (17:12-21:22)."

Greber (Oregon State U): "Harvests in 1992 reached their lowest levels in two decades. This chart shows harvests from 1970 to 1992. This harvest has jumped up and down anywhere from 11 billion board foot to 19 billion board foot, primarily fluctuating with housing demand." Greber states that federal harvests have been about a third of the harvests in the region and are primarily older growth stands. Harvests from private and other public lands have been primarily second growth stands and smaller logs.

"In the last three years there, you see that most of the harvests come off of private lands in even greater percentage, and the public harvest has been dwindling. That harvest has been coming primarily out of timber under contract from sales that took place in 1980's. Research in Washington and Oregon indicates that [private harvests] and the [other public harvests] are pretty much at their sustainable levels, given current management practices, but there's some debate over whether those current management practices on private land are what people desire in the region as well (138:1-22)."

ii. Forest Industries

Hampton (Willamina Lumber): "We have built our plants, our capacities and our employees at a level based on a sustained yield policy on these federal lands. And now the tables are being turned (68:10-13)."

Tomascheski (Sierra Pacific Industries): Responding to Gore: "The Forest Service and the Bureau of Land Management are under sustained-yield, even-flow constraints by regulation so that when they...take land out of the land base, that harvest level that's sustainable automatically drops because they can't produce any more now than they produce over time (136:3-9)."

iii. Environmentalists

P. Lee (Oregon Trout): "When we were school kids, we learned about the boom and bust times in the American West, but we never thought we'd be in the position that we'd have to live through it. Douglas County's motto for years was Timber Capital of the Nation, and now we find that we're at the epicenter of the storm (37:7-12)."

Rick Brown (National Wildlife Federation): "I think the problems that the industry and the communities are facing is not the prospect of protecting the remaining ten percent of the ancient forests. It is the speed and the extent to which we liquidated the first 90 percent...(130:2-6)."

Norman (Headwaters): Responding to question from Gore on lumber prices: "From my perception, it is the scarcity that's been created due to the overcutting on the private lands. You know, the private lands were the primary source of supply in this country up until the 1950's because the private landowners didn't want the markets to be flooded with the public timber. And then in the '50's, the policies changed, and we began to cut off the federal lands to supplement the depletion that had occurred on the private lands. So I think it is just a growing depletion worldwide that we face (230:14-24)."

Wawona (New Growth Forestry): "In '79 to '81, I was on a Timber Supply Task Force to the State Board of Forestry. Now, this is just California. We reviewed dozens of reports, Forest Service reports, UC Berkeley reports....And what they forecast was a timber supply crash on industrial timberlands in California at current rates of harvesting. And the committee asked representatives what were they planning to do? Were they going to reschedule their cut levels so that didn't happen? And the industry representatives told the committee that what they were going to do was go to the Forest Service and ask for increased cutting on the national forest for a 20-year period to cover that timber supply gap, and they asked the committee to write into the policies a request to the federal government for that increased cutting, above and beyond sustained yield levels. Now, I understand that happened in a number of forests during the 1980's. In Mendocino National Forest in my own county, that same thing happened.

Arthur (Sierra Club): "It's not accident this conference is taking place on the edge of the Pacific Ocean. We have cut our way west from the Atlantic to the Pacific. It took a little over a generation to wipe out the great woods of Wisconsin and Michigan and for the logging to move west. We are blessed with bigger, larger, vaster forests here in the Northwest. It took a couple of generations to eliminate 90 percent of the once vast ancient forest that we have here. We have only 10 percent left. We're at the edge of the Pacific Ocean, and the timber frontier is over (51:2-12)."

iv. Forest Workers & Communities

Mason (Western Commercial Forest Action Committee): "Our mill was an old growth mill. The reason it was an old growth mill was because the only available timber supply that was accessible to us was off of federal lands, and the federal lands where I live on the Olympic Peninsula are managed on a 100-year rotation, much longer than on some of the private landowners. And we were 50 years into that rotation (73:23-74:4)."

"At the same time as my mill was being shut down by the injunctions on federal lands, harvest levels on some private levels increased. The age of the timber being harvested increased in an urgency that was fueled by a stock market opportunity and also a fear of private landowners that in the very near future they would be unable to harvest their lands (77:3-9)."

v. Biologists

Gordon (Yale): "Two-thirds of the old growth we talked about in that report [1984 old growth management report] is gone (133:21-22)."

Franklin (U Washington): Responding to Gore: "Well, I think a direct answer to your question is, yes, when you do remove land from the base, the ASQ, the allowable cut should go down. I think there's been great resistance to it...I would express doubt that it's always been done adequately (136:14-137:2)."

vi. Government

Gore: "When you take lands like that out of the base, should the expected harvest be adjusted, and if it is not, then doesn't that redouble the pressure on the percentage that is left in the base? (135:24-136:2)." Tomascheski and Franklin respond, above.

b. Consensus

Several groups agree that harvest levels increased during the 80s. Boom and bust cycles and speculation have been characteristic of the PNW timber industry in several time periods, recent and past. Industry has harvested their own lands preferentially; industry has looked to federal lands mostly when their own lands did not provide adequate supply. Harvests in Pacific Northwest are one part of history of American logging and settlement.

c. Disagreement

Environmentalists seem more likely to describe past harvest levels as overcutting: the value judgements people place on the historical record vary. Hampton, Tomascheski, and Mason emphasize that the federal forests work under a policy of sustained yield, and that their private operations and investments have been based on these expectations, but most other groups claim that federal harvests have exceeded growth, i.e., were not sustained yield, in the recent past at least.

d. Places mentioned

American West, Douglas County, California, Mendocino National Forest, Oregon, Washington, industrial lands, private lands, federal lands, Olympic Peninsula

e. Time periods mentioned

19th century, 1910, 1920s, 1950s, 1960s, 1970-1992, 1979-1981, 1980-1985, 1984, 1980s, boom and bust cycles, 100 year rotations, past 50 years

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2. Short-term timber supply needs

a. Who says what

i. Government

Strauger (Hoquiam, WA): "They've got to have some timber freed up...They've got to have some sufficiency. They've got to know where they stand...(81:6-10)."

Schmidt (Linn County, OR): "Our timber pipeline in most of the areas in Oregon will be running out in the next few months, approximately the fall; a few areas a year from now (242:16-19)."

ii. Forest Workers & Communities

Bailey (Logger's Wife): "[In Trinity County, CA] We still have two mills left that have probably approximately eight to twelve months' worth of logs to ply (46:17-19)."

iii. Forest Industries

Hampton (Willamina Lumber): "A company as ours dependent on second growth timber has not bought a federal timber sale for three years, and we're getting swept up in the trash bin in the old growth argument (65:10-13)."

Spence (Sawmill Owner): "If the Gifford-Pinchot timber sale program is not reinstated soon companies will have no choice but to curtail their production and to begin laying off workers. Employers who depend on the timber from private and state lands are also being damaged (35:18-22)."

Geisinger (Northwest Forestry Association): "If we don't reinstate some federal timber sale program this year, our industry is going to be forced to lay off thousands of workers and curtail production very significantly. Some type of interim ecosystem protection and timber production plan is essential to try to get us from where we are today to when Congress can act on a long-term solution (174:8-13)."

iv. Social Scientists

Greber (Oregon State U): "...timber under contract that we've been harvesting out of the Pacific Northwest is about to come to an end. Those sales from 1980's are marginally going to exhaust this year. In some communities in the region, they have already exhausted themselves. We have less than a year's running supply off of the federal lands. When I say running supply, I mean running supply of the level of the last three years, not 1980's or '70's levels (138:23-139:6)."

b. Consensus

Universal agreement that federal timber supply for PNW mills will run out in the next 6-12 months, which would have significant economic consequences. A short-term plan is urgently needed to address this impending shortfall.

c. Disagreement

None.

d. Places mentioned

Oregon; Trinity County, CA; Gifford-Pinchot National Forest; nonindustrial private lands; federal lands; Pacific Northwest

e. Time periods mentioned

1970s, 1980s, past 3 years, next 6-12 months, this year, next 5-10 years, long-term future

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3. Long-term timber supply needs

a. Who says what

i. Government

Clinton: "The plan should provide a predictable and sustainable level of timber sales and non-timber resources that will not degrade or destroy our forest environment (253:7-9)."

Gore: Asks how easy it would be to "reach an agreement on the definition of the phrase 'sustainable levels of harvest from forests'? (130:8-15)."

ii. Forest Industries

Mater (Mater Engineering): "The first strategy is an obvious one, and we've heard it consistently repeated, and that is to stabilize the supply (212:12-14)."

Minnick (TJ International): "And if we do this [set aside reserves, buffer areas, and commercial timber lands], reports like Dr. Ward's suggest that we can get the -- we can get back to 40 to 50 percent of the pre-owl cut if we just do this. Now, that may not sound so good, but 40 percent of the pre-owl cut is six times as much as the government sold last year, and that provides a lot of certainty...(224:14-19)."

Marson (Lumber Dealer): "And so I just hope today you can find a fair and equitable solution to the timber supply, because we need a stable supply. We can't turn to Canada to expect more. And we just should try to help stabilize the supply so everybody in the United States will have access to the American dream of a home (40:22-41:2)."

"Most of the building materials in terms of lumber nowadays used in the construction of home is second growth timber. But I have a small mill that is started up in our area that uses the highest laser technology from Europe and cutting down to the smallest tree, and they're even concerned in the long run about being able to have access to the second growth... (69:2-8)."

Irvine (Home Builder): Also asks for a stable wood supply for housing needs (228:21-229:11).

iii. Biologists

Gordon (Yale): "There's also hope for a reduced but substantial sustained timber harvest along with the retention of wildlife and old growth values (97:13-17)."

iv. Forest Workers & Communities

Fletcher (AFL-CIO): "At the heart of the long-range solution, the proposal is a sustained and sustainable secure level of harvest of federal timber (200:11-13)."

Ollivier (Longshoreman/Eureka Harbor Commissioner): Mentions importing logs from Russia and New Zealand as supply source (246:4-17).

v. Social Scientists

Hanus (Oregon Department of Forestry): States that in the next 5-10 years, Oregon could realize about a billion board feet from nonindustrial private lands if the maximum amount of technical assistance and incentives was made available to private owners from government and private industry; long-term benefits would be an increased yield of 360 million board feet (153:4-154:7).

b. Consensus

Stability and sustainability of timber supply dominate the discussion of long-term needs, rather than actual quantities of wood products: Minnick states that a stable, reduced supply is preferable to none at all or a very uncertain one. Hanus and Ollivier mention possible new supply sources.

c. Disagreement

None apparent here, though different groups may have different ideas of what a sustainable level of harvest is, when "forest sustainability" includes non-timber forest resources and values.

d. Places mentioned

Canada, U.S., Russia, New Zealand, Oregon non-industrial private lands

e. Time periods mentioned

Pre-owl, last year, present, next 5-10 years, long-term future

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G. Old growth

1. Values of old growth and natural environments

a. Who says what

i. Government

Clinton: "How can we preserve our precious old growth forests which are part of our national heritage and when once destroyed can never be replaced? (4:21-23)."

"We need to protect the long-term health of our forests, of our wildlife, and our waterways. They are, as the last speaker said, a gift from God (252:25-253:3)."

"If we destroy our old growth forest we will lose jobs and salmon fishing and tourism and eventually in the timber industry as well. We'll destroy recreational opportunities and hunting and fishing for all and eventually make our communities less attractive (6:17-21)."

Gore: "... our old growth forests, a part of national heritage which if once destroyed will be gone forever for every generation that follows...If we destroy the old growth forests we lose jobs and threaten entire communities. Jobs in tourism and fishing, recreational activities like hunting and hiking and fishing, water supplies we count on to be clean and safe. And we lose what we've yet to discover: vital new substances like the potential cure for some kinds of cancer, Taxol, that's found in the bark of the yew trees in the old growth forests (14:7-18)."

Roberts (Oregon): "Our forests are as much a part of the economic infrastructure as our bridges, our highways, and our water systems. But they are more. Historically they are an integral part of the culture and the identity of the Northwest. They are also a web tying together animal life and a lush forest flora and towering trees and streams. They define our quality of life from many perspectives, and our economic and environmental stewardship of these resources will in no small part determine the heritage we leave for our children and our grandchildren (10:17-11:1)."

Katz (Portland): "What you will not find is anyone whose soul is left untouched by our natural beauty. It is our land that ties us all together in a web of mutual interdependence and common heritage, and it is that mutual interdependence and common heritage that is at the heart of our dilemma; to strive to meet the needs of all of Northwest, for all of the values we cherish (8:13-19)."

Babbitt (Interior): "Are there any differences in the array of wood products that come from old growth as contrasted to, say, a 60- or 70-year second growth log? (68:19-21)." Hampton describes differences below.

ii. Environmentalists

Rick Brown (National Wildlife Federation): "...these are the most spectacular, most magnificent forests on earth, and that splendor is not simply a function of the awesome and humbling size and age of the dominant trees; it is also a function of the extraordinary richness and complexity of these forests (126:13-17)."

P. Lee (Oregon Trout): "We can all agree that we live in Douglas County because of the beauty that it holds and the resources that are available to us (37:20-22)."

Sher (Sierra Club Legal Defense Fund): "I have for six years now represented...national organizations whose tens of thousands of members in the Northwest and millions of members around the country are all terribly concerned about the future of this region and the ancient forests (89:25-90:8)."

Arthur (Sierra Club): "These great forests do define the character and the culture of the Northwest. They are part of our heritage, but they also ought to be a part of our legacy, the legacy that we leave to our children and grandchildren so that they have choices to make, they have opportunities to experience and enjoy what we have, but also to reap the economic rewards and the economic benefits these forests can provide if we sustain them, protect them, and manage them well (52:7-15)."

Wawona (New Growth Forestry): Describes redwood forests in northern California as "the last of our [nation's] primeval forest heritage (58:11-13)."

iii. Forest Workers & Communities

Fletcher (AFL-CIO): Asks for "protected forest ecosystems because our people are also environmentalists. Those who work in the woods also recreate in the woods (200:23-25)."

Eades (Logger): "Mr. President, my people, my family are forest people. We love the beauty of the forest; we respect it. It's part of what we are. We have a heritage in the forest (48:20-49:2)."

Clinton: "As I've spoken with people who work in the timber industry, I've been impressed by their love of the land. As one worker told me...'I care about Oregon a lot, the beauty of the country.' (4:11-15)."

Coates (International Woodworkers of America): "I hear Andy [Kerr] and some of the others talking about the beauty of the forests. When I go into the beauty of the forest, in the capital forest, and in the park service and in some of the rock quarries, we have people living there. They have no home. They have no water. And they have no power. If I was to divulge where these people were, they wouldn't have their children either (240:12-19)."

Draper (Western Council of Industrial Workers): "Together we can find a solution that protects the forests of God and the families of man (31:9-10)."

iv. Forest Industries

Marson (Lumber Dealer): "I live right on the back door of the Alpine Lakes Wilderness Area and close to the North Cascades Wilderness Area...it's a beautiful place to live and that's why I live there (40:9-17)."

Hampton (Willamina Lumber): Replying to Babbitt: "The old growth trees have very high-quality, clear-type lumber that produces extraordinary values that are unique to these old growth resource. Second growth is a common structural type product (68:22-25)."

Geisinger (Northwest Forestry Association): "We can maintain healthy forest ecosystems in a manner that we've never been able to before, and most importantly, we can have healthy watersheds. We can have fish and wildlife habitat. We can have recreational opportunities, maintain diverse ecosystems, and still produce the wood product needs that this country demands (176:5-11)."

v. Church

Murphy: Describes "the magnificent moss-covered old growth forest of the Olympic National Park, pristine forest, virtually untouched by human hands...abundant forest life which God has graced creation (26:7-15)."

vi. Social Scientists

Whitelaw (U Oregon): "CEO after CEO will be speaking to their ability to attract highly educated, technical, professional personnel at less than national market rates because it's a nice place to live, and specifically most of them will refer to the environmental amenities out here. Now, what's complicated though is, you know, is it the spotted owl, or is it clean streams, or is it forested mountains, or the 491 other species? And the answer is it's probably a lot of those things, and we don't really understand that mechanism, but it seems to be pretty strong (155:19-156:3)."

MacColl (Historian): "But the historical record would indicate that beauty per se was not what pioneer Northwesterners were primarily seeking. They desired a new life with new opportunities. They would not today qualify as nature lovers. To them nature was an obstacle, a rough world to be tamed, a wilderness to be cleared....But over the past 50 years or so the relationship of Northwesterners to the varied natural environment has been a key theme with the old growth debate simply the culmination of years of working the natural habitat. When I arrived in Oregon 40 years ago it never dawned on me that our natural resources were limited. Here was the promised land, with its boundless natural wealth and timber, farmland, water, wildlife and fish. The realization that such resources are limited and all related within the ecosystem has caused much of the frustration and anxiety we currently face (17:5-18:9)."

"Concern about overcutting was slow to develop. In 1927, Oregon's leading banker, John C. Answorth, warned, "Something surely must be done before long to prevent the wholesale slaughtering of our timber." If you listen, reforestation became acceptable only in the past 30 to 40 years. Until that time, and even in more recent years, settlement became the accepted way to salvage logged-off lands. It has only been since the mid 1970's that a concerted effort has been mounted to save the old growth and very quietly at that in its earliest years (21:9-18)."

"Oregonians have always been a people possessed by nature. In recent years, at least, the land has been viewed as both a useable resource available to all and a public trust. But

Oregonians are also divided within themselves. Within each Oregonian sits a concern and often caustic environmentalist. But Oregonians also need to make a living, and nature has been one of the major sources of that livelihood, although less so today than in the past (23:11-19)."

vii. Biologists

Gordon (Yale): "Forests are the long-term basis of society in the Pacific Northwest, and they're thus worth being very careful about (99:12-14)."

b. Consensus

The aesthetic and spiritual values of old growth forests and other natural environments are important both in themselves and in the quality of life and economic benefits (e.g., tourism and recreation, wildlife, fish, clean water, new businesses moving in) to which they contribute.

Forests are integral to the culture and identity of the Pacific Northwest.

Old growth forests are a national heritage, both for present and future generations. Several commenters (Clinton, Gore, Murphy, Draper) also note that forests are a "gift from God." Both of these types of comments imply that people do not own the forests, but hold them in trust. See Section II.A.10. on responsibilities to future generations.

The biological diversity and complexity of old growth forests are also of value, both in themselves and in their potential use to humans, e.g., Taxol.

Forests have been, and to some extent still are, sources of income and livelihood, symbols of opportunity.

Babbitt and Hampton comment on superior wood quality of old growth trees.

c. Disagreement

Coates provide the single dissenting voice by noting that beauty is very nice, but food and shelter are basic human needs that are being neglected by environmentalists. MacColl provides an historical perspective on changing attitudes towards forests that illustrates the mutability of environmental values in the last century or so, a perspective absent from other comments.

d. Places mentioned

Nation, old growth forests, Northwest, Douglas County, northern California, Oregon, Alpine Lakes Wilderness, North Cascades Wilderness, Olympic National Park

e. Time periods mentioned

Pioneers, 1927, past 50 years, 40 years ago, past 30-40 years, since mid 70s, past 6 years, present, future, long-term forest health, children's and grandchildren's generations

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2. Amount of old growth

a. Who says what

i. Biologists

Gordon (Yale): "Past harvesting patterns...although often good forestry from a regeneration and wood production point of view, have greatly reduced the extent of old growth and late successional forest ecosystems and habitats on the Pacific Northwest west side. Most of the remaining old growth is on federal land, and about half of it isn't formally protected from harvest (96:8-15)."

Meslow (Fish & Wildlife Service): "At the time of settlement in the Northwest, the Northwest was blanketed with forests. Perhaps 60 to 70 percent of that forest was old growth. Those are big trees, over 200 years of age. Those extensive stands of old forests are mostly gone now. Essentially all old forest has been cut on the private lands. Depending on where you look, on national forest or BLM lands, old growth forest currently constitutes from as little as 10 percent to perhaps as much as 50 percent of the current area. Not only has the area of the old forest been dramatically reduced what remains has been highly fragmented...Even on public lands, cutting has created so many holes in the blanket of the forest, that the fabric holding that the segments together has been severed. We routinely find that old growth forest exists mostly as islands (105:15-106:6)."

ii. Environmentalists

Arthur (Sierra Club): Only 10 percent of the "once vast ancient forest" is left (51:11).

Norman (Headwaters): "4 million acres of prime old growth forests had been turned into monoculture tree farms in the last 40 years on Forest Service land in Oregon and Washington alone (171:5-7)."

iii. Social Scientists

MacColl (Historian): "A century of indiscriminate logging has eliminated all but about 13 percent of the ancient forest in Western Oregon and Washington. Of that, six percent is protected in wilderness areas and parks, and the other seven percent mostly in national forest and BLM lands which is part of the reason the people are fighting over this issue today (22:2-7)."

iv. Forest Industries

Hampton (Willamina Lumber): "The volume of old growth is in dispute. Other people choose to define old growth in their own terms and to measure the remaining amount of old growth... [The Forest Service's] 1991 inventory established on their land 6.9 million acres of old growth timber at that point in time. And you could ask Dale Robertson who's here today, their forest plans would string that harvest out at a 50-year rotation level. We are not running out of old growth tomorrow (66:8-19)."

Geisinger (Northwest Forestry Association): "I want to share with you our view of the question of how much old growth forest exists today and how much has been logged. The allegation is that only 10 percent is left. Yet the Forest Service, the Bureau of Land Management, and the National Park Service say that they have about eight million acres of old growth forest on their ownerships today. Mathematics would tell you then that at some point in time there was 80 million acres of old growth in existence. Yet I have to tell you there's only 42 million acres of commercial forest land in all of Washington and Oregon. So we don't buy that figure, Mr. President.

And I think the more important issue here is that our ecosystems are dynamic. They have been manipulated by nature with natural catastrophes such as fire and windstorms throughout the centuries. There has never been an ocean of old growth forest in the Pacific Northwest, and I would point specifically to a study done by the Bureau of Land Management just this past year by a fire ecologist who mapped the age classes over the last couple of centuries of timber on the lands administered by the BLM in the Northwest part of Oregon. And what they found, frankly, was that there was never more than 40 percent of our forest in an old growth condition at any point in time... (176:14-177:12)."

b. Consensus

Apparent agreement that of the remaining old growth, about half is protected from harvest.

c. Disagreement

Industry disagrees with other groups on the amount of old growth in the PNW at present and in the past.

d. Places mentioned

Pacific Northwest west side, public lands, national forests, BLM lands, private lands, Northwest, Oregon, Washington, wilderness areas and parks, northwest Oregon

e. Time periods mentioned

Time of settlement, centuries of natural processes, this past century, last 40 years, 1991, present, future, 50-year rotation (future)

3. What should be done with remaining old growth?

a. Who says what

i. Environmentalists

Norman (Headwaters): "We must disturb no more of the last remaining centers of biodiversity. These are the refuges and the seed sources for tomorrow's forest, tomorrow's wildlife, and tomorrow's economy (171:8-11)."

Arthur (Sierra Club): "Our public, our federal forests are literally the only places we have left that can provide the full range of values, the full range of resources. Most of the private lands in the Northwest have already been logged. They're being converted to second growth tree farms and plantations. The Northwest is a great place to grow wood. We will have a future timber industry here. But the future of that timber industry must rely on the forests that we grow, not the ones that we have left that we found here. We do have lots of trees. We have very little ancient forest that remains. Protecting that ancient forest must be the foundation for rebuilding our ecosystems, for protecting the full range of values that we have (52:16-53:3)."

Sher (Sierra Club Legal Defense Fund): "The solution to this problem is not to throw more federal old growth timber at the industry (92:9-10)."

Wawona (New Growth Forestry): "Absolutely no further logging of the last remnants of our ancient forests (60:12-13)."

Kerr (Oregon Natural Resources Council): "When so little of the virgin forest is left, the 10 percent, environmentalists are not in a position to compromise the forest any further. We can't do that because the scientists, the economists, and our own eyes tell us that if we continue to log out the last of the big trees, that the extinction of species, the extinction of ecosystems, and the extinction of economies that are dependent upon the sustainable use of those forests will result. So the forest has been compromised all it can (196:24-197:7)."

Rick Brown (National Wildlife Federation): Argues for fully protected permanent reserves, both because of what we know about the complexity and richness of old growth, but even more because of what we don't know about these systems: "Reserves are a hedge against our own monumental ignorance (126:11-128:3)."

ii. Forest Industries

Hampton (Willamina Lumber): "We cannot stop cutting old growth without creating a huge vacuum that private timber supplies cannot fill. We cannot fill the nation's building material needs. We will have massive unemployment. There is no way to make a transition to second growth in the term (69:12-16)."

Tomascheski (Sierra Pacific Industries): "There is a feeling on the part of many that we already have significant old growth reserves set aside through statute that will be there forever... That would be the death now [sic: knell?] of the industry in the Pacific Northwest, if we set aside significant old growth reserves on top of what's already been set aside (128:25-129:16)."

Geisinger (Northwest Forestry Association): "Past government decisions have left 80 percent of our national forests off-limits to timber production purposes today. A fifth of our national forest lands is what was available for timber production before Judge Dwyer's injunction. Nearly five million acres of old growth forests are off-limits to logging today, and they will never be logged (174:20-25)."

b. Consensus

Environmentalists agree that all remaining old growth should be preserved. Forest industries agree that some old growth reserves are appropriate.

c. Disagreement

Disagreement is over how much should be reserved: are there enough reserves already? Industries thinks there are, environmentalists do not. Industry people discuss short-term economic and social impacts of setting aside old growth, environmentalists focus on long-term benefits and values, do not discuss short-term impacts.

d. Places mentioned

Existing reserves, national forest lands, old growth, ancient forests

e. Time periods mentioned

Before Dwyer's injunction; general past, present, and future

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4. Growing new old growth and old growth structure

a. Who says what

i. Government

Clinton: "How can we preserve our precious old growth forests which are part of our national heritage and when once destroyed can never be replaced? (4:21-23)"

Gore: "... our old growth forests, a part of national heritage which if once destroyed will be gone forever for every generation that follows (14:7-9)."

ii. Environmentalists

Wawona (New Growth Forestry): "Our nation is on a course of mining the last of our primeval forest heritage (58:12-13)."

Rick Brown (National Wildlife Federation): "The best and brightest of us do not have the means of developing management plans or silvicultural techniques that will recreate and produce that extraordinary complexity of the old growth forests (127:4-7)."

iii. Biologists

Franklin (U Washington): "This is not to suggest that we have the techniques to grow old growth forests. We can, with new forestry, grow structurally complex forests. We probably can grow spotted owl habitat, but we do not know, and it's unlikely we're going to know any time soon, how to grow old growth forests because the complexity of those systems is beyond imagination...We can do a lot of good stuff, but growing old growth, that's a challenge for the next century (110:16-111:9)."

Oliver (U Washington): Discusses silvicultural treatments to create old growth structure where it is lacking in the landscape, but these treatments are not a substitute for protecting existing old growth forests (111:21-114:22).

Gordon (Yale): "Remedying this current and projected deficit of old growth ecosystems is the central issue to be resolved...ecosystem management...has the potential, I think, to remedy this old growth deficit (96:16-22)."

iv. Forest Workers & Communities

Eades (Logger): "I represent a family that has been working actively in the logging and lumbering business for almost 200 years. Two hundred years is a long time. Mr. President, that's how long it takes one of these trees to reach that point we call old growth. I like to think that some of those trees that started life when my first ancestor worked in the timber might be old growth today, and the trees that I am so careful to leave might be my grandchildren's old growth. You're going to hear a lot about old growth today, and I'd like to keep it in the perspective that trees are like people: It just grows. And it gets older every day, and I can show you big, big trees growing up out of the ruins of sawmills that aren't there anymore between the ties of the railroads. They grow everyday. We're getting old growth some every day. They're like you and I. You're going to be old growth one day, Mr. President (48:1-17)."

v. Forest Industries

Hampton (Willamina Lumber): "These old growth forests cannot stand to live in splendid isolation. They will deteriorate by themselves. They will not regenerate a Douglas fir crop without a management policy of adapting them through techniques that scientists know how to utilize. If the old growth forests are all preserved they will ultimately reach their demise and will be replaced by white fir and hemlock which are shade-tolerant species (65:18-25)."

Tomascheski (Sierra Pacific Industries): "Jerry [Franklin] is right. We'll never know much about -- enough about old growth ecosystems, but that doesn't mean that we shouldn't try. I mean, we didn't know how to fly 90, 100 years ago; now we do. And I think we ought to recognize the significant contribution that forests can make that are currently off-limits to harvesting. They may not be old growth now, but they're coming along, and even though we'll never understand all those complexities, that again needs to be a piece of this puzzle (119:9-18)."

b. Consensus

Politicians and environmentalists see present stands of old growth as irreplaceable. People who work with forests -- biologists, forest workers, forest industry people -- see all forests, including old growth, growing and changing, and subject to human manipulation in the process. They also identify forests that are not yet old growth but are getting there as important to the long-term management and preservation of old growth.

c. Disagreement

Politicians and environmentalists understand old growth or ancient forests symbolically: as pristine, untouched nature (in Archbishop Murphy's words, "pristine forest, virtually untouched by human hands 26:9") subject to human corruption but otherwise constant, unchanging.

Eades presents the opposite viewpoint of forests as dynamic systems most succinctly: "It just grows." Among people who work with forests, there is varying confidence in how well humans can regrow old growth. Only Eades is perfectly confident: biologists and forest industries say we can't now, but should be trying, and what we know how to do now is better than what we have done in the past. Industry people seem most likely to argue that if old growth is locked up in preserves, it will eventually be lost through natural catastrophe or succession.

d. Places mentioned

The nation

e. Time periods mentioned

200, 100 and 90 years ago, present, "our grandchildren, "the next century, "forever"

H. Ecosystem management

1. State of forest ecosystems

a. Who says what

i. Environmentalists

Sher (Sierra Club Legal Defense Fund): "The breaches of laws that we have seen over the past decade have had concrete, real world terrible effects. They have resulted in an imminent ecological crisis in our public lands (90:24-91:2)."

Rick Brown (National Wildlife Federation): "I first started studying these forests more than 20 years ago as a graduate student. Some 15 years ago, I started actively working as a volunteer for their conservation, partly because of what I was learning about those forests, partly really more so because what I was seeing in the transformation of the landscape in the Northwest, and how policies that gave priority to timber management over the other public values that these public lands were to provide was transforming that landscape (125:21-126:4)."

Wales (Audubon Society): "Historically federal forests in the Northwest have been managed essentially as though they were an inexhaustible raw material stockpile. The result is an ecosystem on the verge of collapse (32:14-20)."

Norman (Headwaters): "My involvement in the forest issue blossomed in the late 1970's when I was working as a river guide and I began to notice the march of the clearcuts across the vast expanses of the tallest and the wildest forests in the world (170:23-171:2)."

Arthur (Sierra Club): "But we have also treated our forests as if they were an inexhaustible resource. But they are not. We have cut our forests like there was no tomorrow, but tomorrow caught up with us yesterday. In my lifetime I have watched our forests and our rivers, once rich with fish and wildlife, turn into battered landscapes...(51:21-52:2)."

Wawona (New Growth Forestry): "Some of the industry-owned watershed where I live have had up to 90 percent of their forest cover removed in the last 10 years. Industry's overhead cost may be lower, but the real costs in terms of cumulative effects to the ecosystem such as soil erosion, loss of forest productivity, habitat destruction, species on the brink, these are the externalized costs that are impoverishing our communities (59:9-15)."

ii. Biologists

Meslow (Fish & Wildlife Service): "The problem with forest management in the Northwest is not that we are growing out of trees. Professional forest managers have become quite adept at replanting cutover areas. What is becoming an increasing scarce commodity in the Northwest are forests, especially old forests. Plantations of trees nurtured to maximize wood fiber production are referred to as tree farms and rightly so. Tree farms lack many of the attributes of forests. Tree farms lack the physical characteristics, with their structure and ecological function of old growth forests they replace (105:4-14)."

Franklin (U Washington): "The Sustainable Forestry Roundtable, which was a process in the State of Washington, gave a very clear direction in terms of the ecosystems that were at risk. It was the riparian ecosystem, and it was the late successional old growth forest ecosystem (122:25-123:5)."

iii. Tribes

Powell: "Generally speaking, the timber industry has come a long way from logging practices of previous decades. Indian forest programs have also made great strides in developing model management programs and systems, unfortunately at the same time trying to recover from decades of neglect, mismanagement, and inadequate funding (87:3-8)."

Strong: "In our time, as natives of this land, our forests grew as many salmon as trees. In the short ten generations, one broad sweep of the geological second hand, America has reduced its life forms to struggling endangered species (249:1-5).

"And we understand that status quo management is completely unacceptable...We cannot linger amidst the technological pollution that we have created (250:14-16)."

iv. Forest Workers & Communities

Mason (Western Commercial Forest Action Committee): "You know, many people have talked about the damage that has been created to the forests in the last 50 years. There have been some inappropriate things that have occurred in the forests. Like all industries we make mistakes. Like all industries, we learn as we go, and we've learned a great deal (76:13-18)."

v. Church

Murphy: "I also pass through private and public lands that have been logged and logged again. Some of these lands have been replanted and the uniform group of Douglas firs awaits some future harvest. Other lands are clearcut and fallow, all but devoid of the abundant forest life which God has graced creation (26:10-15)."

b. Consensus

Forest ecosystems in the Northwest are degraded from what they once were.

c. **Disagreement**

People focus on different time periods: environmentalists claim much degradation has occurred in past 10-20 years; seeing this has spurred them into activism. Biologists, tribal representatives, and forest workers discuss a longer, more gradual process.

Environmentalists speak in terms of imminent catastrophe while others speak with less urgency, or with a sense of hope, that we have learned from past mistakes and will do better in the future (Powell and Mason).

d. **Places mentioned**

Public lands; Northwest; watershed where Wawona lives; the world; eastern Washington, eastern Oregon, west of Cascades (Arthur)

e. **Time periods mentioned**

Past 35,000 years/700 generations; past 10 generations; previous decades; Arthur's lifetime; last 50, 20, 15, and 10 years; late 1970s; present; "tomorrow caught up with us yesterday"

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2. What is ecosystem management?

a. Who says what

i. Government

Clinton: Notes apparent consensus in second panel, at least in theory, about need for new forestry and ecosystem management, including a reserve system. Asks how difficult it would be to get people to agree on the particulars of such an approach in practice (128:13-22).

Nafziger (Washington): "...we must begin to manage our forests differently. We heard that stands managed in a new way not only contained a diversity of wildlife, but also can produce higher quality wood products. We can strive to develop an entire landscape of natural forests, and what we need to reach for is a sustainable ecological system that includes old growth, wildlife, and people who live in real communities...(191:1-8)."

ii. Biologists

Oliver (U Washington): Encourages management across the entire landscape (public and private lands) for a variety of forest structures, similar to the diversity of forest types that would occur under the natural disturbance regime of the Pacific Northwest (111:21-116:6).

Thomas (USFS): "Ecosystem management is in vogue. It's the new means of natural resources management. I concur and I applaud that move because addressing one species at a time is leading us both to an exhaustion of patience and of resources. However, that approach is not going to be simple. It's not going to be cheap. One of my heros said, "Ecosystems are not only more complex than we think, they're more complex than we can think." That leads us to some caution and to be a little bit humble here. There may be not more than a hundred or so people in the entire world that are geared up to really think about what ecosystem management means. I encourage you to convene a working group out of that several hundred people as soon as possible to go to work on giving us some idea of what ecosystem management may be at world scale, national scales, and local scales (209:5-20)."

Meslow (Fish & Wildlife Service): "Mr. President, we look forward to having you revisit the Northwest, but not 480 times, especially to review contentious endangered species issues like this one. What most scientists are advocating is an ecosystem approach to the management of all old forest resources. We need an old growth forest ecosystem management plan that provides for all the species involved. We need to develop a strategy that can focus mostly on public lands that reserve significant tracts of old forests. We also need to manage the intervening public lands with a gentler touch. Such a strategy has as its goal maintaining the full diversity of species associated with our forest system. We believe we have the expertise to attempt such an ecosystem-based approach (107:12-25)."

Gordon (Yale): "From an ecological point of view, ecosystem management, based on sound integrated knowledge of the whole forest, allows us to do many things at the same time rather than saving one or two species at a time and has the potential, I think, to remedy this old growth deficit; focuses on maintaining the health and productivity of the entire forest asset rather than on isolated parts or processes. It's important to recognize that it will probably not anywhere result in the optimization of the yield of any single resource, commodity, or species (96:17-97:2)."

iii. Forest Industries

Geisinger (Northwest Forestry Association): "...we believe there is only one way to break that gridlock [over management of federal lands], and that is to embrace the exciting and innovative concepts that you heard described here today called ecosystem management...our industry will be a constructive player in developing a long-range plan for managing our forests. We just have one stipulation, and that is as we move forward with ecosystem management, that we adhere to the very theory that it is based on, and that is that we manage broad landscapes. We manage entire ecosystems rather than applying these new techniques to just that small amount of land that Dan Tomascheski referred to that is currently available for timber production.

If we can do that, we can avoid the economic catastrophe that is otherwise going to happen. We can maintain healthy forest ecosystems in a manner that we've never been able to before, and most importantly, we can have healthy watersheds. We can have fish and wildlife habitat. We can have recreational opportunities, maintain diverse ecosystems, and still produce the wood product needs that this country demands (175:10-176:11)."

Tomascheski (Sierra Pacific Industries): "Now, what we've done with our implementation of an ecosystem approach on our timberlands is that we've taken a lot of the concepts that were just mentioned and tried to incorporate them on our lands. We were also substantially checkerboarded with public ownership. And what we've tried to do is assess, on a landscape basis, a fairly large-scale look at our landscape. What kind of habitats we have now, in terms of age of forest, structure, canopy closure? Where are they? How big are they? How are they dispersed through space? (116:21-117:5)."

iv. Tribes

Powell: "It seems ironic that we are required to manage within the parameters of complex federal, legal, and regulatory management schemes that are intended to protect the environment, when in reality we have practiced the principles of conservation for thousands of years (85:11-16)."

Powell also describes her tribe's integrated resource management system: "Mr. President, I respectfully submit that Indian tribes such as Hoopa may serve as useful models to the problems confronting this conference (85:7-88:3)."

Strong: "The natives to this land have existed for at least 35,000 years which is an estimated 700 generations. Present day America is approximately 10 generations old. For 690 generations ecosystem management was defined, illustrated and scientifically conducted by each generation of American Indians living on this land. Diverse life forms were naturally integrated and in abundance (248:19-249:1)."

v. Environmentalists

Rick Brown (National Wildlife Federation): "My understanding is that folks who deal in mediations say that, "Sometimes when you're dealing with a can of worms, the trick is to open a larger can of worms," and maybe that's what we need to do with this issue, is to start taking the big picture, take our focus off of the remaining old growth, and really start dealing with the forest landscape (132:22-133:3)."

b. Consensus

Ecosystem management is management of the entire forest landscape and all its natural components. At this scale, it includes both public and private lands, reserves and harvest areas. The intent of ecosystem management is to apply the best available knowledge of ecology to forest management, with the aim of achieving a diverse set of biological and economic values. Checkerboarding of public and private lands in the Northwest complicates ecosystem management efforts.

c. **Disagreement**

Thomas and other biologists claim with industry that ecosystem management is new and exciting; biologists claim special knowledge of ecosystems that places them at the forefront of its development and application. These claims contrast with those of tribal representatives, who consider that they have been practicing ecosystem management for generations, without any western scientific experts.

Industry representatives and Nafziger emphasize the landscape approach to ecosystem management, which in their view should allow for continued harvest, with new techniques on private and some public lands: forests should not be removed from harvest, but managed differently. In contrast, the biologists who advocate ecosystem management present it as a more effective alternative to the single-species management now enforced through the Endangered Species Act, in terms of maintaining diverse biological values. Plenty of room is left for disagreement over the relative weights of biological and economic values when industries and biologists apply their different visions of ecosystem management.

d. **Places mentioned**

Pacific Northwest, Sierra Pacific lands

e. **Time periods mentioned**

35,000 years ago, past 700 and 10 generations, present, future

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3. **Treatment of harvest lands**

a. **Who says what**

i. **Biologists**

Gordon (Yale): Discusses management of federal lands in long rotations, coordinated with different management of private lands, as described to Congress by Gang of Four (97:3-12). Recommends thinning for forest health and productivity, both economic and biological (98:9-14).

Oliver (U Washington): "...most of our forests in Western Washington are in this dense young structure. We need to find a way to encourage creation of all of the different structures across each drainage base in a landscape unit...What we could do would be using the creativity of the local people that you heard of this morning to do the thinning, the pruning, the creating the snags, the creating the openings, some of the new forestry... in doing that, we would also be creating high-quality wood, which, by the way, is an environmentally very sound substitute for aluminum, steel, brick, concrete, or importing wood from elsewhere (114:24-115:13)."

Franklin (U. Washington): "What I've been trying to do during the last decade is take a lot of that information on how natural forest ecosystems work and begin to integrate it with our traditional forestry practices to try to produce approaches to do a better job of integrating both ecological and economic values. And that's fundamentally what new forestry is about, and it includes a tremendous array of different kinds of things (108:16-23)." Franklin gives examples of creating structurally diverse stands, providing for reserves on the landscape level, protecting riparian zones, and growing spotted owl habitat, all in the commodity landscape (108:24-109:8; 110:1-14).

ii. Forest Industries

Minnick (TJ International): "We've got to set aside here on the west side some forest preserves...We've got to surround these areas with some buffer areas that are managed with Jerry Franklin's new forestry with multiple-age, multiple-species, multiple-entry, longer rotations, protection of riparian habitat. But we can get some wood fiber out of them, too (224:3-13)."

Tomascheski (Sierra Pacific Industries): "And what we think that we'll find if we take this kind of an ecosystem approach is that the federal lands will tilt somewhat toward providing the older forests and the species that are dependent on older forests, while the private lands will tilt more toward providing those younger forests, given that those are privately owned timberlands, that they made investments with expectations of having a return, that they keep people employed in a significant way...We do a lot of the same kind of practices that you heard about, leaving stand structure, leaving snags, leaving down and dead material (117:15-118:4)."

Hicks (Plum Creek Timber Co.): Describes and illustrates "innovative harvest techniques that are more compatible with owl habitat needs than some traditional harvest methods," e.g., leaving snags, large downed logs, healthy green trees. Hicks also describes management techniques for other species.

"Though the public and private sectors share a common goal of meeting ecological and economic objectives, they have different roles. Public lands should provide reserves and manage forests. Biological diversity cannot be addressed by preservation alone. Managed landscapes can and should play a role. On the other hand, private lands can experiment with innovative approaches such as new forestry and continue to provide additional habitat through such practices as protection of the inside zones and the wetlands (101:18-104:12)."

iii. Environmentalists

Norman (Headwaters): "...when we protect large areas from logging and road building, we must remember that we are only treating the symptoms and bandaging the wounds. The decline of our forests' health must be dealt with at its source. Cutting practices must be reformed, and diversity must be restored to the 4 million acres of tree farms, otherwise the carefully designed system of reserves will crumble, a victim of forest fires and insect and disease epidemics that might spread from the managed lands (171:21-172:4)."

Wawona (New Growth Forestry): "Sustainable forestry is guided by natural selection and biological criteria, not short-term profiteering...It's time to make the necessary U-turn and make a serious commitment in the United States to sustainable forestry. We need to end the heartless abuse of our forest ecosystem as a mere fiber factory (58:20-60:16)."

b. Consensus

Unanimous advocacy for new forestry techniques on harvest lands, both public and private. Harvest lands are considered to complement reserves in ecosystem management strategies to maintain diversity of wildlife and forest stand structures across the landscape. New forestry techniques include harvest methods that preserve some of the characteristics of the original stand and silvicultural treatments prior to harvest, e.g., thinning and pruning. The latter also contribute to growth of high-quality wood, a secondary issue in this discussion.

c. Disagreement

See previous section on ecosystem management for different weights given to biological and economic values by different groups.

d. Places mentioned

Western Washington, United States

e. Time periods mentioned

Last decade, present, future, longer rotations

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4. Fish and watersheds

a. Who says what

i. Commercial Fishermen

N. Bingham (Fisherman): "...fishing has not been the cause of the decline of the salmon; the destruction of the salmon's habitat has been the cause of the decline of the salmon. The loss of fresh water habitat and the forests, the siltation of streams, cascades of sediment pouring into the streams, loss of shade from removal of the over-story trees, and loss of character of the streams have destroyed the home of the salmon...If we don't do something right now to protect the remaining habitats, we're going to see listings of salmon that will be in the order of magnitude under the Endangered Species Act that will make the spotted owl situation pale by comparison (55:15-56:13)."

Robinson (Oregon Salmon Commission): "It takes 200 years to grow an old growth tree. It takes three years to grow an old growth coho salmon. It takes five years to grow an old growth chinook salmon. Figure it out. We can do a lot of production of salmon in a short period of time. If we put salmon in the middle of this recovery program, we can start generating income again. We suggest a three-prong approach. One is management reform... Point two would be to establish natural production goals for salmon. Point three would be to establish and facilitate hatchery production goals (206:13-25)."

ii. Biologists

Sedell (USFS): Describes declining fish runs, attributes this in part to degradation of habitat in the last 20, 50 years, along with other non-forestry factors.

"When we start talking about new forestry, most of the discussion centers on tree structure and on forest creatures, and, in fact, I would submit that new forestry is really about watershed health and about watershed biology and ecology and hydrology also."

"The best habitat that remains, remains on public lands, and that land that it does remain on is probably in some of the most fragile parts of the landscape that we have left...and when we start to talk about getting a lot of the volume from thinning, when we talk about working in many of these areas, the light touch from watershed's perspective is going to be essential. The protection of the best habitat of what we have left is going to be crucial to anchor any maintenance and recovery of these stocks (123:18-125:4)."

Responding to Babbitt, Sedell describes logging on fragile slopes with helicopters, or taking fragile areas out of the harvest base, when roads are exacerbating watershed problems (135:6-22).

Gordon (Yale): "Roads...urgently need attention in many forests to reduce danger to threatened fish stocks and to improve the transportation network that underpins the management of other resources. The Gang of Four report that I mentioned identified 137 key watersheds on the west side containing 22,976 miles of road, all of which need some kind of review and attention (98:1-8)."

iii. Forest Industries

Draper (Western Council of Industrial Workers): "...the thing that we can't do in this debate, whether it be fisheries, whether it be forest practices, is blame everything on the wood products industry. There are many factors that include the declining runs of salmon, and I think my friend here would agree with that; not just the forest industry or the forest product workers (63:6-12)."

iv. Environmentalists

Doppelt (Pacific Rivers Council): "The problems with salmon and fisheries are in great part directly related to the loss of habitat and healthy watersheds across the Pacific Northwest. Indeed the future of salmon and the future of sustainable supplies of clean water, fiber, soils, and all forms of aquatic life including fisheries is inextricably tied to the future of watersheds that originate on our public lands...identifying and working on the public lands and in these headwaters is going to be critical...(201:23-202:16)."

Rick Brown (National Wildlife Federation): "I think watersheds are the most natural delineation we can make of ecosystems (132:17-18)."

Norman (Headwaters): Advocates a watershed reserve system, with particular attention to key watersheds for salmon (171:11-17).

Sher (Sierra Club Legal Defense Fund): "I have for six years now represented...local fishing groups, sport and recreational as well as commercial fishermen trying to save salmon...(90:1-4)."

Arthur (Sierra Club): "Near Seattle where I live now, there's a creek called Deer Creek which is a tributary to the North Fork of the Stillaguamish River. I'm an avid fisherman. I love to fish for steelhead and virtually anything else that swims in the water...Zane Grey caught his first steelhead in Deer Creek in 1919. Since then this watershed has been heavily logged. It's been heavy roaded, and it's been severely damaged. There are now less than 200 steelhead that now return to a river that once was renowned for its fishery. It's not only that I won't be able to catch steelhead there or that my son won't be able to catch steelhead there, but we're depriving the region and the community of both that environmental resource and the economic resource (53:9-23)."

v. Government

Browner (EPA): "I presume when we talk about ecosystem...that we are in fact talking about the air, the land, and the water, that we are talking about all three. And I would ask maybe Mr. Sedell or maybe Mr. Brown if...watersheds might provide sort of a natural planning unit around which we could develop solutions or proposals for how we deal with the forest and all of the parts of the ecosystem (131:25-132:8)." Sedell and Brown agree with Browner that watersheds are natural planning units.

Babbitt (Interior): "I'm wondering if there are any realistic alternatives to the degree of clearcutting that I saw in much of the Cascades and the intensive road building that goes along with that, where you have these kind of tiered terraced kind of road systems up mountainsides which...almost suggested it's getting ready to go into the river in the next rainstorm (134:22-135:3)."

b. Consensus

Salmon runs and other fish stocks in the Pacific Northwest are in serious trouble, in part due to forestry activities, especially roads and road-building. For people practicing ecosystem management, watersheds are natural planning units. The best fish habitat that remains is on public lands.

c. Disagreement

Draper challenges others who he thinks are blaming too much of the fishery declines on forestry activities. People differ in the degree to which they attribute current problems to habitat loss and degradation or other factors.

Everyone who emphasizes the importance of fish or watersheds is challenging or at least seeking to expand the prevailing forest and terrestrial wildlife orientation of the conference and of ecosystem management/new forestry. Sedell notes that some new forestry techniques could negatively affect fish habitat.

d. Places mentioned

Central Valley of California (Bingham), federal lands, Pacific Northwest, the Cascades, Seattle, Deer Creek, Stillaguamish River

e. Time periods mentioned

1919, past 20-50 years, past 6 years, 1991, 200 years to grow old growth, 3-5 years to grow salmon, present, future

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5. Institutions and processes for ecosystem management

a. Who says what

i. Commercial Fishermen

N. Bingham (Fisherman): "The fishing industry has been working for years developing model programs, putting our own dollars to work through a program we've innovated in California to try to solve the inland habitat problems. We know how to do the job, but we need your help. We want to get together with the forest people, with the Indian tribes and the farmers, and work on a watershed base to empower local communities to go to work to solve this problem (56:20-57:2)."

Robinson (Oregon Salmon Commission): "If we put salmon in the middle of this recovery program, we can start generating income again. We suggest a three-prong approach. One is management reform. Watershed by watershed management, federal leadership, federal facilitation, local people involved designing their destinies (206:19-22)."

ii. Environmentalists

Doppelt (Pacific Rivers Council): "What we need to do in reality is institute a comprehensive region-wide watershed protection and restoration program." Doppelt describes such a program that his organization, and others, have developed in the past 2.5 years (202:16-204:13).

Norman (Headwaters): "We need a scientific review committee for the managed lands. One goal of this committee would be to focus the new ecosystem management policy of the Forest Service and the BLM into a program of well-monitored experiments. As Jack Ward Thomas on this panel stated in the recent Scientific Analysis Team report, "Unless adequate research and monitoring are instituted and pursued vigorously an even stronger habitat reserve system will be needed in the future." To achieve this will require nothing less than a revolution in the Forest Service and the BLM. Those agencies must be placed under new leadership to ensure reform and a proactive compliance with the existing laws (172:5-18)."

Kerr (Oregon Natural Resources Council): "The Forest Service as a bureaucracy doesn't get rewarded for providing mushrooms for people to harvest and sell like it does for timber, so we need to change the agency incentives. We need to also remove duplication in the agencies, and, for example, in Western Oregon, the Bureau of Land Management has been atrociously managed, and I think those lands should be transferred to the Forest Service (198:14-21)."

P. Lee (Oregon Trout): "To accept change people need to understand why change has come about. As we move in a direction of partial harvest and manage for a diversity of tree species, we need to teach the children and adults of our community why changes in forest practices are essential (38:17-21)."

iii. Biologists

Sedell (USFS): "Part of our dilemma has been that we haven't been very good at planning, and we're neophytes at planning at large-scale watersheds. I'm talking about watersheds the size of the Little Tennessee or the Buffalo, and these are the size of rivers that you're going to need to start to manage around if in fact water quality as well as fish stocks that may be at risk need to be managed on and planned around (132:10-16)."

Gordon (Yale): "There will be no final solution to the old growth or any conflict over forest uses and values because times and people and knowledge continually change. The best we can hope for are improved processes and the leadership to use them (15-18)."

iv. Social Scientists

Fortmann (UC Berkeley): "We need locally based planning processes that enable local people to development and implement diverse policy options that take into account the social and ecological diversity of their communities, and we need state and federal policies that will facilitate these local processes. We need community-initiated and locality-based planning and management units that make ecological sense and social sense (144:9-16)."

R. Lee (U Washington): "...the security that people have in their community, in their families, in the tenure relationships they have, and that their children feel about their futures are key to healthy forests. This is where people learn to protect forests, to enhance them. This is where the knowledge is. This is where the creativity is...I think we need some fundamental reforms that where we're going to be producing commodities on what are the now public lands we may need to move toward a system of community trust or something else that brings people together in legal authorities...We can't do it [affirm both environment and people], in my opinion, through the large centralized federal bureaucracies (147:19-150:18)."

MacColl (Historian): "We see today longstanding misguided federal policies with little coordination between the federal agencies and between the federal and the state agencies (21:22-24)."

v. Forest Industries

Tomascheski (Sierra Pacific Industries): "[The USFS and BLM have] gone through a land management planning process where every constituent group got a piece of pie. They wanted this, so we -- okay, we set aside that for them, and then this group wanted this. Well, now we only have this little piece of the pie left to practice timber management on, and as a consequence, in order to try to keep timber supplies coming, we've acted very intensively on that little piece of the pie (118:19-119:1)."

C. Bingham (Weyerhaeuser): "We fund our reforestation and research budgets over decades. It does not go down through economic cycles. I don't think we can fund the great national forests on an annual appropriations. We have to be willing to make long-term funding commitments (195:8-16)."

vi. Tribes

Powell: "Federal agencies...have been plagued by multi-levels of decision making and overly bureaucratic and fractionated approval and appeal procedures (86:23-87:2)."

b. Consensus

To effectively implement ecosystem management, federal agencies (especially the BLM and USFS) will have to change a number of ways in which they do business. Working at a landscape level also requires new sorts of institutions and processes that coordinate and plan over a range of public and private lands.

c. **Disagreement**

Everyone has different ideas for particular programs or reforms that are needed, though none of these are directly at odds with one another. A more subtle distinction can be made between people who advocate local participation for the purpose of effective ecosystem management and those whose primary concern is giving local people control over their lives: see Section II.B.8.c. (Need for local control in rural communities: disagreement).

d. **Places mentioned**

California, western Oregon, Little Tennessee and Buffalo watersheds

e. **Time periods mentioned**

General past, past 2.5 years, present, Doppelt's 10-year plan, general future, long-term funding

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6. **Research and monitoring needs**

a. **Who says what**

i. **Biologists**

Gordon (Yale): "The most urgent restoration need is a better idea of what forest conditions are at a fine-grained local level. We need this information to observe the first rule of forest restoration which is, as for surgery, in the first instance, do no harm (97:21-25)."

"I'd like to say a word also about the research deficit. The lack of fundamental knowledge about old growth's potentially endangered species and disagreement about the information that does exist have been drivers of conflicts over forest management in the Pacific Northwest and elsewhere (98:15-20)."

ii. **Forest Industries**

Tomascheski (Sierra Pacific Industries): "We need more research and monitoring into that whole condition [of habitats]. We need to monitor as we go. That's the whole thing adaptive management is. Try something. Learn a little. Then move on after you've learned something. But we really have a research deficit (122:10-15)."

C. Bingham (Weyerhaeuser): Discusses need to gather data and adjust management accordingly. "We fund our reforestation and research budgets over decades. It does not go down through economic cycles. I don't think we can fund the great national forests on an annual appropriations. We have to be willing to make long-term funding commitments (195:8-16)."

iii. **Environmentalists**

Norman (Headwaters): "We must establish a permanent forest and watershed reserve system based on the best scientific knowledge.

We must also establish interim protection for additional areas to preserve our options while thorough scientific studies are completed. All suitable habitat for threatened species, all roadless areas, key watersheds for salmon, riparian zones, and large blocks of intact forest must serve as our scientific controls during this research period (171:11-19)."

b. Consensus

Research and monitoring are integral to ecosystem management; there is still a great deficit in knowledge of how ecosystems work and respond to human activities.

c. Disagreement

Industry or others might disagree with Norman's proposal: it sounds as if very little land would be available for harvest in the short term.

d. Places mentioned

Northwest and elsewhere

e. Time periods mentioned

General past, present, and future; long-term funding; permanent reserves

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I. East side forests

a. Who says what

i. Government

Clinton: "There's one other topic I want to make sure we touch...that is the issue of whether the administration should deal with the forest on the east side of the Cascades...(125:5-9)."

Schmidt (Linn County, OR): "It was mentioned here a few minutes ago about taking some wood out of the many, many thousands of acres of dead and dying timber, particularly in Eastern Oregon, but we've got the problem coming over in Western Oregon as well. It's a disaster, but it's also an opportunity to extract a lot of fiber, to put some people to work, and to do some of the long-term help that those stands need, reducing of densities have come on since fire is not -- since fire has been controlled by man; to modify the species in the stands to more correctly assimilate the stands as they used to be 150 years ago, things like this (243:5-15)."

ii. Environmentalists

Norman (Headwaters): "These reserves must encompass the east side of the Cascades as well as the west side forests (171:19-20)."

Arthur (Sierra Club): "The east side forests are an ecological time bomb waiting to explode (52:5-6)."

Rick Brown (National Wildlife Federation): "...those reserves must include forests east of the Cascades, as you asked. The salmon, the steelhead that swim the Columbia River pass beyond the Cascade crest, and they don't understand our distinctions between spotted owl forests and non-owl forests, nor do the goshawk, the pileated woodpecker, the American martin, and other species that stand both sides of Cascades. To them the Northwest forest landscape is one seamless tapestry of a forest ecosystem, and we must include, I believe, the east side forests in any resolution that we seek out of the processes that develop from today (127:8-19)."

Doppelt (Pacific Rivers Council): Estimates that $200 million is needed to secure the remaining healthy watersheds on the east side (204:4-6).

iii. Social Scientists

Hanus (Oregon Department of Forestry): Mentions 200,000 acres of land in eastern Oregon that could be converted (151:22-23).

iv. Biologists

Oliver (U Washington): "I think in doing this we would create a system that would be robust, not just for Western Washington, but for Eastern Washington, and incidentally for the red cockaded woodpecker and other species in the country, and I think we'd also create an example for the rest of the world (114:1-5)."

v. Forest Industries

Hicks (Plum Creek Timber Co.): Discusses spotted owl research and new forestry techniques applied on the east side of the Cascades in Washington (101:1-25).

b. Consensus

Environmentalists agree that east side forests need attention; others do not say this directly, but by mentioning east side forests imply the same thing.

c. Disagreement

None.

d. Places mentioned

East side forests, eastern and western Oregon and Washington, west side forests, Columbia River, spotted owl forests, non-owl forests, Northwest forest landscape, Cascade crest, the country, the world

e. Time periods mentioned

150 years ago, present, future

III. Participants in the Conference

BILL ARTHUR is Director of the Sierra Club's Northwest Office in Seattle. He grew up in Montana where his father was a small independent timber operator. He is an economist by training and has been involved with the Sierra Club and forestry issues for the past ten years.

BRUCE BABBITT is Secretary of the U.S. Department of Interior.

NADINE BAILEY of Hayfork, California, is the wife of a logger and a dedicated spokeswoman for loggers whose livelihoods depend on timber harvesting. Nadine's daughter, Elizabeth, participated with the President in the ABC TV Town Meeting for children.

CHARLES W. BINGHAM, Executive Vice President, Weyerhaeuser Company, Director of Puget Sound Power and Light Company; Chair of the Tacoma-Pierce County American Leadership Forum; Vice President of the Mountains to Sound Greenway Trust; and a trustee of the Weyerhaeuser Foundation. He is past chair of the National Forest Products Association Board of Governors.

NAT BINGHAM is a commercial fisherman who owns and operates a fishing vessel and fishes for salmon, crab, and albacore. He served as President of the Pacific Coast Federation of Fishermen's Association and currently serves as their field coordinator for their fisheries habitat program.

RICK BROWN, National Wildlife Federation, Portland, Oregon. Brown is a wildlife and forest ecologist who previously worked for the Forest Service. He has actively promoted 'ecosystem' approaches to forest management.

RON BROWN is Secretary of the U.S. Department of Commerce.

CAROL BROWNER is Administrator of the U.S. Environmental Protection Agency.

JIM COATES, Vice President, International Woodworkers of America Local 3-2. From 1990 to the present, he has served as Community Outreach Coordinator to provide information on training programs and available social service resources, creating innovative programs, such as a weekly television broadcast, "People Helping People", through a local ministerial association, to provide information to timber families.

BOB DOPPELT, Executive Director and Co-Founder of the Pacific Rivers Council. He began the Council because he owned a commercial river trip and fishing business for 11 years and experienced first-hand the environmental impacts on the region's rivers and fisheries and felt a group was needed to specifically focus on these issues. He is known as a creative national expert on riverine protection and restoration strategies.

MIKE DRAPER, Executive Secretary, United Brotherhood of Carpenters, Western Council of Industrial Workers, Portland, Oregon, represents 30,000 members across ten western states. His members work as loggers, in sawmills, and in plywood and particle board manufacturing and re-manufacturing plants.

BUZZ EADES, Eades Forest Resources, is a graduate forester and a sixth generation logger.

MIKE ESPY is Secretary of the U.S. Department of Agriculture.

IRV FLETCHER is President of the Oregon AFL-CIO.

LOUISE FORTMANN, University of California, Berkeley, California. Dr. Fortmann is a rural sociologist who has focused on environmental protest and community well-being. She has conducted major ethnographic and statistical analyses in the region.

JERRY FRANKLIN, University of Washington, Seattle, Washington. Dr. Franklin is a leading forest ecologist whose research focuses on old growth forests. He was one of the "Gang of Four" and has been called the "Father of New Forestry".

JIM GEISINGER, President, Northwest Forestry Association, Portland, Oregon. The NFA represents forest product manufacturers and forest landowners in Washington and Oregon who depend on public lands for fiber supply. He has more than 17 years experience working for forestry trade associations and has spent his entire career on resource issues affecting federal forest management.

JACK GIBBONS is U.S. Science and Technology Advisor

JOHN GORDON, Dean, Yale University School of Forestry. Dr. Gordon is a forest ecologist who spent the majority of his career at Oregon State University. He has written extensively on forest policy issues and was one of the "Gang of Four", the team of four government and university scientists who produced a 1991 study on the health of the forests and different management alternatives at the request of the House Agriculture and Merchant Marine Committees.

BRIAN GREBER, Professor, Oregon State University, Corvallis, Oregon. Dr. Greber's research addresses forest product markets and regional economics. He has been an advisor to several federal task forces, including the "Gang of Four", and the Endangered Species Committee.

JOHN HAMPTON, Chief Executive Officer, Willamina Lumber Company, Portland, Oregon, founded Hampton Lumber in 1950 and became CEO of Willamina in 1970. He currently serves as Chairman of the Northwest Forest Resources Council.

ANN HANUS, Assistant State Forester, Oregon Department of Forestry, Salem, Oregon. Ms. Hanus is a professional forester and economist who has been involved with this issue since 1985. She served as staff to Tom Walsh, the Oregon representative to the Endangered Species Committee.

ROSLYN HEFFNER has been operating her own vocational counseling service since 1987, focusing primarily on assisting injured workers back to gainful employment. She is a registered nurse and has a Master's Degree in rehabilitation counseling.

LORIN HICKS, Plum Creek Timber Company, Seattle, Washington. Dr. Hicks is a wildlife biologist who has conducted research on spotted owls on private and public lands. He was a contributing author of the Spotted Owl Recovery Plan, the Bush Administration's Department of Interior plan for protecting the owl.

ERIC HOLLENBECK began working in the woods at 14, first surveying for timber access roads and later logging. At 24, he began a logging company, the Blue Ox Millworks. Three years later, along with his wife, Hollenbeck built a sawmill and has been manufacturing finished wood products for the last 17 years. Two years ago, they opened the historic facilities for tours and this year they are opening a School of the Traditional Arts to educate tomorrow's woodworkers and entrepreneurs.

JIM IRVINE is Vice President and Treasurer, National Association of Home Builders and is a home builder from Portland. He is President of the Conifer Group, a construction, development and property management company building primarily single family homes and light commercial developments.

VERA KATZ is Mayor of Portland, Oregon.

ANDY KERR is Conservation Director for the Oregon Natural Resources Council, a 20-year-old coalition of more than 40 sports, conservation, recreation, commercial and educational groups interested in the wise management of Oregon's lands, waters, and other natural resources. ONRC represents more than 6,000 individual members and maintains offices in Portland, Eugene, and Bend.

GUS KOSTOPULOS, Executive Director, Woodnet, a non-profit network of more than 300 wood products manufacturers on Washington's Olympic Peninsula. Before establishing Woodnet, Kostopulos held a number of management positions, employing many of the techniques and strategies characteristic of flexible manufacturing.

BOB LEE, University of Washington, Seattle, Washington. Dr. Lee's field of study centers on the social aspects of forest resource use. For many years, he has studied the social and cultural consequences of wood supply reduction on forest-dependent communities. He is affiliated with the non-profit group, The Temperate Forest Foundation, which seeks to develop a middle ground for the development of sustainable use practices.

PATRICIA LEE, Charter member Oregon Trout, Streamside Inn, Steamboat, Oregon, runs an inn and is in the process of creating an environmental education center for the children of Douglas County.

KEN MARSON, Marson & Marson Lumber, runs a retail lumber yard, Ace Hardware Center and Truss Manufacturing Plant. He also is active in the National Lumber Dealers and Building Material Dealers Association.

LARRY MASON, Western Commercial Forest Action Committee, is from Forks, Washington, and owned a mill that had to close. He now heads a group of 500 individuals who represent a broad section of timber dependent communities.

KATHERINE MATER is Vice President of Mater Engineering, Inc., a forest products engineering and market research firm based in Corvallis, Oregon, which has served the wood products industry for 50 years. She is recognized as an industry leader in researching and identifying value-added wood product manufacturing solutions which adapt to reduced raw resource supplies, yet offer profits and job security for the industry.

CHARLES MESLOW, Director, U.S. Department of Interior Fish and Wildlife Service, Cooperative Research Unit, Corvallis, Oregon. Dr. Meslow is a research biologist and professor of wildlife ecology at Oregon State University. He is known for his research on northern spotted owls and was a member of the Scientific Analysis Team that released its report to the court on March 19, 1993.

WALTER MINNICK is CEO of a $400 million facility, TJ International, one of the largest purchasers of veneer in the west. They have 1,000 employees in Oregon and own four mills on the west side. He is currently a member of the Governing Council of the Wilderness Foundation, American Business Conference, Idaho Conservation League, and the Nature Conservancy.

ARCHBISHOP THOMAS MURPHY, Catholic Archdiocese of Seattle. Archbishop Murphy has led the Roman Catholic Church in western

Washington since 1991. He has helped organize relief and social service efforts for timber-dependent communities.

RICH NAFZIGER is currently Deputy Insurance Commissioner for Policy and Legislative Affairs for the State of Washington. Between 1988 and 1993, he served as Special Assistant to the Governor for Timber Policy and Rural Development and was Director of the Governor's Timber Team, responsible for coordinating state policy and programs relating to forestry issues and timber community development.

JULIE NORMAN, President of Headwaters, a southwest Oregon grass-roots group working for federal forestry reform through policy research, timber sale monitoring, public education, and negotiations/litigation.

CHARLES OLLIVIER has been an active participant in the International Longshoremen and Warehousemen's Union Local 14 for 27 years, 12 of which were as President. Presently, he is elected Commissioner, 5th District Humboldt Bay Harbor, Recreation and Conservation District and is the Vice President of the District.

CHAD OLIVER, University of Washington, Seattle, Washington. Dr. Oliver is a silviculture and forest policy professor at the University of Washington, School of Forest Resources.

FELICE PACE is Program Coordinator for the Klamath Forest Alliance, a community-based, non-profit organization based in northern California. The KFA works to reform public land management with special emphasis on rehabilitating damaged watersheds on public land to restore salmonid and other fisheries at risk of extinction. He has lived in Siskiyou County for 18 years and has been active in forest issues since 1980.

MARGARET POWELL, Member, Hoopa Tribe, Hoopa, California, is the owner of a small mill located on the Hoopa Valley Indian Reservation. She also has served on the Hoopa Tribal Council for 14 years and is active in other tribal affairs.

ROBERT REICH is Secretary of the U.S. Department of Labor.

ALICE RIVLIN is Deputy Director of the U.S. Office of Management and Budget.

BARBARA ROBERTS is Governor of Oregon.

TOM ROBINSON for the past six years has been manager of the Oregon Salmon Commission, representing the Oregon troll fishermen and primary processors through product promotions, education, communications and research. He has served as an official salmon fishery representative on the Pacific Fishery Management Council By-Catch Committee and on the Oregon Coho Review Committee.

DAVE SCHMIDT has served as County Commissioner of Linn County, Oregon since 1988. He is a member of the Council of Forest Trust Lands and is a Board Member on the Western Interstate Region of Public Lands, which works with the Bureau of Land Management and the Forest Service on local issues.

JIM SEDELL, U.S. Department of Agriculture Forest Service, Corvallis, Oregon. Dr. Sedell is a fishery biologist who is a leading researcher into how forest land use affects fish habitat. He was the principal fishery biologist on the Scientific Analysis Team. He is a native Oregonian and local fisherman.

VIC SHER is the Managing Attorney for the Sierra Club Legal Defense Fund in Seattle, Washington. His practice is devoted entirely to representing citizens in litigation and administrative action related to environmental protection. He has been counsel to the environmental plaintiffs in a series of cases relating to the forest and wildlife management issues in the region.

BOB SPENCE, President, Pacific Lumber Sales Company, Seattle, Washington. Mr. Spence and his family operate this privately-held company which owns three sawmills and exports both logs and finished wood products.

PHYLLIS STRAUGER, Mayor, Hoquiam, Washington, has served on the Hoquiam City Council from 1969 to 1988. She has served as Mayor since 1988. She has been active in state service and in the National League of Cities.

TED STRONG has been the Executive Director of the Columbia River Inter-Tribal Fish Commission for four years, created by the Confederated Tribes of the Warm Springs Reservation of Oregon, Confederated Tribes of the Umatilla Indian Reservation, Confederated Tribes and Bands of the Yakima Indian Nation, and the Nez Perce Tribe.

FRANK TALLERICO, Superintendent of Schools, Siskiyou County, Yreka, California, has served as Superintendent for the past eight years. Prior to that, he served in other capacities in the Superintendent's office and taught fifth through twelfth grade classes.

JACK WARD THOMAS is the Chief Research Biologist and Project Leader for Range and Wildlife Habitat Research for the USDA Forest Service. He has published more than 250 works and was a member of the "Gang of Four", the team of four government and university scientists who produced a 1991 study on the health of the forests and different management alternatives at the request of the House Agriculture and Merchant Marine Committees. Dr. Thomas chaired the Interagency Scientific Committee, which established the conservation strategy for northern spotted owls.

He also was the leader of the Scientific Analysis Team which, under court order, released its report on the management of old growth ecosystems in March.

DAN TOMASCHESKI, Vice President, Sierra Pacific Industries, Redding, California. Tomascheski's company owns 1.1 million acres of commercial forest land in California. It is also the largest California purchaser of timber on federal lands. Tomascheski was active in efforts to reach consensus with environmentalists on private forest lands in California.

DIANA WALES is a partner in a small law firm in Roseburg, Oregon with a practice limited to family law. She is also co-chair of the Umpqua Valley Audubon Society Conservation Committee as well as other environmental, professional, and civic organizations.

MECA WAWONA is the founder of New Growth Forestry in Ukiah, California. She and her husband run a small business cooperative that specializes in forest and salmon habitat restoration.

ED WHITELAW, University of Oregon, Eugene, Oregon. Whitelaw is an economist who believes that northwest regional economies are in transition and that most timber workers and companies realize federal lands will provide less timber than in the past.

Appendix VII-B

Post-Forest Conference Public Input: A Summary of Policy Issues

Prepared by Catherine Woods Richardson and Debbie Deagan

June 4, 1993

Post-Forest Conference Public Input

A Summary of Policy Issues

Prepared by

Catherine Woods Richardson and Debbie Deagen

for the Interagency Social Assessment Team

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I. Introduction

Sources of Comments

At the conclusion of the Forest Conference on April 2, President Clinton directed the Cabinet to begin drafting a long-term plan to address the socioeconomic ar1 ecological issues that had been discussed that day. In so doing, he commented to those present, "You have got to be part of this solution. Even if we make the most enlightened possible decisions under the circumstances, they will be all the more resented if they seem to be imposed without a continuing mechanism for people whose lives will be affected here to be involved."

Although the teams of natural and social scientists who were brought together after the Conference worked on possible solutions behind closed doors, written comments and suggestions were solicited and accepted from outside groups. This document describes how comments received by May 14 were directed internally and gives a basic summary of the major policy issues in these comments. **Comments received by the Social Assessment Team after May 14 were not distributed and are not included in this analysis.** They were logged in and will be forwarded to the team conducting the Environmental Impact Statement on the Conference plan.

Most comments were directed to Tom Tuchmann in Washington, D.C., who contacted the Social Assessment Team in Portland with a request for assistance in analyzing them. Jeff Rogers and Jack Ward Thomas in Portland also received some comments, which were included in this analysis.

Disposition and Analysis of Comments

We reviewed 229 documents, catalogued in Table 1, for basic content that would be of value to the different working groups in the Interagency Team. Any document that contained technical information or substantive scientific or policy recommendations was copied and distributed to the appropriate working group(s): Aquatic, Terrestrial, Economic, Social, and Policy (J. Pipkin). Each group was instructed to review each document, record how they used it in their working group, and report back to the Social Assessment Team.

Time constraints prevented us from completing a thorough analysis of the comments, given the richness of the material that they contained, but we did review all 131 documents directed to the policy working group, focusing on the policy issues that commenters raised.

The summaries and examples that follow represent the range of issues that appeared in the comments, not the number of times they were mentioned, or all the people or organizations who commented on each issue. We did identify the types of organizations that made similar statements, to gain a general sense of the degree of consensus or disagreement on each issue. The issue list also is not exhaustive, but representative of the types of policy issues that were raised.

<u>Groups identified in public input</u>
Environmental Organizations
Forest Industry
Tribes
Government (Local, County, State)
Sustainability Organizations (Organizations practicing and promoting sustainable resource management)
Academic/Professional Individuals and Societies
Civic/Grass-Roots Community Organizations
Forest Workers
Individuals claiming no formal affiliation

<u>Differences between the Conference and Post-Conference comments</u>

<u>Specificity of post-conference comments</u>

* Post-conference comments address particular places of interest, federal laws or taxes, community development programs now under way.

* This is a function of the different formats -- short sound bites vs. written submissions

<u>Representation of different groups</u>

* Post-conference comments represent <u>a lot</u> of small, local environmental groups who were not invited to the conference and have things to say about <u>specific</u> places that were not said at the conference

* Very little is said about conditions in rural communities or heard from rural community representatives or timber workers in post-conference comments
  - a lot was said on these topics at the conference; much of this is general testimony: "We're losing our livelihoods and families"
  - this is not a group with the same degree of political organization/operation as environmental groups and industry, especially when it comes to written input

* Post-conference comments also came from groups and individuals outside the PNW (again, mostly environmental)

<u>People asking about bigger picture in post-conference comments</u>

* What about changing consumer demand for wood products? (How is it expected to change, how can it be changed?)

* Where will/can wood or wood substitutes come from if not the PNW? (Alaska, Siberia, recycling, etc.)

* What about forests in the rest of the country, especially on the east side? (Forests all over the country are in trouble: national forest policy and national reform are needed.)

<u>Focus on legislation as preferable to administrative policy, including submission of proposed bills</u>

II. Comment Summaries

A. Socioeconomic issues

A1. Import and export of raw logs and forest products
Many groups commented on the issue of raw log exports. Environmental groups generally favored a ban or restrictions on exports, as did groups of forest workers. Some industry groups favored bans or restrictions, particularly secondary manufacturing industries, but other industry groups, and some nonindustrial private forest owners favored continued exports. Some commenters opposing exports mentioned current export subsidies on logs that could be revoked. A civic/community group noted that adjusting tariffs would be preferable to banning exports; the former action would benefit private landowners economically while the latter would cause them economic loss.

Comments by environmental groups on the possibility of importing raw logs from Siberia or elsewhere were negative, citing the likelihood of pest introduction.

A2. Rural businesses, including value-added manufacturers
Comments and proposals for ways to encourage local business in rural areas were myriad. Industry, environmental, sustainability, civic/community, worker, and government groups all had suggestions for both developing forest-based businesses and promoting economic diversification. Tax credits, community development banks, loans, technical and marketing assistance, and grant programs were all frequently mentioned. Also at issue were ways the Forest Service and other resource agencies could promote community development, e.g., through changing timber sale procedures to favor smaller operators and mills. Sustainability organizations offered suggestions for promoting "Green" business in rural areas, and government groups discussed non-timber forest products such as mushrooms and florals. Government and worker groups also identified the importance of coordinating information and efforts among economic development agencies and of investing in infrastructure to support new businesses.

A3. Displaced workers
Nearly all groups who commented identified environmental restoration and/or timber stand improvement as sources of jobs in rural communities, both on public and private lands. Incentives could be offered to private owners to contract such services. Groups commenting included environmental, government, worker, and civic/community groups, plus individuals. The need for family-wage jobs and secure employment for displaced workers was also identified. Worker groups addressed education and skill training for displaced and soon-to-be-displaced workers and pension supplements for older displaced workers.

A4. Nonindustrial private forest lands
Most groups commenting on these lands identified them as potential sources of both high-quality timber and environmental values, but in need of active management to produce these amenities. Tax laws, e.g., on estate and capital gain taxes, and federal and state incentive and technical assistance programs for reforestation and restoration were identified as means to these ends. Incentives were considered preferable to regulations. Environmental, academic/professional, sustainability, industry, civic/community, and nonindustrial private land owner groups all commented on this issue.

A5. Private property issues
Industry groups expressed concern that any future policy or legislation assure private property rights of timberland owners. Current spotted owl restrictions are viewed as taking of private property without compensation, and the possibility of banning exports of raw logs from private lands is also seen as an obstruction to private property rights and free enterprise.

A6. Federal receipts to counties
Government, environmental, and academic/professional groups identified the impact of a loss of federal timber receipts on PNW counties. Possible approaches to minimizing that impact include providing federal funds in lieu of private property taxes based on the area of federal land in the county, or, for O&C counties in Oregon, merging BLM lands into National Forests and directing the administrative savings to county budgets.

B. Ecosystem management issues

B1. Restoration
Many comments focused on the need for river and stream restoration, also on reforestation, timber stand improvement, the need to deal with introduced species and pests, and opportunities to diversify forest structure across the landscape. Worker and civic/community groups identified salvage of diseased and downed trees as an aspect of restoration. Environmental groups noted particular areas in need of restoration, and a recreation business noted the dependence of the recreation industry on healthy forests and streams. Academic/professional and government groups also commented.

B2. Reserves
The use of reserves as a part of ecosystem management appears contentious: local environmental groups wrote in about numerous particular places they would like to see reserved, several of which are scheduled for timber harvest in the near future. Some civic/community, industry, and academic/professional groups questioned the use of permanent reserves in ecosystem management when PNW ecosystems are dynamic systems in which disturbance (especially fire) is common. Civic/community and worker groups

were of the opinion that enough land is already in reserves in the PNW.

B3. Nonreserve forest lands

Academic/professional, civic/community, industry, environmental, and sustainability groups had recommendations about how to treat forest lands that would be managed for timber, most of which focused on new forestry and other silvicultural practices. Other comments addressed need for agencies to consider adjacent or embedded private lands in their planning and management efforts, and to work to acquire some of these private lands into the public base.

B4. Watershed management and fisheries

Environmental, government, sustainability, and worker groups noted that watersheds should be the basic planning unit for agencies, and also the basic reserve unit for reserves, rather than patches of old growth. Protection and restoration of fish habitat were considered by many to be basic to restoring fish populations; however, a civic/community group noted that many factors have contributed to declining fish stocks, and not all the blame should be placed on forestry. Fisheries rehabilitation is complicated by dam and reservoir systems on the Snake and Columbia Rivers and by political, bureaucratic, and institutional constraints.

B5. Spotted owl management

Industry commented on the presence of spotted owls in second growth, especially in California, that should revise scientists' estimates of population numbers, viability, and viable habitat. An industry/worker group noted that current spotted owl plans for federal lands do not consider spotted owl management areas on adjacent private lands. In general, industry seems to agree that federal actions on the spotted owl have been excessive, and more moderate, considered policies are in order. A civic/community group noted that multi-species management is preferable to single-species management, which does not work, while an environmental group noted that poor habitat management in British Columbia may require greater conservation measures in the adjacent U.S.

C. Processes of forest management

C1. Groups that want to be included

Many groups felt they were not adequately represented at the Forest Conference and are not allowed adequate voice in developing solutions: family-size tree farmers, advocates for the forest, the Karuk Tribe, practitioners of sustainable forestry/ecoforestry, secondary wood products industries, mining interests, professional foresters, local businesses, and private landowners.

More generally, environmental, worker, civic/community, and academic/professional groups and individuals emphasized the importance of community-based solutions and forest management processes that draw on local knowledge and talent in designing plans and projects. An associated issue is the need to include Native American interests, identified by both tribes and environmental groups.

C2. Need to address short and long term
Environmental, industry, worker, sustainability, civic/community, and government groups identified the need for a short-term timber supply program to address immediate problems in the context of a long-term plan of sustainable forest management and stable timber supplies. Short-term remedies should not be inconsistent with long-term goals. Commenters suggested that the 60-day period be used to develop a transitional plan or planning process, allowing more time to develop a sound long-term plan.

C3. Criteria for decision-making
Environmental groups and others asserted that forest management decisions should be based on the best science available, but other comments by academic/professional, industry, government, and worker groups suggest that everyone may have different ideas about what or where the "best science" is.

Comments on how a plan might work included the importance of considering funding sources and setting and working toward measurable goals rather than following procedures and allocations. Also that local forest ecology, not a regional PNW plan, should drive local forest management.

C4. Research and information exchange
Research needs were identified in a number of areas: spotted owl and marbled murrelet biology, forest practices, processing technologies for small mills, engineered wood products.

Needs for improved information exchange, cooperation, and technology transfer were noted in wood products among academia, agencies, and small industries and in ecology among agencies and between agencies and industry. A civic/community group identified local, experiential and academic, scientific knowledge as complementary sources of information for responsible management. Environmental, tribal, government, civic/community, and sustainability groups commented.

C5. Environmental regulations and legislation
The greatest number of comments on any law were on the Endangered Species Act, which all groups supported, though workers, industry, and government asked that it be amended to recognize social and economic effects while environmental groups wanted it to be amended to further encourage ecosystem protection.

Industry, civic/community, and environmental groups agreed that conflicting directives in national laws and regulations, e.g., ESA and NEPA, need to be resolved.

Industry/worker and civic/community groups suggested actions to reduce the number of appeals and litigation and generally speed the planning process; one industry/worker group provided extensive comments on federal statutes and regulations that could be changed or reinterpreted to do this.

Comments were received on a number of other existing laws, and proposed legislation was also submitted.

More generally, environmental groups argued for protection of reserves in legislation rather than administrative policy.

C6. Agency reform and redirection

Everyone had comments on how the Forest Service and other resource agencies needed to be reformed or at least redirected. Comments on legal violations, difficulties working with the FS, and FS personnel who should be replaced reveal, as one person wrote, "a major rip off of the public trust," at least for some of the public, especially those with an environmental bent. Some of these commenters wanted some form of empowered citizen review of FS activities.

More generally, the FS needs to change from a timber management to an ecosystem management organization, according to general consensus, which necessitates changes in bureaucratic structure, budgets, staffing, etc.

Environmental, civic/community, tribal, and sustainability groups wanted the FS to take more active responsibility for local communities, e.g., in community development and conflict resolution.

An industry/worker group made extensive comments on the role the U.S. Fish and Wildlife Service should take on both public and private lands; they are currently overstepping their bounds.

D. Broader issues not addressed at the conference

D1. Effects of PNW forest policy on lands outside the PNW

Academic/professional, civic/community, environmental, worker, and industry groups asked that the administration consider the environmental effects of reducing harvest in the PNW on forests in the rest of the world, especially in Siberia, the Tongass in Alaska, British Columbia, and countries that do not practice reforestation.

D2. Consumer demand for wood products
Academic/professional, worker, and environmental groups also asked why ways of changing consumer demand for wood products were not addressed at the Conference, e.g., use of alternative materials, improving efficiency, recycling.

Civic/Community and Worker groups advocated wood products over alternative materials that require much more fossil fuel to manufacture.

D3. Need for policy on forests and ecosystems outside the PNW
Consensus appeared among all groups that the federal government should not limit its focus to the PNW: forests and forest policies nationwide need attention. Specific proposals for an umbrella National Organic Act, an Endangered Ecosystem Act, and a North American Commission on the Environment were submitted.

D4. Global warming
Environmental groups commented that global warming and ozone depletion should be considered in all forest plans, and studies and programs should be implemented that address these problems in the U.S. and internationally. A worker group noted that trees store carbon dioxide, while using fossil fuels to make alternatives to wood products would release more carbon dioxide into the atmosphere; therefore, we should continue to harvest and replant trees.

E. Eastside forest issues
Sixteen commenters wrote in specifically about forests on the east side, and another fourteen commented extensively on eastside forests in more general submissions. Many more mentioned that these forests need attention in the current interagency effort. The relationship of the Eastside forest to the Northwest ecosystem planning effort for threatened and endangered species (including anadromous fish in the Columbia River basin) was stressed.

Forest health is deteriorating rapidly, and dubious Forest Service policies and actions (high-grading, fire suppression, even-aged plantations, inadequate biological evaluations of sales, questionable inventories, misuse of salvage sales) are exacerbating eastside forests' decline. Owl injunctions on the west side have contributed to higher cutting rates and even more mismanagement by the Forest Service in these already stressed forests. The most extensive comments on eastside issues came from environmental groups, but there was general consensus among all groups that this region needs immediate attention. Industry/worker and civic/community groups advocated salvage sales on the eastside for forest health and to meet short-term timber supply needs.

Appendix VII-C

Community Adaptability: Percent of Communities By State
(expressed as a percentage of communities assessed)

	Low	*Moderately Low*	*Moderate*	*Moderately High*	*High*	*# Cases.*
Washington	**21**	**16**	**32**	**17**	**15**	**126**
Oregon	**20**	**17**	**38**	**8**	**12**	**105**
California	**54**	**13**	**2**	**12**	**10**	**52**

Community Adaptability: Percent of Communities By Washington State and Washington Subregions
(expressed as a percentage of communities assessed)

	Low	*Moderately Low*	*Moderate*	*Moderately High*	*High*	*# Cases*
Washington	**21**	**16**	**32**	**17**	**15**	**126**
Central	8	19	46	15	12	26
Lower Columbia	16	6	31	31	16	32
Olympic	25	23	23	5	25	40
Puget Sound	32	14	32	18	4	28

Community Adaptability: Percent of Communities By Oregon State and Oregon Subregions
(expressed as a percentage of communities assessed)

	Low	*Moderately Low*	*Moderate*	*Moderately High*	*High*	*# Cases*
Oregon	**20**	**17**	**38**	**8**	**12**	**105**
Central	18	18	29	6	29	17
Northwest	8	8	68	12	4	25
Southwest	11	29	43	11	7	28
West Central	37	14	17	17	14	35

Community Adaptability: Percent of Communities By California State and California Subregions
(expressed as a percentage of communities assessed)

	Low	*Moderately Low*	*Moderate*	*Moderately High*	*High*	*# Cases*
California	**54**	**13**	**2**	**12**	**10**	**52**
Northern	54	13	2	12	10	52

Success of the Current Harvest Scenario in Communities by State
(expressed as a percentage of communities assessed)

	Low	*Moderately Low*	*Moderate*	*Moderately High*	*High*	*# Cases*
Washington	**17**	**9**	**25**	**24**	**25**	**130**
Oregon	**16**	**20**	**38**	**10**	**15**	**117**
California	**52**	**13**	**17**	**12**	**6**	**52**

Success of the Current Scenario for Washington State and Washington Subregions
(expressed as a percentage of communities assessed)

		Moderately	*Moderate*	*Moderately*	*High*	*# Cases*
	Low	*M. Low*	*Moderate*	*M. High*	*High*	
Washington	**17**	**9**	**25**	**24**	**25**	**130**
Central	0	2	38	15	35	26
Lower Columbia	6	3	25	44	22	32
Olympic	34	9	14	23	20	44
Puget Sound	18	14	32	11	25	28

Success of the Current Scenario for Oregon State and Oregon Subregions
(expressed as a percentage of communities assessed)

	Low	*Moderately Low*	*Moderate*	*Moderately High*	*High*	*# Cases*
Oregon	**16**	**20**	**38**	**10**	**15**	**117**
Central	6..25	31	25	6	31	16
Northwest	8	4	56	12	20	25
Southwest	22	20	39	10	10	41
West Central	20	26	31	1	11	35

Success of the Current Scenario for California State and California Subregions
(expressed as a percentage of communities assessed)

	Low	*Moderately Low*	*Moderate*	*Moderately High*	*High*	*# Cases*
California	**52**	**13**	**17**	**12**	**6**	**52**
Northern	52	13	17	12	6	52

Success of the No Harvest Scenario in Communities by State
(expressed as a percentage of communities assessed)

	Low	*Moderately Low*	*Moderate*	*Moderately High*	*High*	*# Cases*
Washington	**27**	**11**	**25**	**25**	**12**	**130**
Oregon	**38**	**27**	**19**	**6**	**10**	**117**
California	**58**	**17**	**12**	**8**	**6**	**52**

Success of the No Harvest Scenario for Washington State and Washington Subregions
(expressed as a percentage of communities assessed)

	Low Low	*Moderately M. Low*	*Moderate Moderate*	*Moderately M. High*	*High High*	*# Cases*
Washington	**27**	**11**	**25**	**25**	**12**	**130**
Central	12	23	23	19	23	26
Lower Columbia	13	9	31	44	3	32
Olympic	45	5	23	11	16	44
Puget Sound	29	11	25	32	4	28

Success of the No Harvest Scenario for Oregon State and Oregon Subregions
(expressed as a percentage of communities assessed)

	Low Low	*Moderately M. Low*	*Moderate Moderate*	*Moderately M. High*	*High High*	*# Cases*
Oregon	**38**	**27**	**19**	**6**	**10**	**117**
Central	19	31	19	6	25	16
Northwest	12	24	32	16	16	25
Southwest	54	29	12	5	0	41
West Central	46	26	17	0	11	35

Success of the No Harvest Scenario for California State and California Subregions
(expressed as a percentage of communities assessed)

	Low	*Moderately Low*	*Moderate*	*Moderately High*	*High*	*# Cases*
California	**58**	**17**	**12**	**8**	**6**	**52**
Northern	58	17	12	8	6	52

Success of Three Harvest Scenarios in Communities by State
(expressed as a percentage of communities assessed)

	Low	*Moderately Low*	*Moderate*	*Moderately High*	*High*	*# Cases*
Washington	**5**	**4**	**25**	**26**	**41**	**130**
Oregon	**2**	**11**	**30**	**34**	**23**	**117**
California	**31**	**14**	**20**	**24**	**12**	**51**

Success of the 1985-87 Scenario for Washington State and Washington Subregions
(expressed as a percentage of communities assessed)

	Low	*Moderately Low*	*Moderate*	*Moderately High*	*High*	*# Cases*
Washington	**5**	**4**	**25**	**26**	**41**	**130**
Central	0	4	12	50	35	26
Lower Columbia	0	0	6	34	59	32
Olympic	11	9	27	11	41	44
Puget Sound	4	0	54	18	25	28

Success of the 1985-87 Scenario for Oregon State and Oregon Subregions

	Low low	*Moderately M. Low*	*Moderate moderate*	*Moderately M. High*	*High High*	*# Cases*
Oregon	**2**	**11**	**30**	**34**	**23**	**117**
Central	6	6	19	31	38	16
Northwest	0	0	32	32	36	25
Southwest	2	20	41	27	10	41
West Central	0	11	20	46	3	35

Success of the 1985-87 Scenario for California State and California Subregions
(expressed as a percentage of communities assessed)

	Low	*Moderately Low*	*Moderate*	*Moderately High*	*High*	*# Cases*
California	**31**	**14**	**20**	**24**	**12**	**51**
Northern	31	14	20	24	12	51

Nine Strategies for Enhancing Community Adaptability Selected by Panelists in Workshop One as Most Important

1) Integrate and consolidate federal, state and local government programs, land management and planning, and business assistance programs under one roof.

2) Empower local decision making.

3) Encourage alternative uses and alternative markets, develop national and international markets for alternative uses and products.

4) Provide leadership training for citizens officials and agency staff in community development theory, conflict resolution, and stewardship ethics.

5) Make funding and technical immediately expertise available to communities for watershed/fisheries planning and restoration.

6) Provide incentives for forest stewardship, expand current cost share programs, change tax structure to reward good forest management.

7) Protect and stabilize forest receipts.

8) Develop ecosystem baseline data and monitoring.

9) Develop guidelines appropriate to specific local areas.

VIII

Implementation and Adaptive Management

Chapter VIII

IMPLEMENTATION AND ADAPTIVE MANAGEMENT

This chapter is intended to provide a view of how a selected management option may be instituted over the longer term -- including the Phase II planning called for in the Overview and Summary Chapter. If one of the options is chosen for management action, it may be executed by alternative means than those suggested herein. We do believe, however, that the principles put forward are sound.

We expect that the forest management option selected by the President will lay the groundwork for the development over time of a regional economy in the Pacific Northwest that is simultaneously ecologically sound, economically sustainable, and socially responsible. Implementation of the selected plan will require several actions by the relevant resource agencies. These actions include implementing an adaptive management process within the framework of existing laws and policies. This process includes planning, monitoring, evaluation and adjustment, research, and following an implementation strategy. Full participation -- active collaboration -- will be required of many state and federal agencies, tribes, industrial and nonindustrial landowners, conservation groups, and other publics.

President Clinton and others at the Forest Conference stated the basic requirements for an acceptable plan for future management of forests and rivers of the Northwest:

> **"Never forget the human and economic dimensions of these problems"**...This requires people and community involvement in guiding change.

Chapter VIII Contributors

Mike Collopy chaired the Implementation and Adaptive Management Group. The primary responsibility for this group was to investigate and describe the processes related to implementation of a strategy for forest management. The group provided the initial input into the Agency Coordination Working Group, chaired by Jim Pipkin, and participated in discussions with that group as they developed their interagency coordination document. The following persons participated on the Implementation and Adaptive Management Group: John Cannell, Steve Daniels, Duane Dippon, Elizabeth Gaar, Gordon Grant, Barry Mulder, Charles Philpot, John Steffenson, and Fred Swanson. Additional background material on regulatory mechanisms was provided by Robin Bown, Phil Dietrich, Jim Michaels, and Teresa Nichols.

In addition to the people noted above, the following people participated in formative discussions that led to the initial development of the implementation chapter: Cara Berman, Kelly Burnett, Lisa Brown, Roger Clark, Jerry Franklin, Brian Greber, Grant Gunderson, Richard Holthausen, Joe Lint, Margaret Shannon, David Solis, George Stankey, John Tappeiner, and Fred Weinmann. Members of the Agency Coordination Working Group, particularly Jim Pipkin, Elaine Zelinski, and Mike Crouse provided valuable input.

"Protect the long-term health of our forests, our wildlife, and our waterways"....This requires setting desired future ecosystem conditions and developing ecosystem management as an approach to getting and keeping ecosystems in those desired conditions.

"Our efforts must be, so far as we are wise enough to know it, scientifically sound, ecologically credible, and legally responsible"...This is an essential component of any comprehensive conservation strategy.

"Produce a predictable and sustainable level of timber sales and nontimber resources that will not degrade or destroy the environment"...This also should be an objective of a comprehensive conservation strategy for public forest lands in the Pacific Northwest.

"Make the federal government work together and work for you"...This requires policies and cooperating institutions suited to the task.

In Chapter II, a multiphased approach to the shift to ecosystem management was described. In Phase I (this report), an array of 10 options was developed that would provide the "backbone" of an ecosystem management approach in which there was the achievement of a functional system of Late-Successional and Riparian Reserves that would provide for an interactive network of such forests and the protection of habitat for the northern spotted owl and marbled murrelet (both of which are listed as threatened) and for spawning and rearing habitat of at-risk fish species. Phase I ends with the selection of an option for management and the completion of the associated Environmental Impact Statement.

In subsequent phases of planning the concept of ecosystem management should be integrated across Forest Service and Bureau of Land Management lands. This should assure a coordinated approach to achievement of ecosystem management on federal lands, and help determine if the concept of ecosystem management can be extended beyond the boundaries of federal lands. It is in this chapter that the subsequent aspects of implementation are addressed.

Our Current Situation

In this chapter, we briefly summarize some of the prevailing attitudes and perceptions of people affected by forest management in the Pacific Northwest (for details, see chapters "Economic Evaluation of Options" and "Social Assessment of Options"), the current state of these ecosystems and their management, and the status of the federal institutions responsible for their stewardship. Our goal is to provide a perspective of the complexity of these issues, including some of the positive and negative aspects associated with these issues, which lead to identification of changes that are needed if agencies are to move forward from their current situation. In subsequent sections of this chapter we will establish the setting for implementation, identify the research and monitoring approaches required for adaptive management, and lay out the framework for implementation that needs to be addressed by agencies in both the short and long term if our effort is to be successful.

People and Communities

The complexity of issues in the Northwest is characterized, in part, by the diversity of opinion over how much of the public forests should be converted to young, even-aged forests designed to produce products for human use and how much should be retained in late-successional and old-growth forests. Regardless of the position individuals take in this debate, it has been made clear time and again that people care about the environment. This commitment was articulated at President Clinton's Forest Conference, where people representing forest-dependent communities, industrial and nonindustrial landowners, government scientists, environmental groups, and academicians recognized a need for change. These representatives wanted the current management situation in the region to end and were prepared to work toward creating a new vision for forest management in the Pacific Northwest that was biologically sound, economically sustainable, and socially acceptable. Unfortunately, their visions of the direction of change diverged widely. The balance between the national interest, as articulated in law, and regional and local interests is particularly difficult to resolve.

In the current situation many people are dissatisfied with the decisionmaking processes used by the federal agencies to manage lands. For example, many participants (including environmental and timber interests) consider the planning process currently used by the Bureau of Land Management and Forest Service to be ineffective at incorporating public views. People, particularly those directly affected by these decisions, often feel their opportunity to be involved throughout the development of plans is too limited and occurs too late in the process. Although substantial changes can, and often are, made by agencies following public review, people often regard the functional nature of their involvement as "tokenism" (Mohai 1987). Yet, others who are well informed about the planning process feel that their opportunity for involvement is excellent and the agency response is gratifying.

Rural and urban communities throughout the Pacific Northwest depend on federal forest lands. The relationships between these communities and the federal lands are complex, ranging from obvious employment linkages to more subtle issues of culture and self-identity. Management choices on the federal lands affect the lives of individuals in these communities positively and negatively, and may affect the futures of entire communities.

A commonly heard argument is that Congress and the federal land management agencies have made a series of explicit and implicit promises to the forest-dependent communities in the region. Terms such as "sustained yield," policy objectives such as "community stability," and revenue-sharing formulas such as the 25 percent Fund Law for Forest Service lands and the 50 percent payments from the Bureau of Land Management's Oregon and California (O&C) railroad lands can all be used to support such an argument. However, some contend that the federal agencies have not fulfilled their commitment to support the communities because the areas open for traditional use, such as timber harvest and motorized recreation, have been reduced.

No general agreement exists on what responsibility the federal land management agencies have toward forest-dependent communities. Most people appear to agree, however, that the politics that currently characterize such management are divisive. The institutions that have been trying to craft policy (agencies, courts, and Congress) have all struggled to divide the land base so that every interest gets a piece, hoping to meet everyone's needs. That distributive notion is not compatible with the holistic aspects of ecosystem management, nor has it furthered the sense of community in the region. We suggest this situation may be, at least partially, rectified through implementation and the process of adaptive management.

Ecosystems and Their Management

The forested ecosystems of the Pacific Northwest have been altered by past land management practices carried out to implement public policy. Historical and recent emphasis on commodity production has resulted in habitat fragmentation and a significant reduction in the amount of old-growth (200 years and older) forests in the region. Changing social values, coupled with a greater scientific understanding of the effects of past management practices on fish and wildlife, have resulted in much closer scrutiny of the consequences of forest management practices on public lands. This -- coupled with the listing of species such as the northern spotted owl and marbled murrelet, and petition to list Umpqua River sea-run cutthroat trout -- has resulted in much stronger environmental efforts to protect the remaining old-growth forests.

During the past 2 decades, intensive research has been conducted on old-growth ecosystems and many associated species and is continuing. Of these, the threatened northern spotted owl has received most of the attention by both researchers and the public. During this period there also has been an unfortunate and polarizing "owls versus jobs" debate. What many do not understand, however, is that there are other listed or at-risk species (e.g., marbled murrelet, fish stocks) or processes (e.g., old-growth forest ecosystem processes) about which more information would enhance our ability to address their conservation. This recognition of inadequate knowledge to make fully informed decisions extends across all renewable natural resource areas and should not be taken as a reason not to make decisions on the basis of the knowledge that does exist. This lack of information contributes to the debates among scientists and advocates on both sides of the issue regarding the degree to which logging or other forest management activities should take place on federal forest lands. This is a primary reason that the staged approach described earlier has been applied in which the first phase lays down a general strategy and the subsequent phases involve refinement based on additional study, monitoring, adaptive management, and analysis.

In contrast, in situations where loss of habitat has long been recognized, little has been done to reverse the trend. Degradation of riparian areas and declining salmon stocks are a notable case. Restoration efforts have long been ignored because of inadequate funding within the management agencies or denial that impacts were occurring. Consequently, agencies now find themselves in the midst of a biological and management crisis that needs immediate attention. In the short term, while the necessary levels of protection and restoration of these systems are identified and initiated, agencies are likely to lose a great deal of management flexibility on federal forests.

If an approach to forest management that recognizes conservation needs is adopted on federal lands, most of our biological options for management can be retained for the future. To accomplish this, however, agencies will need to develop and implement interdisciplinary efforts that address the diverse array of conservation and management issues that occur at the watershed, province, and regional scales. To achieve the vision of ecosystem management we must plan, achieve, and maintain not only the ecological objectives identified for those systems, but fully integrate the socio-economic aspects as well. Humans are a functional and integral part of managed ecosystems and successful federal land management requires the human dimension to be fully integrated into the process.

Federal and state agencies (Salwasser 1990; Overbay 1992) and scientists (Franklin 1989; National Research Council 1990; Lubchenco et al. 1991; Stankey and Clark 1992; Society of American Foresters 1993) are in the midst of formulating and implementing ecosystem management concepts. As a concept, ecosystem management focuses land management on the well-being of ecosystems, examines ecosystems at multiple spatial scales and ownerships, addresses resource including socio-economic issues at the appropriate scale, encompasses conservation and restoration activities, and accepts that commodity outputs are inextricably linked to the health of the ecosystem. This approach focuses on entire biophysical systems (including landscapes and regions) and attempts to maintain natural ecological processes and functions. A system of reserves may be an integral part of ecosystem management, depending on objectives. In other areas, active management (e.g., silvicultural practices, ecosystem restoration programs) to achieve different objectives is also a part of this strategy.

Unfortunately, there is a long way to go before ecosystem management is in practice. Traditional research and management of wildlife populations, for example, have been species-specific and limited to a narrow range of the biological diversity found in our forested ecosystems. Ecosystem research and landscape ecology are similarly in an early stage of development. The information generated by scientists and applied by managers has been aimed more at the stand management level or at the level of habitat relationships of individual species. As we move into ecosystem management, research needs to be reoriented into a broader community view and at a broader landscape scale.

While we strive to develop a comprehensive ecosystem management perspective, we also need to recognize that this approach may create conflicts with the management of particular species or with other resource management objectives, and may affect or involve private lands. For example, some uncertainty regarding the viability of certain components of old-growth ecosystems stems partly from an incomplete understanding of the species and processes that occur there. A consistent information and an aggressive adaptive management philosophy can help reduce this uncertainty. Implementation of ecosystem-based management is not a short-term process with a fixed goal, but rather a dynamic process that requires continuing evolution, commitment, and involvement.

Institutions

From the 1950's through the early 1990's, management of public lands focused increasingly on outputs (e.g., board feet, visitor days) with environmental considerations treated as constraints. Environmental directives came from Congress through laws such as the Federal Land Planning and Management Act and National Forest Management Act, while commodity output levels (i.e., allowable sale quantity of timber) was set through the annual appropriations process (fig. VIII-1). Our current management gridlock reflects in part the federal judicial branch's determination that the agencies had not satisfactorily complied with environmental laws -- most specifically the procedural requirements of such laws as the Endangered Species Act and the National Forest Management Act. This gridlock plus a greater scientific understanding of the impacts of past management practices led the Forest Service and Bureau of Land Management to move toward ecosystem management as a guiding principle.

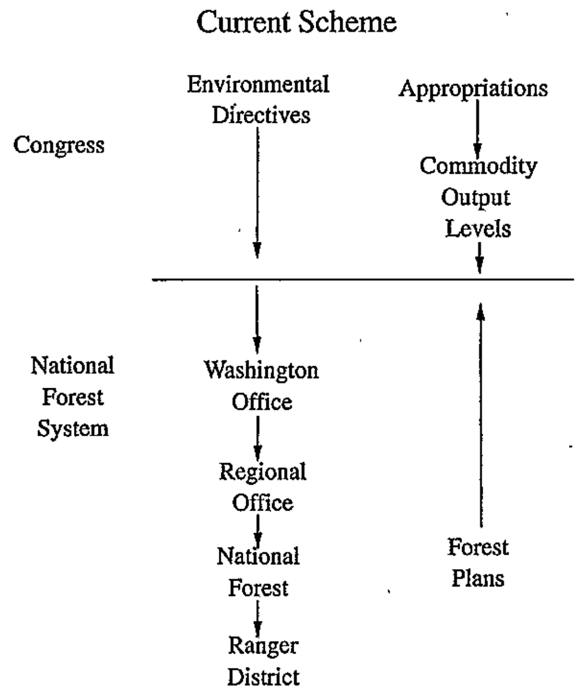

Figure VIII-1. System used for defining environmental directives and timber output levels (targets) that evolved in the 1970-1980's.

Land management in the Pacific Northwest is in a period of profound change, including development of ecosystem management, regional conservation strategies, and silvicultural practices. Regional conservation strategies, such as those being proposed in this effort, can have major influence on the management of watersheds and forest stands (fig. VIII-2) by determining management objectives and land allocations (e.g., reserves for old-growth species), management of lands outside reserves (e.g., riparian buffers), and analysis procedures (e.g., watershed analysis). Landscape and watershed approaches to ecosystem management have involved development of ecosystem-based riparian management systems and watershed analysis (see "Ecosystem Management" section of this chapter) to identify critical processes, sites of potential management impact, and restoration opportunities. In planning, forest/district and project scales of analysis and decisionmaking must shift to a more biologically significant regional and watershed scale.

A major aspect of this change is the shifting perspective on allowable sale quantity, the estimated level of timber sales from federal lands. Allowable sale quantity has been a major currency of forest management policy (fig. VIII-1), a basis for evaluation of accomplishments of management units and individuals, and a focal point of distrust between land management agencies and the public, and between biologists and managers within land management agencies. Allowable sale quantity may be an outdated concept; it runs counter to the goals of ecosystem management and it will be a shifting target under the incremental planning context of adaptive management described in this chapter.

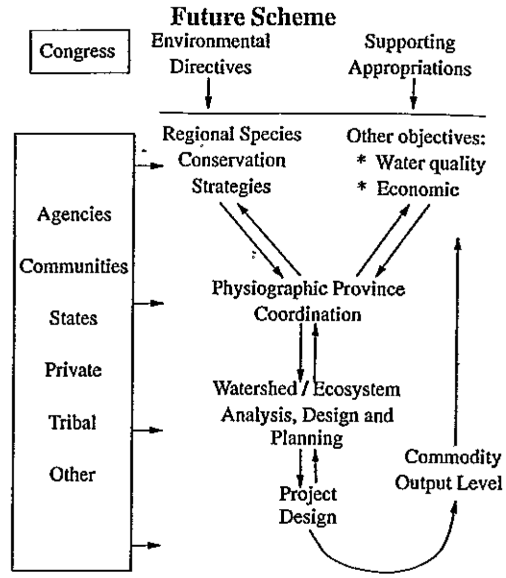

Figure VIII-2. Schematic diagram of potential future relations among environmental directives and appropriations, implementation of conservation strategies at different scales, and project planning. In this scheme, commodity output is shown as a result of the process rather than a driving force.

With the increased emphasis on conserving biological diversity and ecological function within old-growth forest ecosystems, land management and regulatory agencies struggle to redefine their role as stewards of public lands. Federal leadership appears ready for a change. Fundamental change, however, will not be easy. Strong leadership will be needed at all levels of government and in the public to successfully implement whatever forest management program is developed.

Historically, the land management and regulatory agencies have not worked together effectively, mainly because they lack shared missions and objectives. They have worked independently, with limited collaboration or coordination. Where coordination has been attempted, data sharing and communication are difficult because of differences in terminology, data bases, and their interpretation. Agency planning efforts have often not been ecologically based or developed across the appropriate spatial scales or agency boundaries. Administrative, programmatic, and budgetary structures within the agencies have also impeded attempts to take interdisciplinary approaches.

On top of these problems, lawsuits and confrontations between land management and regulatory agencies have created an environment hostile to proactive change or collaboration. Within agencies, some researchers suspect that land managers do not support their efforts and circumvent recommendations regarding threatened, endangered, and at-risk species or ecosystem protection. Conversely, some land managers believe research scientists have usurped their management decision role by narrowly focusing scientific interests so as to severely restrict management options.

Altogether, the result is delay, miscommunication, and conflict both within and between agencies, and between agencies and the public. A concerned public ends up confused and mistrusting, believing that the agencies are out of touch with contemporary societal values. To successfully break this gridlock and develop a more trustful environment for all parties, the agencies must establish a common vision and shared missions for managing public lands in the Pacific Northwest. This must be based on extensive interagency coordination and an interdisciplinary approach as we move toward ecosystem management.

Policies

The United States has some of the most comprehensive environmental legislation in the world. But comprehensive environmental protection requires a great deal of political commitment and a strong scientific basis. The Endangered Species Act, for example, calls not only for the protection of threatened and endangered species but also the habitats upon which they depend. The National Forest Management Act and the Federal Land Planning and Management Act call for an interdisciplinary, integrated approach to physical, biological, economic, and other sciences. But the policies directing federal land management in the Pacific Northwest have not provided for the diversity of values identified in these acts and have instead focused principally on commodity outputs. This has resulted in federal regulatory agencies, such as the Fish and Wildlife Service, and public conservation groups challenging Pacific Northwest land management agencies both through administrative processes and in the courts, many of which have been successful.

Such challenges shift the attention from the larger old-growth forest ecosystem issue to the legal issues surrounding the protection of selected species such as the northern spotted owl. The conservation and management of old-growth ecosystems is a far more complex issue than the single species (owls versus jobs) debate and subsumes many other issues that have since emerged (e.g., marbled murrelets, declining salmon stocks, and degraded riparian areas). Federal agencies must refocus their attention back to the broader level of the ecosystem, while at the same time recognizing that these lands serve important social functions.

This refocusing of attention requires society and the federal agencies to seek a shared vision, common policies, and collaborative management. Where agency policies and regulations are inconsistent with this new vision, they should be changed. It is not possible for the Bureau of Land Management and the Forest Service to maintain the high timber harvest levels established for them in the past and simultaneously protect fish and wildlife species, and the ecosystems upon which they depend. In addition, the regulatory agencies must become more involved in the planning process to effectively help land managers meet new objectives.

Vision For Managing Ecosystems

To chart a useful path out of the present gridlock it is essential to look ahead to where we believe people, institutions, ecosystems, natural resource management, and policy should be in future decades, a step that is critical to the successful implementation of the process described in this chapter. A vision of future ecosystems is implicit in the conservation strategies described in this document and that vision varies dramatically between the options presented. A vision of the future under the options selected should be developed. Such a vision of the future condition of the federal forests should then guide managers as they move toward that goal.

The options described in this report focus largely on critical conservation strategies for selected species of fish and birds and for late successional/old-growth forests. But the overall management of ecosystems involves issues broader than these conservation strategies--namely, the social context. A sound conservation strategy has little prospect of success in saving threatened species and breaking a gridlock in a social context of conflicting values and distrust. Therefore, this discussion begins with an implementation strategy for future ecosystem management with a focus on the human dimension.

The Human Dimension

The relationship between people and environment is the focus of several academic disciplines, and there is no way to capture completely the richness of their findings in this chapter; we recommend the Social Assessment of the Options chapter of this report for additional discussion. Although the purposes of the federal land management agencies are to carry out their statutory responsibilities, the agencies are important links between the general population and the federal lands. The agencies should be able to help society understand the federal lands and the choices for managing them.

A major challenge facing the agencies is the continual refinement of their relationship with citizens. The agencies must balance two competing tenets of faith that are fundamental to the American psyche: (1) the belief that citizens should have a voice in the public decisions that affect them and (2) the belief that problems have rational or technical answers. How can we craft natural resource policy using the best science, which by definition becomes increasingly complex over time and is understood by a fairly select group of scientists, while at the same time involve the broadest segment of the citizenry in the process? How can society balance the politics of expertise with the politics of inclusion? Pierce et al. (1992) stated that this balance has become more precarious in recent years and referred to it as the "technical information quandary." They argued that "forceful and persisting public demands for participation and a growing complexity of public policy issues are fundamental aspects of post industrial societies."

Considerable evidence shows that the techniques used by the federal agencies to involve their publics have not succeeded in a meaningful manner (USDA Forest Service 1990, U.S. Congress Office of Technology Assessment 1992). The public/agencies relationship is unlikely to improve if people only are at the periphery of an ecosystem management model that is crafted by experts in isolation. The Forest Conference offered the people of the region a voice, a chance to state their cases forcefully and honestly, and thus become part of the policy-making process, not merely constraints upon it.

In the future, forest management must require agencies and the public to work together. We know that we are unlikely to come to perfect agreement about these lands -- they are too valuable, the issues are too complex, our interests are too varied, the biological knowledge too imperfect, and our value differences too apparent. However, if we cannot learn to manage adaptively, gridlock and paralysis will continue and both the biological and social dimensions of the federal lands will suffer.

New forums such as the Forest Conference will need to emerge as social values are more meaningfully incorporated into federal land management. Stankey and Clark (1992) reviewed the Forest Service's New Perspectives program and found that "there is a lack of non-threatening environments in which debate and discussion of critical issues facing resource managers, citizens, and others can occur." A number of techniques can promote meaningful discussion, such as transactive planning (see Carroll and Hendrix 1992). It is not important that any particular technique be used, but that the process be inclusive, flexible, and stress learning as opposed to just fact finding.

Results of inventories of natural resource collaborations offer some insight. Bingham (1986) identified over 200 cases on natural resource/environmental negotiation, primarily in the Northeast. Daniels et al. (1993) identified 56 instances of collaborations regarding natural resources in the Northwest since 1990. Johnson (1993) synthesized a series of nine case studies into an explanation of how to move natural resource policy in the Pacific Northwest beyond polarization. These inventories indicate a tremendous interest in collaborative rather than agency-centric approaches to public resource management. This interest may have arisen from the recognition that ecosystem management must cross land-ownership boundaries and that the more traditional venues for decision making appear to be at impasse. This collaborative approach is critical to the success of the adaptive management strategy envisioned here.

We must recognize that collaborations, while an important source of goals and innovation for federal lands, cannot foreseeably replace the land management agencies. Well-organized, adequately funded agencies are society's major tool for achieving its goals on federal lands, for monitoring the impacts of management, and for leading the discussion of what our options are for public lands. The federal agencies have been entrusted with decision authority through Congressional action; they must be given the wherewithal and freedom to make those decisions.

Desired Ecosystem Conditions

The actual future of the Pacific Northwest landscape is impossible to predict--it will be the product of social, political, and ecosystem understanding and adaptive management procedures. However, given the current charge of moving to ecosystem management in the context of present law, the desired future condition of federal forest and riverine ecosystems of the Pacific Northwest should incorporate levels of biotic diversity, ecological processes and functions, including habitats, that sustain viable populations of native species as well as the productive capacity of the ecosystems. These visualized conditions are explicit in laws directing federal land managers and implicit in the standards and guidelines of the options described in this document. To attain these goals, the landscapes must retain their inherent dynamic nature, including resistance and resilience to disturbance by wildfire, flood, insect attack, climate change, and other internal and external agents of change; maintain their productive capacity; contain a distribution of forest age and structural classes and stream environments that provide habitat for a full range of native plant and animal species; and be managed in an environment of interagency and public trust and socio-economic well-being. A particularly challenging aspect of long-term management of ecosystems and biological diversity, given present law, is recognition that natural processes of evolution lead to gain and loss of species.

One vision for the future of federal forests is that significant portions of the landscape be in old forests (e.g., older than 80 years). Areas of old forest should be well distributed geographically, considering both north-south and elevation gradients to accommodate the types and richness of biotic diversity. Some of these old forest areas could be in reserves, areas of long-rotation cuttings, or areas of perpetual uneven-aged management.

Reaching this condition requires a path that accommodates changing society, shifting societal values and expectations, and growing understanding of ecosystems. This path will likely include ecosystem reserves (places to learn about natural systems and to preserve management options in the face of limited knowledge) and explicit learning processes (research, monitoring, watershed analysis and ecosystem planning procedures, and adaptive management programs). Ecosystems do not stop at artificial borders. All lands, public and private, are important to supporting and maintaining healthy, functioning ecosystems. This requires close collaboration among federal agencies, nonfederal landowners, and the public. Conservation strategies and adaptive management could result in quite different future landscapes. The adaptive management process is intended to help us move in the appropriate direction.

Ecosystem Management

We recognize that ecosystem management as a term and as an agency or interagency agenda may be ephemeral, as similar terms and management initiatives have been in the past. The underpinnings (e.g., empirical knowledge, ecological theory, social expectation, funding, law, available tools, etc.) of natural resource management are in rapid flux and deal with imprecise concepts, such as ecosystem management and sustainable development. Ecosystem management as a guiding principle, focuses attention on ecosystem well-being in senses consistent with Congressional expressions of social values. Furthermore, the concept directs the attention of land managers and others to understanding ecosystems and developing appropriate site-specific management. A potential downfall of ecosystem management as a directive is that it could downplay the significance of people in setting management objectives and procedures, and that it could become viewed as a fixed set of practices or objectives that cease to evolve with new information. To avoid this, agencies must function in an open, learning mode; ecosystem management is useful to the extent that it fosters a learning attitude within agencies. It is in this spirit that we use the term in this chapter.

Conservation strategies, a component of ecosystem management, will have a profound effect on near-term management of the Pacific Northwest public forest lands. The conservation strategies addressed by the Scientific Assessment Team (Thomas et al. 1993), and by many of the options evaluated in this document, involve layering relatively independent management schemes to accommodate northern spotted owls, old-growth ecosystems, marbled murrelets, and selected fish stocks (fig. VIII-3). The next step is to assign multiple roles to individual land allocations in an overall conservation strategy. This process would evaluate questions such as the extent to which Key Watersheds for fisheries protection can also provide habitat for owls and murrelets. This step leads to development of a single conservation strategy with multiple phases to accommodate the various species and ecosystems (e.g., riparian and old-growth) of interest. The improved integration across objectives gives a better balance between ecological and economic objectives. One option (Option 9) is an initial attempt at describing this type of approach (see chapter "Option Development and Description").

A multiphase conservation strategy ultimately could give way to more ecosystem-oriented management (fig. VIII-3). Conservation strategies emphasize single species and maximum care of the best remaining habitat. Ecosystem management, on the other hand, works with present conditions and an understanding of natural ecosystem patterns and disturbance regimes to direct ecosystems to a potentially different future. Getting away from single-species management will require substantial restoration and adaptive management actions. These activities will accelerate the transition from conservation to ecosystem management.

An important element of managing the future landscape of the Pacific Northwest will be an integrated understanding of ecosystems across ownerships--federal, state, and private. Streamflow and species of fish, wildlife, and other organisms know no interjurisdictional or ownership boundaries. Consequently, increased ecological knowledge, concern with environmental protection, and an ecosystem approach to management will foster interownership cooperation and ultimately will lend improved efficiency in balancing ecological and economic objectives. The Clean Water Act, for example, makes state agencies responsible for a broad range of programs to protect water quality. These programs apply to waters that cross ownership boundaries within a watershed.

New technologies also foster interownership cooperation. Satellite remote sensing lets us observe spatial patterns and time trends of forest cutting and regrowth (fig. VIII-4). Other technologies, such as landscape visualization and decision support systems, will permit public examination of past and potential management and its consequences on a mix of ownerships. All this links society, policy, land management, and science.

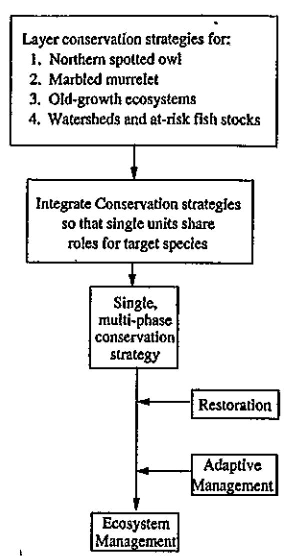

Figure VIII-3. Conceptual diagram of the transition from our current "layering" approach using largely species-specific conservation strategies, through a single, multiphase strategy to an ecosystem-based, rather than species-based system of management.

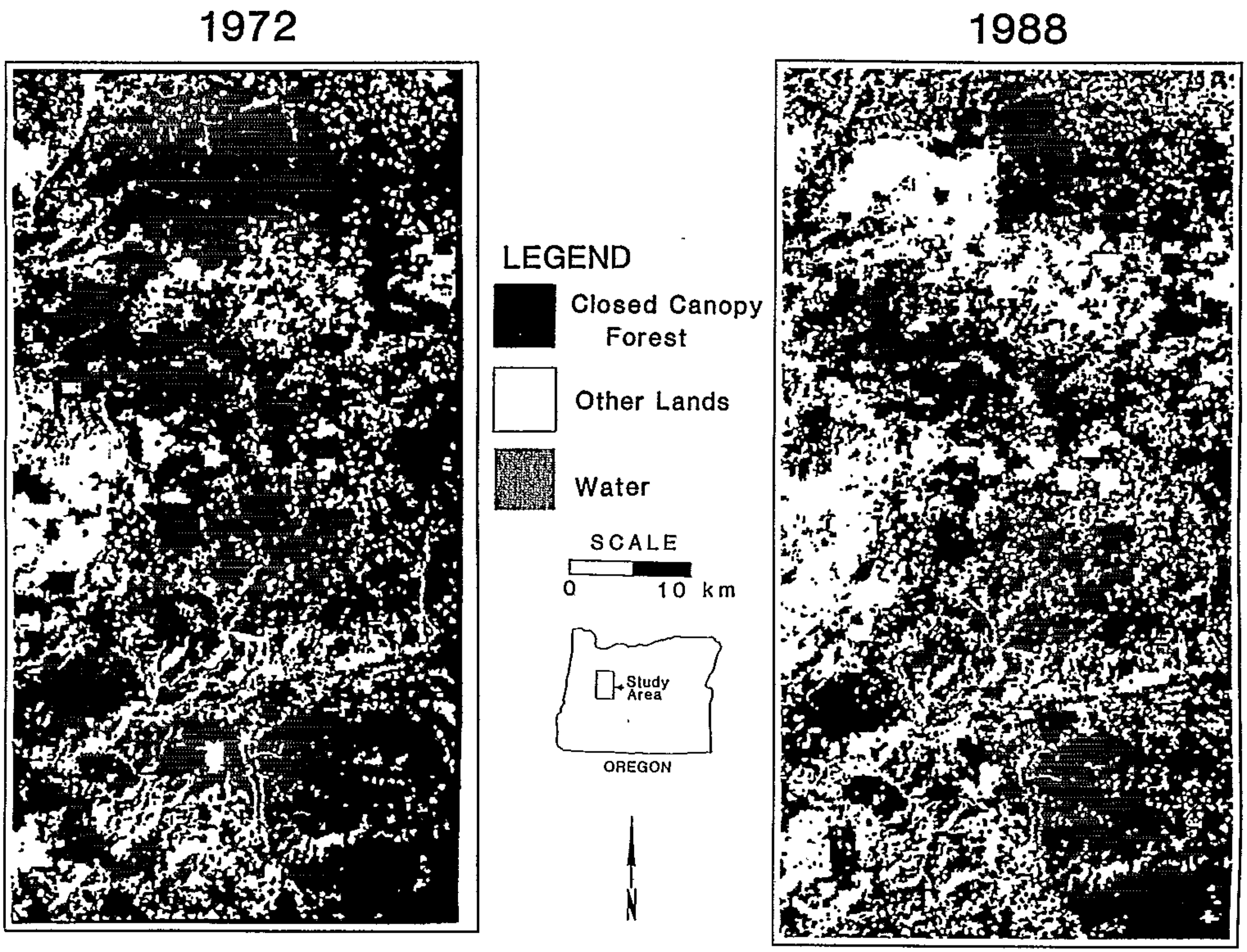

Figure VIII-4. Map of closed canopy (natural and managed stands generally older than 30-40 years) and other lands (clearcut, younger plantations, rock outcrops, etc.) in the central Cascades of Oregon. Willamette National Forest covers roughly the central and eastern thirds of the area. Wilderness areas are evident in the 1988 image in the southeastern corner (Three Sisters) and top center (Middle Santiam). Other extensive patches of closed canopy forest include another wilderness area (Menagerie), H. J. Andrews Experimental Forest, and Hagen Research Natural Area in the central 50 percent of the map. Private industrial lands are located predominately in the western half of the image. (Image prepared by F. Bradshaw and W. Ripple).

Watersheds as Basis for Management

Implementation of effective ecosystem management will require ecosystem planning as a multiscale, hierarchical process designed to deal with multiple values, scales, and disciplines (table VIII-1). Central to this process is the concept that watersheds represent a physically and ecologically relevant and socially acceptable scale for managing forest resources. Watersheds are an appropriate spatial unit for implementing ecosystem management because they link regional conservation strategies for terrestrial and riparian species, provincial and landscape objectives, with project implementation.

Many key physical processes are best understood at a watershed basis (i.e., movement of water, sediment, wood, and consequent effects on channel structure and habitat), and understanding these linkages is essential for understanding onsite and offsite effects of human activities. Recognizing watersheds is essential to achieving objectives for organisms whose habitat needs cross ownership boundaries (e.g., marbled murrelets) or that use different habitats over their life cycle (e.g., fish). Incorporating watersheds into conservation planning for species that are not watershed-based allows coordination and flexibility in developing management options that influence all species, and may offer opportunities for creative solutions that meet multiple objectives.

Finally, watersheds provide a rational and effective spatial scale for citizens to participate in natural resource decision making. Watersheds represent a natural demarcation of geography that encompasses a wide diversity of ownerships, issues, and viewpoints. Many of the best examples of community-based resource planning -- the Applegate Project in southern Oregon and the Mattole and Redwood Community Watershed Associations in northern California -- are organized on a watershed basis.

Spatial Scales

Ecosystem planning needs to be conducted at four spatial scales: regional, province/river-basin, watershed, and site (table VIII-1). It should be understood that management activities continue under plans in force while new planning takes place. The *region*, for the purposes of this report, is the Pacific Northwest, encompassing the range of the northern spotted owl. *Provinces* are areas of common geology, climate, and physiography in which technical information from one area can be widely extrapolated. Their scale is comparable to that of major *river basins*, such as the Klamath, Umpqua, or Willamette, or groups of small coastal watersheds with similar beneficial-use and resource-value issues. Provinces may overlap several river basins, and river basins may contain parts of several physiographic provinces. *Watersheds* are sub-basins of 10-200 square miles and are the scale at which watershed analyses are conducted. *Sites* are areas of variable size but typically range from tens to hundreds of acres, where specific activities take place, including timber harvest, habitat restoration, silvicultural treatments, and road construction.

At each scale, analyses describe human needs, environmental values, and important watershed and ecosystem functions. Information collected at the broader spatial scales (regional and provincial) guides analysis and development of management options at the finer scales (watershed and site). Conversely, information collected at the finer scales provides feedback on cumulative effects at the larger scales.

Table \ ıI-1. Issues to be addressed at different scales in ecosystem planning.

Scale:	Approximate Size (sq mi):	Examples:	Issues Addressed:
Regional	10,000- 20,000	Westside forests, owl region	* Regional conservation strateby for species and ecosystems; * Standards and Guidlines for managed lands: * Public participation in shaping regional strategies: * Regional restoration strategies: * Water Quality Objectives
Province/River Basin	1,000- 10,000	Oregon Coast Range, western Cascades, Klamath River Basin	Beneficial uses; * Large-scale water development (i.e. hydroelectric, irrigation); * Dominant physical processes (i.e., mass-movement types, hydrologic regimes); * Dominant vegetation patterns and distrubance processes (i.e., fire, insects); * Historical land-use patterns; * Distribution of at-risk/T&E species; * Refinement of Standards and Guidelines *Public participation in shaping strategy.
Watershed	10-100	Augusta Creek (Willamette NF) Elk River (Siskiyou NF)	* Landscape-specific physical and biological proceesses; * Merging management objectives for upland and riparian; * Incorporating public expectations for wato management options; * Designing monitoring and restoration strategies.
Site	0.01- 0.1	Individual timber sales; restoration projects	* Implementing management options; * Implementing monitoring.

Regional Scale

Information from the regional scale (table VIII-1) identifies important beneficial uses, resource values, and economic issues and is used to evaluate how resources in a particular river basin or watershed influence resource values throughout the region. In many cases, regional issues transcend river-basin or watershed boundaries and may constrain management options at these scales. For example, habitat protection for threatened and endangered species may be established as a regional network, based on region-wide habitat conditions or availability of refugia. However, there often is insufficient information at this scale for it to be appropriate for project planning.

Province/River Basin Scale

At the province/river basin scale beneficial uses and ecosystem values for large river basins and physiographic provinces are analyzed, and interagency and interownership planning is coordinated. Key issues at this scale include distribution of threatened and endangered species or stocks, patterns of historic and current resource use, water quality issues, identification of communities at risk, and management of multiple reserve systems. The context of river basins with respect to other large basins and intrabasin/regional issues that cross drainage basin boundaries are identified. The distribution of key physical processes influencing species and habitats are mapped, as are the location of Key Watersheds and ecological reserves. Watersheds are prioritized for analysis, and the results of watershed analyses are synthesized to assess provincial and regional cumulative effects.

Watershed Scale

The most comprehensive and detailed analyses are conducted at the watershed scale. Watershed analysis is a process for collecting information and implementing ecosystem management at the scale of 10-200 square mile watersheds and is intended here to characterize planning for terrestrial as well as riparian species. This systematic procedure (see chapter "Aquatic Ecosystem Assessment" for details) gathers information on ecological processes to help characterize and meet specific management and social objectives. This information then guides management prescriptions, sets restoration priorities, and reveals the most useful ways to monitor environmental changes. Watershed analysis is the method by which issues and concerns developed at regional, physiographic, and large river basin scales are refined and applied to specific landscapes, and is critical to future project planning.

Watershed analysis plays several roles under the options presented in this report. It provides information to drive planning, including the identification of issues, processes, and constraints that are likely to influence land use activities. It also is required to adjust boundaries of riparian and late-successional reserves. Watershed analysis provides a functional mechanism for coordinated evaluation of fish, hydrologic, and geomorphic linkages and upland landscape patterns, wildlife habitat, and silviculture.

Watershed analysis is both an analysis procedure and the first step in watershed planning. Fully developing and implementing watershed planning as a coherent stratum of ecosystem planning will require experimentation, learning, and the perspectives of a wide circle of individuals and disciplines, including planners, resource specialists, managers, sociologists, and scientists.

Site Scale

Finally, at the site scale of 10s to 100s of acres, individual projects are planned and initiated. These may include timber sales, silvicultural treatments, restoration activities, and so on, and are designed to be compatible with information developed in the watershed-level analyses. Monitoring activities are also planned and initiated at this scale.

Adaptive Management

A formal process of adaptive management will be required to maximize the benefits of any option described in this report and to achieve the long-term objective of ecosystem management. The entire effort must be supported or driven by multivalue inventories, research and development, experience, new policy, regulations and legislation, and shifts in goals and objectives.

Adaptive management is a crucial element of any ecosystem-based strategy. It is based on a continuing process of action based on planning, monitoring, evaluation, and adjustment (fig. VIII-5). This process, if adequately designed and effectively implemented, will enable managers to determine how well their actions meet their objectives and what steps to take to modify activities to increase successes. This section includes recommendations designed to ensure effective implementation of whatever management option is selected.

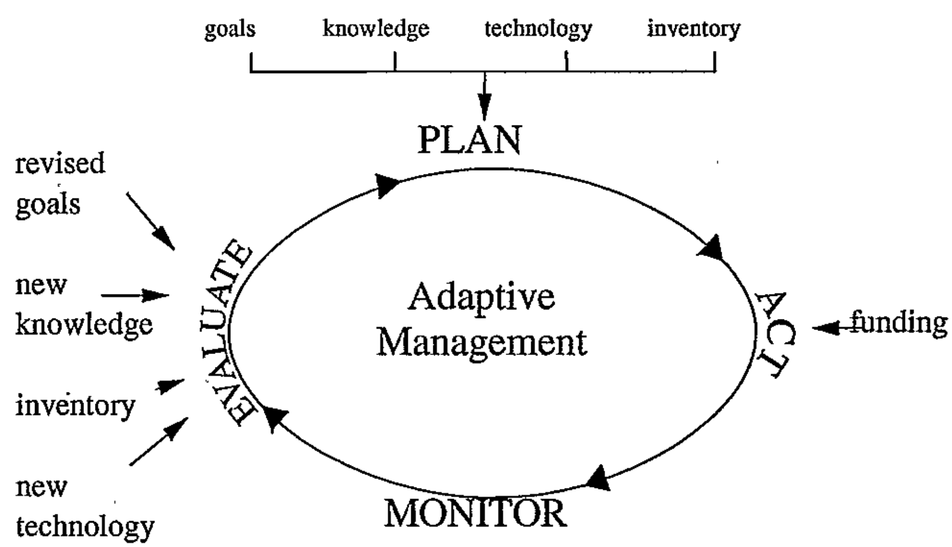

Figure VIII-5. Process of adaptive management.

Because adaptive management leads to change in direction as new information becomes available it ideally will improve or refine standards and guidelines over time. To attain those improvements and refinements, an adaptive management system might logically include:

- A legal, policy, and regulatory foundation.
- Review of the process and oversight.
- Organizational accountability.
- Specific mechanisms to ensure all components are effectively implemented.
- Effective information handling capabilities.
- Adequate funding.
- Multiagency linkages.
- Public support and participation.
- A research and monitoring program.

Examples of questions related to forest management strategies developed for the Pacific Northwest that would be addressed by adaptive management include:

- When and how would it be appropriate to alter boundaries of Late-Successional Reserves?
- When would it be appropriate to change riparian habitat management strategies?
- What management activities will be appropriate in Late-Successional Reserves?
- Are the management strategies in the Matrix meeting intended objectives?
- Are thinnings in Reserves producing anticipated results?

Recommendation: The federal resource and regulatory agencies in cooperation with public and private interests should develop an adaptive management process that includes multiagency and independent oversight and evaluation. Oversight issues might include assessment of:

- **Adequacy of incorporation of new social, biological, and physical information.**
- **Change in management direction based upon new information.**
- **Public involvement.**
- **Quality of monitoring and inventory systems.**
- **Evaluation of cumulative effects.**
- **Barriers to effective adaptive management.**
- **How well management addresses the standards and guidelines adopted with the forest management strategy selected.**

Planning

Current federal resource agencies' planning processes have not always produced legally, scientifically, or socially defensible products. Furthermore, the array of planning scales has been too limited for addressing current resource issues. A new, or greatly modified, planning process would support effective implementation of the options and objectives described in this report. Current planning processes should be evaluated for:

- Context - Is it consistent with ecosystem management?
- Scale - Is planning done at the appropriate scales? Are alternatives presented to the public at all scales?
- Action - Is provision made to ensure the plan is actually implementable on the ground?
- Nonfederal lands - Is the role of state and private lands analyzed and described?
- Public involvement - Is it adequate, meaningful, and participatory?
- Science and technology - Are there adequate mechanisms to ensure incorporation of scientifically credible information into plans? Is there an impartial review process?
- Policy and law - Are current laws and policy adequately addressed?
- Cost effectiveness - Does the budget allow for the intended outcome?.

Recommendation: The federal forest management agencies in collaboration with regulatory agencies and public and private interests should develop a planning process that addresses the contemporary requirements of ecosystem management, multiscales, public participation, current law, nonfederal land relationships, adaptive management, impartial review, and multiagency oversight.

As a first step, development of the watershed analysis process needs to occur. Watershed analysis is recommended in this report as an explicit element of forest planning for federal lands. A first tier of candidate basins will need to be selected. These basins will serve as prototypes where analysis procedures can be tested and refined, cost, personnel, and time estimates can be assessed, and institutional and other obstacles can be identified. Selection of these first sites should be based on the following criteria:

- *Physiographically representative.* Because the processes and ecological issues addressed by watershed analysis will vary across the region, several initial sites should be chosen to be representative of major physiographic provinces. Identified Adaptive Management Areas (if these are included in the selected option) might be ideal sites for such efforts. Major provinces within the owl region include:
  a. Klamath province (southern Oregon/northwestern California)
  b. Western Cascades of Washington/Oregon
  c. Coast range of Washington/Oregon
  d. Olympic mountains of Washington
  e. Eastern Cascades of Washington/Oregon.

- *Basin size.* Basins should be between 10 to 200 square miles acres.

- *Multiple ownership.* Addressing the institutional barriers posed by multiple ownerships will be a major challenge for watershed analysis. Basins initially selected for watershed analysis should include a mix of federal ownerships (Forest Service, Bureau of Land Management, and National Park Service) as well as watersheds falling under jurisdiction of federal regulatory agencies (U.S. Fish and Wildlife Service, National Marine Fisheries Service). Later efforts should include watersheds with a mix of both public (federal and state) and private lands.

- *Existing data and data-handling capabilities.* To minimize startup time, watersheds selected as prototypes should have a rich store of existing data in the form of basic geographic information system layers (typography, hydrography, soils, vegetation, land-use history, etc.) as well as up and running geographic information system capabilities locally (including hardware, software, and specialist staffing for support). Data also should include time-series aerial photographs, time series remotely sensed imagery, and stream, riparian and upland inventories (ecological unit inventories, mass movement and fire history inventories, road inventories, watershed and improvement needs inventories). Other good candidates are basins that have already been targeted for analysis through other ongoing processes or that have high quality, long-term data for other reasons (e.g., experimental forests, Research Natural Areas, former barometer watersheds, prior research involvement).

- *Critical issues.* To provide a test of the robustness of watershed analysis for dealing with complex public interest questions, selected watersheds should represent a mix of key issues: presence of at-risk or threatened and endangered species, water quality-limited streams, presence of owl or other reserves in uplands, economically valuable timber or other resources. Initially, it may be prudent to limit the number of critical issues to one or two (if possible) to focus on the process itself, but it is expected that there will be some benefits in struggling through these first prototypes.

- *Local talent.* The ultimate success or failure of watershed analysis (or any other process) rests with the people who will be carrying it out. While the first prototypes will likely have a high level of involvement of both regional specialists and researchers, selection should rest on sites having a good pool of trained and enthusiastic local talent (planners, resource specialists, accomplished leadership) -- people who know the ground and know how to get a job done efficiently and effectively.

Recommendation: The watershed analysis process described in this report should be tested, refined, and evaluated in terms of personnel required and costs incurred. Test sites should be selected immediately and studies implemented. The sites should be selected based upon the characteristics described in this report.

Monitoring

Monitoring is a key component of adaptive management and a needed activity for ecosystem management, implementation of conservation strategies, and compliance with forest management laws and policy. Monitoring is significant because of the uncertainty of our predictions. Though currently required, this activity, up to the present, has not been well-designed, effectively implemented, or adequately funded.

Adaptive management will be successful only to the degree that it is based upon accurate and credible monitoring. Because adaptive management is based on the ability to monitor and to make modifications, the lack of monitoring sufficiently sensitive to detect changes of ecological importance will result in the failure of adaptive management. Monitoring should occur at the relevant resource scales -- the region, the basin, the watershed, and the site (project) -- and thus be sensitive to responses of ecological systems to individual and cumulative management actions. The system should provide an acceptable basis for natural resource policy decisions. Monitoring can be costly, so the system should be designed to serve particular policy and management needs. Additionally, monitoring should strive for collective efficiency so that data from individual projects can be integrated into a common regional data base for use beyond the original site.

A monitoring program for Pacific Northwest forests will be expensive; however, it should become a major agency activity in the future. Characteristics of an effective monitoring system include that it:

- Be objective driven, not just a list of things to measure.
- Be multiscale.
- Be scientifically designed and defensible.
- Address regional as well as local questions.
- Include independent oversight of design, quality control, and modification.

Recommendation: The federal agencies through the interagency coordination effort, should develop a multiorganizational resource monitoring system. Standards and guidelines that address design and quality control should be included. The agencies should strive to ensure monitoring activities are adequately funded and that organizational roles and responsibilities are clearly identified.

Evaluation and Adjustment

Managers often have believed they understand the full implications of current practices. They assumed implicitly that few surprises would follow -- such as endangered species listings, water quality impairments, regeneration failures, declining yields after repeated harvest, increased insect outbreaks, and increased potential for catastrophic fires. But events in the region, and elsewhere, have taught society that the full ramifications of any management strategy can never be known. Thus, managers of public lands have no choice other than to try to learn from each management decision through a process of evaluation of the results. The fastest way to learn is, philosophically, to consider all management as an experiment, remembering that much of extant knowledge comes from just such an approach.

Managing as an experiment or managing "to learn" entails implementing an array of practices, then taking a scientific approach in describing anticipated outcomes of those practices and comparing them to actual monitored outcomes. These comparisons are part of the foundation of knowledge on ecosystems on which ecosystem management might be more soundly based and in a more rapid manner than waiting for formal research results.

Managing to learn also includes society by identifying a range of treatments, and practices based upon the needs of individual communities of interest. Treatments would be distributed across the landscape, perhaps with the cooperation of adjacent landowners. This strategy allows different communities to participate and to evaluate the effectiveness of that participation. Such a strategy is included in the "adaptive management" area concept described with Option 9 (see chapter "Option Development and Description").

We must be sure "managing to learn" is not used as a license to implement a socially unacceptable agenda under the guise of "research." Thus, agencies should share decisions with the public, managers, and scientists. Scientific oversight also is required. Specific plans need to be developed that describe actions that meet species needs and are compatible with applicable laws and policies.

Managing to learn is an important extension of the concept of adaptive management. It increases societal participation and the role of science, and it diversifies management practices, so that at least some of the alternatives produce desired results, rather than putting all of the ecosystem eggs in one basket. Scientists, independent from management institutions, would help evaluate the effects of the different treatments from a scientific perspective. Experiments would be simultaneously evaluated by managers and members of society as well. Together, these groups would gain the information needed to design the next experiment and to ensure that the information gained would be shared with managers of nonexperimental landscapes. Managers, for their part, must take the evaluation process seriously because it will probably lead to changes in the way they do business -- the whole point of adaptive management.

Recommendation: Federal land management agencies should consider "managing as an experiment" or "managing to learn" an integral part of the adaptive management concept.

Research

Recent evaluations of the use, management, and conservation of Pacific Northwest forests has identified the need for advanced knowledge and understanding of forest resources. The research organizations (federal, state, and university) in the Northwest are inadequately funded to provide the science required to effectively address many of the emerging issues. Many sections of this report refer to the need for enhanced scientific knowledge. Some examples:

- Habitat requirements of many plant, animal, and fish species so that viability ratings may be improved and management programs may be designed to ensure adequate habitat while producing multiple forest values.
- Design of management strategies that will accelerate the production of "suitable" habitat.
- Design of riparian management systems and evaluations of the biological and economic benefits of fisheries restoration projects.
- Long-term ecosystem productivity impacts from forest management strategies.
- Assessment of the expectations society has for forest lands and the associated political, legal, and public relations problems.
- Economic values of ecosystem components, systems, and processes in light of contemporary planning and assessment requirements.
- Design of cost effective multivalue resource inventory and monitoring systems.

- Predictions of the future yield of forest commodities under proposed alternatives to current timber management practices.
- Addressing many resource issues at the landscape scale and larger.

Research is needed to develop analytical tools for ecosystem management. These tools include:

- Risk assessment methodologies to address such issues as causes of population decline and options for protection and restoration of wild salmon stocks in the Columbia River basin.
- Decision support systems and analysis methods for setting priorities, assessing risks, and defining management options at the watershed or larger scale from both a socio-economic and biophysical standpoint.
- Evaluation of existing integrated monitoring of ecological condition and trends that will answer regional assessment questions.
- Design of regional inventory, monitoring and evaluation data bases to support adaptive management.
- Development of risk assessment and restoration strategies specific to riparian areas.
- Design and testing of remote sensing systems to inventory and monitor at the landscape scale.

Research may be able to expand the resource productivity options within Pacific Northwest forests. Such options include:

- Innovative forest management within riparian areas consistent with fisheries protection requirements.
- Enhanced timber production on those public and private lands available and suited for this use.
- Production of "nontraditional" alternative forest products, including harvesting methods, management strategies, marketing assistance, and evaluation.

Recommendation: The federal agencies in collaboration with public and private interests through the interagency coordination effort, should develop a research plan for the Pacific Northwest. The plan should:

- **Describe research needs specific to the strategy selected for Pacific Northwest forests.**
- **Describe information and understanding needed to implement ecosystem management over the long term.**
- **Tabulate and evaluate current research capabilities in the public and private sectors.**
- **Identify research needed along three major thrusts, displaying the several levels of investment and the programs supported by each level, and including specific multiorganizational planning and management mechanisms:**

  1. **Understanding ecosystems - Research on ecosystem processes, habitat requirements, diversity, forest health**

relationships, aquatic systems, fishery dynamics, and atmospheric linkages.

2. **Human dimension in natural resources - Research or determine societal resource needs and expectations, mechanism for effective participation in resource planning and management, economic analysis techniques, and information systems.**
3. **Alternative management strategies - Research on stand, watershed, landscape and regional management systems to produce specific or multiple resource products and values. Determine resource productivity and capability under alternative management systems. Monitoring and inventory systems and methods. Restoration systems for forest, riparian and aquatic components of the ecosystem evaluation process. Decision support systems that integrate biological, social, economic, and legal considerations.**

Many of the current problems resulted because agencies did not incorporate available scientific information into plans and management activities, or they rejected scientific information for political and other reasons, real or imagined. There is little point in supporting the development of additional scientific information if it is not included in policy formulation, planning, decisionmaking, and actions.

Recommendation: Agencies should develop mechanisms to ensure that new information is incorporated into the planning and regulatory processes and the adaptive management system and that managers and staff are held accountable for incorporating this information. The Adaptive Management Area concept may be useful in furthering the development of these mechanisms.

Several large areas of forest in the Pacific Northwest have been set aside specifically for research. These include the Wind River Experimental Forest in Washington and the H.J. Andrews Experimental Forest in Oregon. Pacific Northwest universities also own and manage experimental forests. Because most of these forests are on public land, they could experience severe limitations on their use under the options in this report. For example, several large-scale field experiments designed to improve our knowledge about societal values, ecosystem processes, long-term ecosystem productivity, silvicultural alternatives, fisheries management, landscape level planning, economic evaluation, and development of habitat for threatened and endangered species have been stymied by restrictions on land use and forest management. Several research and development partnerships, addressing these issues in integrated programs, have formed within the past 2 years to address the emerging issues of the Pacific Northwest. Notable examples include the Olympic Natural Resource Center in Washington and the Cascade Center for Ecosystem Management in Oregon.

Recommendation: The Administration should explore ways to allow research to continue on National Forest or Bureau of Land Management lands where restrictions now exist or will develop from implementation of an option from this report. Research projects specifically designed to test or improve the strategy should be given special consideration.

Landscape-scale experiments are needed in the Pacific Northwest to address the many remaining biological and sociological questions. Concerns were identified as high priority, including the effects of forest fragmentation, habitat management for wide-ranging species, cumulative effects, and alternative silviculture systems within a landscape context. The social context of these concerns and the role of local communities in forest planning and management are also important. An opportunity exists for large-scale experiments to be carried out in conjunction with some of the previously mentioned recommendations, such as under the managing to learn concept, in partnerships through the adaptive management process, or in association with federal research projects noted above.

Recommendation: The federal agencies in collaboration with state and private interests should encourage the design and implementation of landscape-scale research and demonstration projects that include federal, state, and private forest land and addresses citizen roles in planning, management, and monitoring. The role of local communities in adaptive management should also be considered. These programs are to be scientifically designed to test alternative mechanisms of citizen participation and various levels of local community control of plans and activities. Adaptive Management Areas are a prime candidate for location of such efforts.

Information Resources

Although ecosystem management as a concept has a variety of definitions, a key element common to management and research is the need for consistent, accurate, and current information about basic physical and biological resources and their distribution across the landscape. Adaptive management demands that such information not only be available, but that linkages between scales of resolution be firmly established. The assembly and use of disparate data from different sources in analyzing alternative ecosystem management scenarios can be problematic.

Watershed analysis as defined in this report establishes a multiscale, hierarchical process (see appendix VIII-A). To be successful, that analysis requires information collection, storage, and use, i.e., building an information base that will serve ecosystem management at multiple scales. This information base is the common link between adaptive management processes, implementation steps, and research.

Current direction to federal agencies engaged in the collection of spatial data comes from the revised Office of Management and Budget Circular A-16. It established the Federal Geographic Data Committee, which assigned lead agencies for the development of standards relating to cartographic, bathymetric, cadastral, cultural, geodetic, geologic, transportation, soils, vegetation, and wetlands information. While many of these standards are not yet far enough along to benefit this issue, they do establish responsibilities and provide a framework from which agencies are to work. This presents an opportunity for federal agencies to work cooperatively in establishing consistent information on ecosystems of the Pacific Northwest and their management.

Although cooperative efforts are largely lacking, several federal and state agencies have developed significant data bases. Most of the existing data were not collected, analyzed, or tabulated in a consistent manner and are difficult to compare. A serious need is for standardization of data collection and maintenance.

As all forest resources become limited and their use more intensely debated, it is important that a more accurate accounting of the amount, condition, and trends become available. A multiorganizational, multivalue inventory system is indicated to facilitate effective implementation, appropriate modification, and meaningful evaluation of management and protection strategies in Pacific Northwest forests. The current fragmented inventories do not meet this need. Many resource components are not currently inventoried so populations are estimates from research studies, special surveys, and "modelled" projections. Even the more traditional commodity-based inventories such as timber volume are not standardized across ownerships and are not reliably aggregative at the various scales conducive to decisionmaking.

To implement the several interagency recommendations in this report, a multivalue inventory should be accessible to all interested parties. This could be facilitated by common protocols, database management, quality control, and a centralized delivery mechanism. Characteristics of a multiorganization, multivalue inventory system:

- Boundary neutral - should cross administrative and ownership boundaries.
- Multiscale outputs - should be useful at all scales.
- Dynamic - should include trends.
- Social, economic, biological, and physical components.
- Geographic information systems and remote sensing capability.
- Quality control standards and processes.
- Cost efficient.

The information resources assembled for this report came from many sources and covered the entire range of scale, quality, accuracy, detail, and standardization. A tremendous effort was made to assemble these data into a common format for analyses. This required several thousand worker-hours that would not have been necessary had information standards and methodologies been in place across agencies and within agency administrative designations. The databases created here are primarily contained in a geographic information system and represent the most comprehensive effort ever put forth to assemble natural resource and social information in this region.

These databases also were unique in that they were developed by an interagency geographic information systems working group assembled within the Forest Ecosystem Management Assessment Team and included data from the Forest Service, Bureau of Land Management, National Park Service, Fish and Wildlife Service, Environmental Protection Agency, Geological Survey, various agencies in Washington, Oregon, and California, and interest groups. Additional data required for this effort were digitized and entered into the database. The interagency cooperation was mutually beneficial and efficient.

A recurrent theme in all of the recommendations in this report is increased interagency cooperation in data sharing. Agencies must coordinate the collection, maintenance, and use of key resource information. A major incentive for cooperation would be common information resources for regional analyses. These data should be derived from the same sources, and the focus of this information gathering must be at the finest scale, the project level. If coordinated, these data can be easily aggregated for use at increasingly broader scales of resolution. The databases created for this report, for example, are a beginning of an integrated set of such finer scale resource information. The following recommendations addresses both short-term and long-term issues related to the collection, maintenance, and use of key resource information.

Recommendation: Federal agencies in collaboration with state interests establish through the interagency coordination effort a central information and Geographical Information System resources database and clearing house to support the implementation effort. The agencies should capitalize on the information investment of this project (short term) and develop processes for long-term investment in information resources critical in ecosystem management. This effort should:

- **Maintain and update the current database.**
- **Design and test a multivalue resource inventory system for Pacific Northwest forests that is open and accessible but capable of protecting proprietary information.**
- **Design a system to gather and use information on a watershed basis.**
- **Coordinate resource information standards among agencies.**
- **Develop and provide training.**
- **Use appropriate information technologies consistent with the scales, standards, and multiagency needs.**

Implementation Strategy

The current status of the late-successional and old-growth forests and associated forest species, and the concerns of local communities and the public, requires prompt decisions about implementation of a forest ecosystem management strategy in the Northwest. From the set of options described in this report, a preferred option may be selected by the Administration as the approach for management of the late-successional and other forests. However, no set of options could be constructed to avoid or minimize every potential ecological problem or societal concern. The solution is to establish a workable process where potential problems can be identified and resolved *before* they become major conflicts. This section describes that process.

The land management and regulatory agencies, through the Agency Coordination Working Group, are currently working together to develop more specific guidance based upon the following concepts and are expected to provide more explicit direction in a separate report. Therefore, this section will only describe the general concepts of an implementation strategy.

The primary goals of an implementation strategy are:

- To provide a basis for rapidly incorporating the concepts of ecosystem management into federal agency planning processes.
- To reduce potential conflicts by shifting from an ownership boundary to a watershed scale.
- To help frame a common approach among agencies.
- To identify opportunities for improving and increasing interagency cooperation.
- To identify incentives to encourage public support and participation.
- To clarify budgetary needs.

The preferred option may be implemented through administrative processes consistent with existing law, new legislation, or a combination of both processes. If administrative processes are used, implementation will require National Environmental Policy Act documentation and must be consistent with and responsible to other applicable regulatory mechanisms, such as the Endangered Species Act, Clean Water Act, etc. These planning and regulatory processes should be closely coordinated to avoid delays in implementation.

Current planning and regulatory processes provide the basis for implementing a conservation strategy, but ecosystem planning on federal lands will drastically change the way that agencies conduct business. It will require an unprecedented level of interagency cooperation, involving the coordinated efforts of all federal agencies involved in planning and regulating of forest and forest-related activities in the Pacific Northwest and northern California. Effective implementation of an ecosystem management approach requires that other parties (e.g., landowners, stakeholders, etc.), not just federal agencies, be integrally involved.

Planning Levels

Implementation of the selected option will rely on general recommendations (standards and guidelines) that will need to be refined at increasingly more site-specific levels, as we move from the regional, to province, to watershed, and finally to the site (or project) level. In moving to the long-term goal of true ecosystem management, we will need to refine and revise components at each of the following steps:

- *A regionwide conservation strategy* that provides general guidance to be considered at lower planning levels.
- *A physiographic province conservation strategy* that provides more specific guidance for land managers to consider as they develop site-specific planning strategies for watersheds or other units of analysis and planning.
- *A watershed level analysis* for individual watersheds that takes into consideration site-specific information and needs, and which provides the basis for refinement of provincial conservation strategies as well as project-level decisions.

A regionwide plan provides a method for standardizing processes across provinces. However, the physiographic province is intended to become the focal point for ecosystem planning. Conservation plans, developed at that level, are ultimately expected to replace the current forest (National Forest) and district (Bureau of Land Management) plans (see fig. VIII-6). These provincial plans should be explicit enough to assess impacts of actions but still be advisory in nature to allow flexibility at the local level because two agencies, the Forest Service and Bureau of Land Management, will still have basic decisionmaking responsibility on those lands.

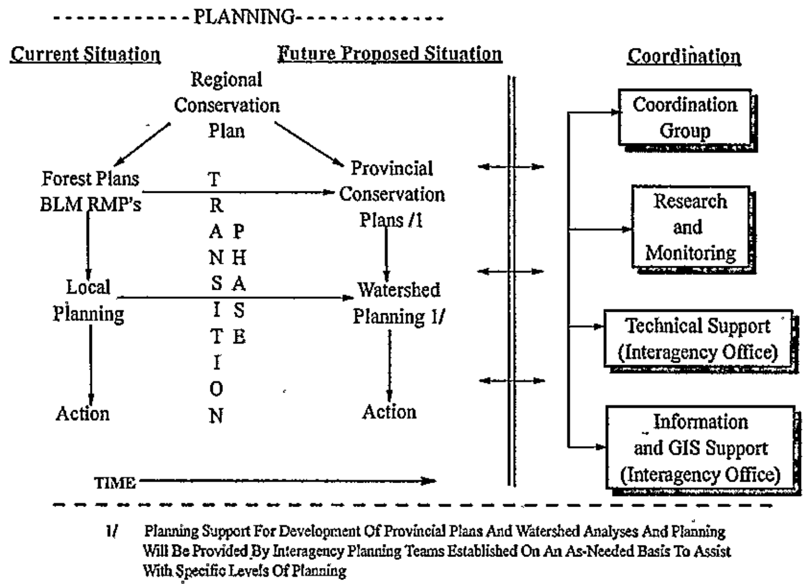

Figure VIII-6. Relationship between current and proposed planning, and interagency coordination efforts.

Watershed analysis is proposed as a key component of the general framework for identifying and assessing appropriate actions at the local level (see "Ecosystem Management" in this chapter). Watershed analysis would be the foundation for revising province-level plans as information is collected and assessed through the adaptive management process, and would provide a method to assess the current situation and relationships between species and mechanisms that should be considered as a whole. Land planners will need to assess the appropriate analyses. Our discussion uses this approach in identifying the major steps in implementation.

The transition from forest-based or district-based land management planning to planning at the provincial/watershed scale may be difficult for agency planners. Time frames and schedules appropriate to individual agencies will affect the development and completion of planning in the short term but will become less constrictive as we adapt planning to focus on the long term through the steps identified here (see a tentative stepdown schedule in table VIII-2). Interagency planning teams may be needed to make a smooth transition from the current to the proposed planning scenario (see "Interagency Coordination" section and figure VIII-6).

The intent during this period is three-fold: (1) refine the option and standards and guidelines so that local differences and needs can be addressed, (2) initiate adaptive management so approaches can be developed and integrated into a more ecosystem-oriented approach to land-use planning, and (3) identify and resolve potential regulatory conflicts (e.g., endangered species concerns) early in the planning process so delays can be avoided or mitigated.

Table VIII-2. The process of adjusting or adapting the selected option through time.

SHORT TERM:	Estimated Time	Planning and Regulatory Processes	Reserve Boundaries	Reserve S&Gs	Matrix S&Gs	Existing Plan Allocations
Regional EIS	2-6 months	NEPA (EIS) (Section 7)	Establish, subject to future refinement	Establish, subject to future refinement	Establish, subject to future refinement	to be determined
Interagency review for physiographic provinces or other ecological zones	1-6 months	none	Refine terrestrial boundaries, refine guidance	Refine based on province/zone information	Refine and adopt based on local information and subject to existing plan allocations	Change only as necessary to adopt reserve boundaries and new S&Gs; provide interim PSQ figures
Forest and District plan revisions	3-9 months	NEPA (EIS) (Section 7)	Refine and adopt terrestrial boundaries and interim aquatic boundaries	Refine and adopt based on local information	Refine and adopt based on local information and subject to existing plan allocations	Change only as necessary to adopt reserve boundaries and new S&Gs; provide interim PSQ figures
LONG TERM:						
Watershed and project analyses	6 months to 3 years	none (EA)	Refine terrestrial and aquatic areas based on local information and analysis	Refine based on local information	Refine based on local information and apply within context of existing plan allocations	Use existing allocations but analyze opportunities for new allocations
Province-level conservation strategies/plans	2-4 years	NEPA (EIS/EA) (Section 7)	Minor refinement and adoption of all boundaries	Adopt - refine if needed	Adopt within context of new allocations	Reconsider all existing allocations based on information from watershed analysis. Provide new PSQ figures.
Continuing Adaptive Management	Ongoing	(as necessary)	Continue refinements based on the adaptive management questions and process developed in this effort	Continue refinements based on the adaptive management questions and process developed in this effort	Continue refinements based on the adaptive management questions and process developed in this effort	Continue refinements based on the adaptive management questions and process developed in this effort

This is a chart of how various portions of the conservation strategy could be adopted and refined through time through a series of agency actions. Interagency oversight is needed for each of these steps, but there is opportunity for significant local input and control. Change in PSQ would occur due to reconsideration of existing plan allocations and to refinement of Riparian Reserve boundaries following watershed assessment. The Forest and District plan revisions including changes in existing allocations and in reserve boundaries, would all be driven by information collected as part of the watershed analysis process.

Implementation Strategy Components

There are similar components in all the options that will need to be considered in implementation. The five specific components to consider are:

1. Late-Successional Reserves and Riparian Reserves with specific boundaries delineating the areas.
2. Standards and guidelines for managing the reserves.
3. Standards and guidelines for managing the forest Matrix (between reserves, including the Adaptive Management Areas) and Key Watersheds.
4. Analysis procedures.
5. Monitoring protocols.

Refinement of these components will occur through a series of steps in agency planning. Through these steps information will be integrated and aggregated at different planning levels and adjustments made in the regional as well as more locally based plans, as appropriate.

There may be some initial concern over the need for additional levels of planning (and planning teams), but the described process should help reduce that perception as the transition unfolds. The entire process, described here, is intended to provide for a smooth transition, so that there is consistency in planning as an option is selected, implemented, and refined over time. This will require an interim phase during which time the current plans will need to be revised and actions taken to meet specific time frames (see section "Actions in the Transition Phase"). Short-term actions may be different than those proposed for the long term, although they should be consistent and be focused on obtaining overall objectives.

Because changes in agency planning may evolve as the concepts described in this document are tested, it is premature to describe in any great detail a step-by-step approach for long-term planning. The specific approach will depend upon the focus of the planning unit (e.g., forest or district, province, watershed), and will require close cooperation and oversight to ensure consistency with long-term goals. This process will require an extensive training and education program for professional staff, and should include members of nonfederal entities and the public.

Phases of Implementation

Implementation should occur in several phases. Although use of the word "phase" indicates sequential steps, we recommend that some of the actions identified here be implemented *immediately* and *concurrently* to the extent possible to reduce the time involved in making the transition from current operations to a focus on the watershed and provincial levels. Management activities will continue in keeping with the selected option and current plans until new plans are completed.

Phase I: Develop options to satisfy the objectives outlined in the instructions to the Team (see Preface). This was partially achieved by this overall report. This Phase is complete when an option is chosen.

Phase II: Identify and carry out actions that need to be completed in the immediate future (e.g., within the first year).

1. Refine regionwide components (reserve boundaries, standards and guidelines).
2. Complete regulatory requirements and initiate project planning (as appropriate).
3. Complete development of the watershed analysis approach incorporating concepts for assessing both riparian and terrestrial species.
4. Design and implement adaptive management process, including establishment of coordination efforts, monitoring and research programs, and a multiagency information system.
5. Identify priority activities necessary for the next phase (e.g., prioritize watersheds for analysis, identify test areas, continue assessment of species of concern).
6. Initiate training, education, and public information programs.
7. Facilitate a short-term timber sale program.

Phase III: Identify and carry out actions that need to be completed in the short term (e.g., 1-4 years).

1. Refine the components described in the regionwide strategy at the province level (e.g., boundaries and standards and guidelines applicable to each of the physiographic provinces) and begin development of provincial conservation plans.
2. Carry out agency planning processes to develop or revise Forest Service forest plans and Bureau of Land Management district plans.
3. Complete regulatory requirements between land management and regulatory agencies.
4. Refine the watershed analysis process and initiate high priority watershed analysis.
5. Identify high priority actions required for the next phase in the planning process (refer to recommendations in this chapter).
6. Facilitate achievement of the timber sale level specified in the selected option.

Phase IV: Identify and carry out actions that need to be completed to implement a selected (and refined) option over the planning period (e.g., 1-10 years).

1. Continue watershed analyses.
2. Refine the provincial guidelines at the watershed level for each watershed identified within the planning process
3. Refine forest/district or provincial level plans as necessary to meet the goals and objectives resulting from the watershed planning process.
4. Complete regulatory requirements (as needed).
5. Facilitate achievement of the timber sale level specified in the selected option.

Recommendations: The federal resource agencies should immediately initiate steps so that implementation of the selected option can proceed smoothly. These steps include:

- Establish a coordination group with appropriate work groups and supporting office(s), including assessment of nonfederal involvement.
- Establish local planning teams to develop agency plans.
- Initiate and conduct a comprehensive monitoring and research program and develop a method for maintaining, standardizing, and updating analysis tools and interagency databases, from the "ground up," with particular emphasis on a Geographical Information System.
- Develop the framework for carrying out watershed analyses, including the steps that identify how to apply the watershed analysis concept to upland and other terrestrial species, and the priority areas where watershed analyses would be initiated.
- Develop the framework for integrating the adaptive management concept into agency planning and decisionmaking processes.
- Determine budget, staff, and organizational/structural changes needed to adapt existing planning processes and methods of doing business.
- Initiate training and education programs.
- Facilitate the achievement of the timber sale levels judged appropriate in the selected option.

Actions in the Transition Phase

An orderly transition is needed as we move toward implementation of a preferred option for future forest management. A major issue is continuation of ongoing programs (e.g., timber sale programs) and, specifically, decisions on existing timber sales that were planned under previous agency management plans.

An evaluation of these sales has been initiated by the Forest Service and Bureau of Land Management. Over 1,300 timber sales currently exist, including sales developed under Section 318 of Public Law 101-121, sales that are currently enjoined, and new sales that have been planned. Most sales have already passed through the regulatory and planning requirements of applicable laws and policies. Steps should be taken to provide for completion of the review for remaining planned sales.

Evaluation of these sales will require careful consideration of the effects they may have on the ability of the options to meet the specified objectives. Priority for timber harvest should be given to existing sales that have the least impact on the described options.

Sales outside of areas, such as Key Watersheds, roadless areas, marbled murrelet habitat, spotted owl reserves, and critical habitat, should be given priority for consideration in any interim timber sale program (See Chapter V "Aquatic Assessment" for examples of factors to be considered when structuring sold and awarded, enjoined and prepared (unenjoined) sales). The agencies should continue to cooperate in developing guidelines, using the information in this document, to help identify sales that can be harvested in the immediate future.

Recommendation: The land managing and regulatory agencies should coordinate their reviews of existing sales so that a timely decision can be made and sales carried forth immediately in keeping with the selected option.

Planning and Regulatory Mechanisms

The Assessment Team was requested to provide a set of management options that complied with all requirements of applicable law, including the Endangered Species Act. For listed species within the range of the northern spotted owl, the federal land management agencies are responsible to carry out programs for the conservation of listed species and to insure that any action funded, authorized or otherwise carried out by the federal agency is not likely to jeopardize the species' continued existence or result in the destruction or adverse modification of critical habitat. A proactive (but not mandatory) responsibility of federal agencies is to take actions that contribute to the recovery of listed species through the recovery planning process.

One aspect of the Assessment Team's analysis rates the sufficiency, quality, distribution and abundance of habitat to allow the species populations to stabilize across federal lands. This viability of federal habitat does not directly correspond to viability of the affected species. This is due, in part, to impacts or cumulative effects from nonfederal activities and to activities in other habitat sectors where the species might spend a portion of their life cycles.

As a result, it may not be possible to construct an option for forest management that obviates the need for continued regulatory review of the impacts of actions that may affect listed species, water quality, or other laws. The federal land management agencies intend to consult under Section 7 with the Fish and Wildlife Service on implementation of the preferred alternative that is selected from this report. Because of the lack of sufficient detail, this consultation will likely not be sufficient for implementing specific actions, such as provincial conservation strategies or individual actions (e.g., timber sales) without additional consultation on these actions in the future.

Therefore, it is critical that the land-managing and regulatory agencies work closely together through the implementation process associated with the chosen plan to ensure that conflicts can be identified and resolved early in the planning process so that future train wrecks are avoided. This will require that the agencies find new ways and methods of communicating such that integration of their activities becomes a normal and accepted method of future operations.

In the long term, the planning and regulatory processes should be better coordinated and should take a proactive approach to problem solving so that consistency in conservation strategies can be obtained. Appropriate regulatory processes (e.g., through Section 7 of the Endangered Species Act or Environmental Protection Agency water quality programs) will need to be integrated with the applicable planning processes at an early stage in planning to avoid delays or future conflicts.

Regulatory agencies should become involved at the field level in planning from the initial stages. This will result in a shift in regulatory review from later in the planning process to an earlier phase -- a significant change in the way of doing business. The intent of early review is to help identify potential regulatory conflicts (e.g., actions that may impact listed or candidate species) so that actions can be taken to avoid or reduce those conflicts before irretrievable commitments of resources have been made.

The primary planning and regulatory processes are based on provisions of the National Environmental Policy Act, National Forest Management Act, and Federal Land Policy and Management Act, Endangered Species Act, and Clean Water Act. Agencies must also comply with a variety of other laws, such as the Migratory Bird Treaty Act, Coastal Zone Management Act, Clean Air Act, and the Administrative Procedures Act. The objectives of some of these laws as well as their substantive and procedural requirements are not uniform. Moreover, their interpretation falls to different agencies. To facilitate implementation of the selected option, the federal agencies should work together to develop a common understanding on the interpretation and application of the appropriate statutes in relation to the responsibilities of the individual agencies so that problems or delays can be minimized.

Recommendation: The planning and regulatory agencies should establish ad hoc planning teams to assist in initiating cooperative planning efforts at the provincial and local level (watershed) so that land use decisions can be made with the greatest level of input early in the decisionmaking process. Agencies should evaluate both short and long term staffing needs to ensure they can accommodate this level of involvement in planning so that budgetary needs can be anticipated.

Interagency Coordination

The achievement of ecosystem management goals seems likely to require a greater level of coordination and cooperation than has existed. This may be even more true in areas of mixed federal and nonfederal ownership. Coordination among the land-managing agencies and between the land-managing and regulatory agencies is critical to successful implementation of any option (also see "Implementation Oversight" section in this chapter).

Improved coordination might profitably involve establishment of a regional coordinating group, which includes representatives of the primary participants in land management planning. To be successful, particularly in the short term, any coordination effort would involve permanent technical support groups to carry out day-to-day activities and might include staff from all appropriate federal agencies (fig. VIII-7). These groups should be responsible for such tasks as ensuring adequate participation and timeliness in planning, monitoring, guiding, analyzing new information, and providing a forum for deliberating questions.

Technical teams under the coordination effort would be responsible for the following activities:

- Review and refine options (from the regionwide to the local level, including refinement of boundaries and standards and guidelines).
- Provide information and education to appropriate parties.
- Provide agency guidance on key issues.
- Help respond to problems and concerns, including biological, social, and legal.
- Prepare for future adjustments to plans and activities.

- Coordinate monitoring activities, data information management, and sharing of information.

Local planning teams also will be necessary to assist in coordinating the appropriate planning and regulatory processes at the local level (e.g., province and watershed) and help respond to problems and concerns. Planning and analysis teams would be expected to operate at the field level and would include staff from cooperating agencies to the extent that they would need to help assist in planning. Regulatory agencies could profitably participate on these teams primarily to provide guidance. These ad hoc teams are not intended to be a subset of the overall regional coordination group, except to the extent that guidance would be needed from that group. They are primarily intended to provide technical support to agencies as those agencies carry out planning. Figure VIII-7 illustrates the relationship between ad hoc agency planning teams and the more formal interagency coordination effort.

Interagency planning teams would work primarily through the land-managing agencies in cooperation with other appropriate agencies (National Marine Fisheries Service, Fish and Wildlife Service, Bureau of Indian Affairs, Environmental Protection Agency), states, and tribes. These ad hoc teams should become part of an agency's regular planning efforts at the field level. This level of planning may affect current staffing levels and assignments.

Because of the importance between land ownerships in an ecosystem approach to forest management, it is critical that federal/nonfederal partnerships be retained and fostered. Both regional and local efforts should include close coordination with the appropriate state agencies, tribes, interest groups, and local communities.

It also would be appropriate to include representatives of these groups at various levels in the planning process especially where management actions on federal lands may affect or be affected by actions on nonfederal and tribal lands (see section "Relationship to Nonfederal Lands"). This would allow nonfederal parties to participate in the planning process as opposed to reacting to the results of those processes after decisions are made. Regional planning councils, for example, may provide an appropriate forum. This may be most appropriate in application of the "adaptive management" area concept described under Option 9 (see chapter "Option Development and Description"). It should be noted, however, that the land management agencies have the sole responsibility for the decisions that are finally made.

The number and types of groups involved in coordination will depend on the type of planning being undertaken. Phase I would mainly involve the primary federal agencies (both field and higher level groups). Later phases would likely include active participation of state and local groups to ensure that state and local interests and responsibilities are identified and addressed, especially at the provincial level of planning. The degree to which these groups would be involved should be decided as the more formal groups or teams are established after selection of a preferred option.

To assist in the immediate transition from development of a set of options through refinement and implementation of an option over the next year may require establishment of a temporary interagency working group. This temporary group would continue analysis of the issues raised through the initial planning process, help expand the selected option into a more detailed plan, address questions raised by the planning

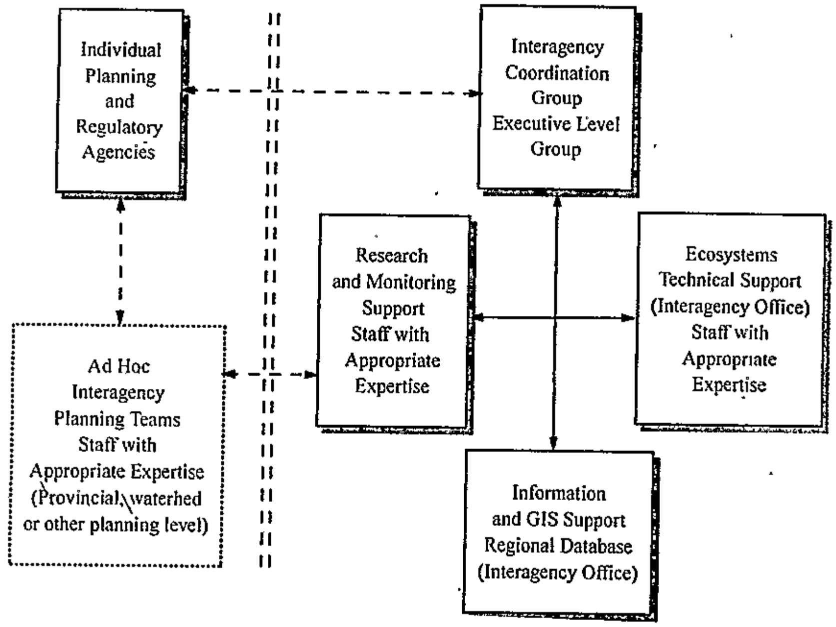

Figure VIII-7. Relationship between agency planning processes and interagency coordination efforts.

and regulatory agencies as they move toward implementation, and assist in developing concepts of watershed and adaptive management processes.

Recommendation: Agencies should establish an interagency working group to assist in the transition from completion of a set of options until agencies have completed their planning processes or a more formal coordinating group has been established that has assumed responsibility for this process.

Implementation Oversight

Because of the history of distrust and concern generated from past activities, there is a strong need to ensure that planning, monitoring, and implementation can be accounted for at least in the short term. Oversight is essential to ensure that adequate and timely steps are being taken to meet the goals of this process.

Recommendation: Draft plans should be submitted for independent technical review. The process for attaining such review should assure selection of appropriate credentialed reviewers.

Recommendation: The agencies and interagency coordination group should be responsible for reporting annually to the Administration on the status of implementation, on problems encountered, and on progress made relative to the selected option.

Relationship to Nonfederal Lands

The majority of species inhabiting late-successional forests in the Pacific Northwest are not restricted to habitat on federal lands. Maintenance of viable populations on federal lands will depend in part on how actions on nonfederal lands in the region affect the status of those species. Whatever their relative location and proximity to federal lands, nonfederal lands are an integral part of any strategy that seeks to address the overall landscape as an ecosystem. This is particularly important for threatened and endangered species or other at risk species.

Both federal and nonfederal lands contribute to maintenance of healthy ecosystems in a variety of ways including contributing to management of riparian or upland areas for habitat, contributing to soil and site productivity, managing a range of forest age classes for timber production, and developing information useful to future ecosystem management planning efforts. Therefore, if this interrelationship is to be considered in an ecosystem management approach, it will require cooperation between state agencies, tribes, private landowners, and federal agencies. Overall benefits to society that may accrue from ecosystem management will be optimized only if the relationships among federal and nonfederal lands are examined and collaboration encouraged during planning and implementation for the federal lands. This will be successful only to the extent that nonfederal landholders choose to participate..

Coordination of activities will play an integral part of ecosystem management at the regional, provincial, and watershed scales, regardless of the landowner or manager if ecosystem management is to achieve its anticipated potential. Because of the importance of using a watershed scale for successful ecosystem management, planning activities for mixed ownership areas should be coordinated with nonfederal agencies or landowners wherever appropriate and wherever nonfederal landholders choose to be involved. Watershed analyses and implementation of watershed management activities on nonfederal lands should be carried out through a multiagency (state and federal) process that facilitates participation of all parties with a stake in the process.

The states should be actively involved by taking the lead in developing conservation ecosystem management objectives applicable to nonfederal lands. This can be accomplished through state-led working groups with federal agency participation.

Planning for ecosystem management can identify opportunities to provide incentives to nonfederal landowners and managers. Mechanisms for providing incentives should be explored to encourage cooperative and coordinated efforts. These might include trading land to protect critical areas or reducing protection on some areas of federal lands in return for contributions to habitat protection and ecosystem management on nonfederal lands ensured by appropriate legally binding agreements, such as easements. Additional assistance may be made available in the form of expertise, coordinated spatial analyses with Geographical Information System and access to information systems, cooperative monitoring and analyses, and support through existing grant and assistance programs. Projects such as the Applegate/Ashland Watershed Project in Oregon illustrate integrated efforts where federal and nonfederal parties can work jointly on developing planning efforts on a landscape basis.

Aspects of some federal laws are relevant to implementation of ecosystem management for both federal and nonfederal landowners and managers (e.g., the Endangered Species

Act, Environmental Protection Agency programs). This is important for those species currently listed under the Endangered Species Act. Even as provisions are implemented on federal lands to maintain viable populations of these species (e.g., spotted owl, marbled murrelet, salmon), there will remain a need to provide protection to those species and habitats found on other land ownerships.

A proactive approach to reduce potential conflicts such as preventing future listings should be emphasized here. The information gathered through watershed and other cooperative analyses can be used through conservation planning processes under the Endangered Species Act to help nonfederal landholders contribute to preventing listing of candidate species at their discretion. Planning tools, such as conservation agreements, also offer ways to reduce the need for future listing of species and, thus, avoid conflicts with the Endangered Species Act. In these types of planning processes, priority should be given to finding ways of handling problems with multiple species (e.g., the spotted owl, anadromous fish, marbled murrelet), so that there is not an additive effect. While the needs of different species will need to be addressed, to the extent possible planning should take the opportunity to focus on ecosystems and not on specific species (e.g., the spotted owl).

A number of programs and authorities may be useful in the coordination of activities on federal and nonfederal lands. State agencies implement a wide range of programs for protection of water quality and aquatic life, including the Clean Water Act Section 319, and the Coastal Zone Act Reauthorization Amendments Coastal nonpoint source programs. Environmental Protection Agency statutes address nonpoint pollution control on nonfederal lands and provide funding through grants for implementing program requirements.

The Environmental Protection Agency also has initiated a watershed protection approach that recognizes the need to refocus water quality programs on geographically targeted areas. The target watersheds are those where pollution or ecological stressors pose the greatest risk to human health, ecological resources,or desirable uses of water. This approach encourages and facilitates the participation of all parties with a stake in the local situation in the analysis of problems and the development of solutions. The watershed approach provides for the participation of different levels of government, multiple agencies, and groups. These cooperative projects are intended to integrate the applicable authorities and techniques into a multi-organizational action to address the ecosystem problem. These projects also provide opportunities for using land management practices which take into consideration ecosystem concepts and contribute to the overall goal of ecosystem management. Partnerships between local, state, and federal parties offer unique opportunities to share information on these practices and to test different management techniques (e.g., Applegate Project).

Recommendation: Nonfederal entities, including states, private interests, and tribes, should be encouraged to participate in an integrated approach to ecosystem management for nonfederal lands. This approach should draw on the appropriate state agencies, private interests, and tribes to develop and implement an ecosystem management strategy and should be carried out in close cooperation with federal interagency efforts and private interests. Appropriate mechanisms for federal agency involvement should be determined. These mechanisms and roles will need to be established by the recommended interagency coordinating group.

Recommendation: Federal agencies should work with the states to coordinate the planning and implementation of the selected option for federal lands, with a strategy for nonfederal lands. This coordination should occur from the earliest stages of planning and analysis and should encourage private involvement and commitment. Appropriate mechanisms for this coordination should be developed by a coordinating group (which includes nonfederal representatives) for the regional, province, and watershed scales. A mechanism should also be developed to facilitate technical assistance and transfer of research results and lessons learned from the adaptive management process to managers of nonfederal lands.

Administrative, Budget, and Staffing Needs

Because this interagency approach requires up front involvement by all the agencies, past methods of operation must change to accommodate a more interactive approach to planning along with opportunities for others (e.g., states, interest groups) to participate. Greater benefits to society will result from this type of approach, particularly from the standpoint of avoiding or reducing the conflicts that currently arise from the lack of coordination between agencies. However, barriers exist in changing the way that agencies carry out planning, such as changes in current approaches to planning, in budget and staff allocations, in organizational structure, and in the methods to evaluate performance and accountability.

The greatest impact on the implementation of any plan is the availability of adequate resources (staff and budget) to carry out the expected tasks. The current budget process may not be compatible with integrated resource management, particularly one such as is proposed here. The magnitude of the changes will require a change in the way Congress allocates budgets, particularly for the land-managing agencies who previously received funds based on an assessment of commodity and other resource-based output. Considerations, such as funding to support habitat restoration projects and, in particular, funding to support a strong monitoring program, will be essential. Monitoring may be the most important function to be undertaken throughout the life of the plans (see "Adaptive Management" in this chapter).

Regulatory and land management agencies need to change the focus of their mutual involvement from an adversarial to a more cooperative situation. This will entail a change in the way mandates are carried out and a shift from pure regulatory review to a more planning-oriented process.

Recommendation: Congress should be encouraged to revise the appropriations process to better provide for the land management agencies' ecosystem-based objectives and activities, rather than link appropriations primarily to commodity outputs.

Recommendation: Land management agencies need to determine the potential commodity output levels based on land capability, compliance with applicable laws, and ecosystem sustainability.

The Forest Ecosystem Management Assessment Team did not examine the potential costs to the federal government of implementation of the options described in this report. However, the team is concerned about some public assumptions. Considerable effort will be needed to carry out the expected planning, monitoring, research, and associated projects that are essential to the success of this effort. This includes a recognition that the roles and needs for current staff do not disappear, but evolve as we implement news ways of conducting business. Sufficient funding needs to be available to support the efforts described in this document.

Pending additional fiscal analysis, we **emphasize that the option selected should not be hastily coupled with reductions in funding and personnel based upon the inappropriate assumption that ecosystem management is somehow cheaper than traditional commodity production-focused plans.**

Recommendation: The Secretaries of Agriculture, Commerce, and Interior, and the Administrator of the Environmental Protection Agency should consider a review of the steps necessary to undertake a more coordinated and cooperative interagency approach to planning.

Conclusions

We have presented our view of steps to be instituted to achieve the ecosystem management approach that may be adopted as the policy of the Forest Service and Bureau of Land Management. Obviously, there are other potential means of carrying out the next phase(s) of the conversion to ecosystem management that build on the framework laid out in this report. However that is accomplished, it is well to note that the selection of any option in this report is only the first building block for ecosystem management. It is visualized that a second phase be initiated whereby the concept is extended to a broader land base and in a larger landscape context.

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Appendix VIII-A
Methodology of the Forest Ecosystem Management Team with Respect to Information Development

Considerable effort brought the best information, technology and people together to support the analytical needs of the Forest Ecosystem Management Assessment Team. The following describes the effort to build a spatially explicit database and utilize geographic information system technology. It does not include a full discussion of the data and analysis needed to analyze current timber volumes nor projections of allowable sale quantity. For a full discussion of this analysis see the "Economic Assessment" chapter. This is provided as a context with which to evaluate future needs and as a record for future reference. A significant effort was made to document all of the data used and processes employed during this project. If information is not contained here, it can likely be found in the project records.

Information

Much of the spatial information used in this effort was coordinated through the Geographic Information Systems Analysis Group. This group within the Forest Ecosystem Management Assessment Team was an interagency group whose charge was to locate and assemble the required information and provide analyses in support of the scientists and others on the team. The group created a spatially unified database for the study area -- the range of the northern spotted owl, approximately 57 million acres. Most of the data came from the USDA Forest Service, USDI Bureau of Land Management or the USDI Fish and Wildlife Service. Data was also received from the U.S. Environmental Protection Agency, U.S. Census Bureau and the USDI Geologic Survey. Sources outside the federal government include all three states (Washington, Oregon and California), the EROS Data Center (Earth Resources Observation Satellite), the Natural Heritage Database, Oregon State University, and others.

Technology

We used state-of-the-art hardware and software technology extensively for this effort. This included six IBM RS6000 workstations and six SUN SparcStations utilizing the Arc/Info (Environmental Systems Research Institute, Inc.), ERDAS Image Processing (ERDAS, Inc.), and Oracle Relational Data Base Management System (Oracle Corp.) software. Both the Bureau of Land Management and Forest Service provided plotting services on color electrostatic plotters. Digitizing and scanning were accomplished on microcomputer-based Line Trace Plus systems. [Note: mention of trade names of software and hardware is intended as information only, it is not a endorsement or recommendation by the Forest Ecosystem Management Assessment Team nor any of the affiliated agencies.] Given the time allowed, there was little choice but to assemble fast equipment, reliable software, existing digital data, and the most experienced people who could be found. Much of this was already available within the three agencies. Normally, a project of this size and scope would require many times the 2 months allowed, and this did have negative, though not critical, impacts on the analyses and options presented here. We expect that additional analyses will build on this process in the future. The development and maintenance of spatial data requires an investment of time and information resources and a commitment from managers to collect and maintain data that meet agreed-upon standards.

Capabilities of the technology, data, and people were available to produce nearly any needed analysis or produce virtually any type of output desired. Even so, prioritization was required because there simply was not enough time to complete all of the desired analyses. Additionally, time constraints did not permit any major digitizing efforts to capture new information across the study area. Hundreds of hard copy maps utilizing available digital data maintained by the agencies were produced over the span of the project area showing everything from distribution of species to maps portraying what the forests of the Pacific Northwest might look like 50-150 years from now under different management scenarios. Visual displays are powerful and represent part of the reason that geographic information system technology and spatially explicit resource information is so critical to sound resource management, particularly management based on ecosystem management principals.

The other, perhaps more important, capability that geographic information system technology lends to such efforts involves analyzing the distribution and spatial characteristics of resources and their relationship to other phenomena. Cross tabulations of resources relative to each other were developed (e.g., acres of suitable owl habitat by physiographic province and administrative unit) for virtually all information available across the study area. Additional analyses included the computation of shape metrics (e.g., nearest neighbor, fragmentation) for vegetation. Reserve options across the landscape and over time were valuable in estimating the relative capability of the options to provide for the viability of spotted owls and dozens of other species. Information on nearly 200 species associated with late successional and old-growth forests were assembled and analyzed.

Methods

The basic methodology involved assembling the various data into a common format within the Arc/Info environment. A total of 75 map layers were captured or collected from various sources. Another 115 species range maps were also collected and treated as a single map representing the species analyzed by the Scientific Assessment Team. Once installed and accuracy checked, 31 of these map layers were converted to a raster based data structure (see fig. A-1) with each cell in the data structure representing a land area 400 meters square (approximately 40 acres or 18 hectares) within the Arc Grid software environment.

The advantage a raster-based data structure provides relates primarily to the speed with which analyses can be completed and the fact that many analytical processes are more easily performed in a raster environment. Vector-based operations are computation intensive and require significant input/output communications resources. Raster-based data structures use a simple row/column Matrix that streamlines computational transactions and reduces communications bottlenecks. It is fundamentally easier for a computer to perform raster-based transactions than it is to calculate the new geometry of combined vector-based data during analysis operations. Another reason for moving to a generalized grid was it was an easier environment for combining disparate data into a single data set. Because many of the data were collected independent of the others, common boundaries between disparate sets do not often match. In a vector

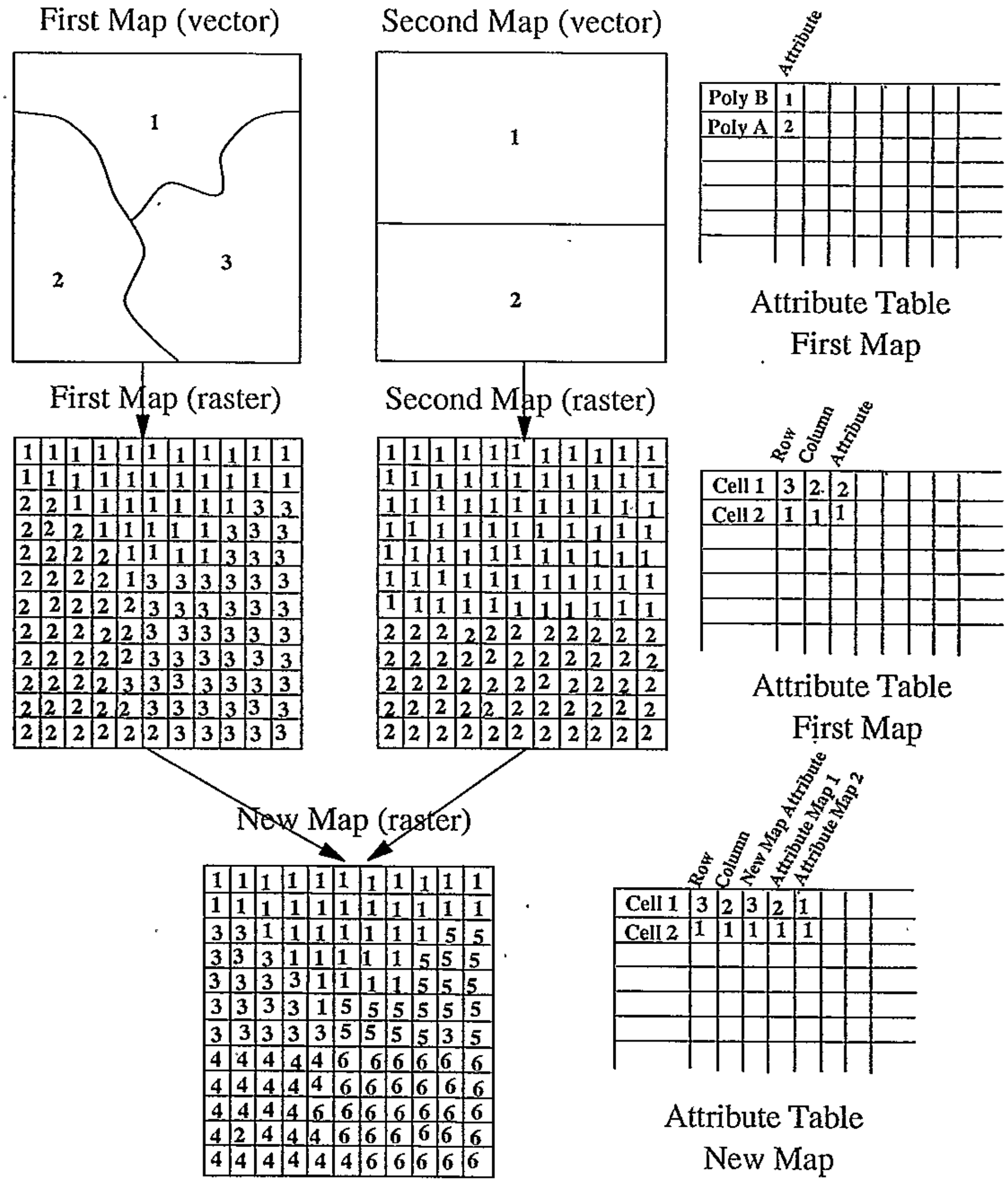

Figure VIII-A-1. Schematic diagram illustrating vector-based maps, associated attributes and the process of combining raster maps.

environment, many hours of tedious work would be required to edit these discrepancies. In a raster environment, each cell takes on the identity of its majority component.

The result, was 31 raster maps each containing one or more attributes regarding the majority of the land area each cell represents. Over the study area, these raster representations provided an accuracy within 1 or 2 percent compared to the original vector-based data. Only when comparisons made on land areas of less than approximately 500 acres were the results, when compared with the original data, found lacking. The area summaries for small features were accurate across the study area but are not reliable for site-specific analyses. Given that the study area was approximately 57 million acres, with most of the map layers installed having coverage of over 24 million acres (total acreage of Forest Service, Bureau of Land Management, and National Park Service managed lands in the three states), this level of accuracy was far in excess of the requirement for most of the analytical needs of this project. For analyses of land areas smaller than a physiographic province or administrative unit, the vector data were used directly. This approach ensured accurate analyses regardless of the scale and provided a significantly streamlined analysis process over purely vector-based analyses.

Other analytical needs could not be handled by this approach, and alternative analyses were designed and implemented in support of these. A significant data set representing stream data is not available for the study area. Several stream map layers are available including a relatively detailed map for the Columbia River basin from the U.S. Geological Survey Water Resources Division, but none of the these provide the detail or accuracy needed to analyze intermittent streams. In lieu of this, approximately 50 sample areas of roughly 5 kilometers each were mapped and digitized across the study area. These samples included all intermittent streams as well as perennial streams. The samples were distributed across physiographic provinces to estimate stream densities for the range of landforms and drainage patterns found in the study area. Factors representing stream miles per square mile were calculated along with corresponding buffer acres for use in estimating the acres of total riparian buffers.

An excellent digital map of bedrock geology for Oregon was obtained from the Oregon State GIS Service Center. Attributes were added to this map representing debris and earth flow potential. This map was then combined with a slope map generated from a 1:250,000 elevation map to produce maps of potential high risk areas for both debris and earth flow. Initial analysis indicated that the 1:250,000 elevation data are not sensitive enough for areas of steep slopes and high drainage densities so additional work was done on the Siuslaw National Forest using 1:24,000 scale elevation data. Results from this analysis produced significantly more lands prone to debris and earth flows than the analysis using the smaller scale data. This information was used in estimating effects of protecting these lands and in formulating a proposal to perform additional analysis across the study area.

There is no consistent source of vegetation information within the study area. Therefore, a vegetation seral class map was created from existing information. Satellite classifications of vegetation size/structure, crown closure, and species were available for all National Forest and National Park Service lands in Oregon and Washington. Vegetation polygon information was available for Forest Service in California and Bureau of Land Management lands in California and Oregon. All of these data were reclassified and merged into a map representing seral vegetation classes. The resulting data were used extensively in estimating vegetation patterns over time. These data also were used, along with software developed at the Forest Service Research Lab in Corvallis, to generate fragmentation statistics and nearest neighbor calculations, and to shape statistics of vegetation patterns for both present conditions and projected future conditions under the various alternatives. These represent just some of the analyses performed in support of this report. To truly implement ecosystem management on the forests in the Pacific Northwest, additional analyses will be needed. Furthermore, all forested lands, regardless of ownership, should be included in such analyses in the future if full assessment of the landscape is desired.

Database Reporting

Once the core data were converted to a raster-based data structure with associated attribute data, all of the raster data sets were combined into a single raster (see fig. A-1). Essentially, a single raster was developed with all of the associated attribute data related to all of the 31 mapped data associated to a single raster. Because the attribute data, at this point, all resided in a single table of information, this table was exported and used in a Relational Data Base Management Software (RDBMS) environment. Moving the attribute data to this environment allowed fast and efficient reporting of resources and relationships between resources. This methodology allowed both simple and complex database queries to be performed. One disadvantage of this methodology was that any updates of the core data required several steps to effect changes to the database before update queries could be performed. Once assembled, the database provided the ability to quickly produce statistics by option, province, state, administrative unit or any other component contained in the database.

An important aspect of this approach was the ability to quickly and accurately visualize the results of specific queries. Because of the nature of a raster data structure, output involves the reporting of cells in the raster that meet the criteria defined in the query and can include the exact location in the raster of each cell meeting these criteria. If the results of a specific query include the row and column location of each cell meeting these criteria, it is simple to route this information back to the geographic information system software and display the result regardless of the database tool used to perform the query. This process allowed both a tabular summary and visual display of information so fundamental in using geographic information system technology.

The reports and hard copy maps generated were subjected to rigorous accuracy checking that compared output to source information. Discrepancies were identified and routed back for additional comparisons to either database analysts or geographic information system analysts for error determination and correction. It is important to acknowledge that the accuracy of information produced is only as accurate as the least accurate part. While some of the information used in the analyses are highly accurate and accuracy assessed, others are not. However, this report is not a project level assessment, it is a broad-scale analysis of habitats, ranges, and existing and future conditions given management options. *It is not appropriate to use this database for project level analysis though many of the original vector components are appropriate inputs to such analyses.* Finally, it is important to point out that regardless of the inherent accuracy or appropriate use of these data, the purpose of this database was to provide a consistent analysis of options for comparative purposes.

Other Efforts To Build Regional Data Sets

Interagency Scientific Committee

In assessing the efficacy of applying regional data sets to resource problems and determining future needs, it is valuable to briefly review other, similar, efforts. The Interagency Scientific Committee did not employ the use of geographic information system technology directly. While many of the maps and data used in this effort were generated from data contained within agency geographic information systems, the team did not use technology directly. Maps were assembled relating to the northern spotted owl, vegetation, etc. Manual comparisons of these were made by members of the Interagency Scientific Committee. While this type of analysis can be effective, the labor-intensive nature of the process often precludes extensive analysis.

Scientific Panel on Late-Successional Forest Ecosystems

The Scientific Panel on Late-Successional Forest Ecosystems was one of the first efforts to build and utilize geographic information system technology for broad-scale analysis. This effort was unique in many ways and serves as an example of one possible approach to developing an information base for informed decisionmaking. Several committees from the U.S. House of Representatives commissioned four scientists to assemble alternative management options for consideration in determining the management of the remaining late successional and old growth ecosystems. To do this, the scientists enlisted the help of over 180 specialists from several federal and state agencies over a period of approximately 1 week. A large conference facility in Portland was rented for this effort, and under the direction of the four scientists, these specialists proceeded to develop maps of late-successional and old-growth forest ecosystems. Maps depicting vegetation, Habitat Conservation Areas and known locations of northern spotted owls were integral to the effort in designating significant areas of late-successional forests and management options.

Specialists delineated four categories of information: Most Significant Late-Successional/Old-Growth (LS/OG1), Significant Late-Successional/Old-Growth (LS/OG2), Owl Additions, and Key Watersheds. Members of the Interagency Scientific Committee were present and reviewed the maps of the Most Significant Old-Growth (referenced as LS/OG1 in the report). These maps were critically reviewed using the criteria set forth in the Committee's findings. If the LS/OG1 network did not meet the criteria outlined in the Interagency Scientific Committee report, additional areas were identified that, coupled with the LS/OG1 areas, met the standards in the report. These areas are defined as Owl Additions. The final map information developed during this effort was called Key Watersheds and represented areas containing potentially threatened fish stocks or particularly high quality habitat. The development of the LS/OG areas, Owl Additions, and Key Watersheds was a significant contribution to all concerned and were used extensively in the development of this report.

While considerable information regarding spotted owls was assembled or collected during this effort, little information was available or collected regarding other species associated with late-successional forest ecosystems. As a result, the primary use of geographic information system technology during this effort was in producing hard copy maps and for the calculation of timber volumes resulting from alternative land use options. Geographic information system technology was not utilized to the extent it has in this process in providing a range of analyses. The data have been used to some degree recently since it has become available and is utilized extensively in this analysis as well as by interest groups.

Northern Spotted Owl Recovery Team

One of the major challenges in developing the draft Northern Spotted Owl Recovery Plan was assembling data from three states and a variety of ownerships. These data included information about forest vegetation, suitable owl habitat, a spotted owl range map, forest productivity, owl locations, land ownership, land allocations, streams, locations of variety of other species, critical habitat designations, physiographic province boundaries, and a variety of possible conservation strategies. These data were installed on a geographic information system and used to produce the considerable information used to develop the draft recovery plan.

This data base was the first multiownership, multistate data base developed for spotted owls and their habitat. The Northern Spotted Owl Recovery Team was the first group to bring together information on spotted owls and other key attributes into one regional geographic information system database; their efforts built from the initial database developed for the critical habitat designation process begun by the U.S. Fish and Wildlife Service and utilized information contained in systems maintained by the states. The data base took two years to develop. The Recovery Team's data base served as the starting point for the Forest Ecosystem Management Assessment Team's efforts.

Forest and District Planning

Both the Forest Service and Bureau of Land Management utilized, to some degree, geographic information system technology in their ongoing efforts in resource planning.

Forest Service

The Forest Service administers the most forested land of any agency within the area addressed by this study. It is by far the largest federal land management agency represented here and, in many ways, presented the biggest obstacle in the development of this information resource. This situation was not by design or lack of foresight though many may argue to the contrary. Rather, it is an artifact of a number of factors, namely past Congressional and Administration direction or lack of direction, implementing regulations, and agency culture. The National Forest Management Act (1976), requires the Forest Service to conduct analyses and produce forest plans for each Forest within a prescribed time frame and with specific objectives. Implementing regulations faithfully prescribed a process for conducting these analyses and producing the needed plans. The focus of the forest planning process was aimed at the administrative unit known as a National Forest.

Each Forest in the National Forest System established a Forest Planning Team, an interdisciplinary group of resource specialists who analyzed current conditions, conducted public scoping, and developed alternative plans for management of a particular Forest. Upon completion of this process, the decisionmaker, generally the Regional Forester, chose one option with or without modification and a Record of

Decision was signed. The majority of National Forests have completed this process once and some are well into the next round. Agency direction for development of these plans comes from both the Washington Office of the Forest Service and the Regional Offices.

As implemented in the Pacific Northwest, efforts to develop forest plans are generally centralized in the Supervisor's Office of each National Forest. Databases were developed specifically for this task, often separate from other analytical processes ongoing within the Forest, both in the Supervisor's Office and at the Ranger District level. If information processes on the Forests do not recognize this, and many do not, there is significant opportunity for these different data sets to become increasingly in disagreement especially because the forest planning process can take years to complete. The net result is obvious: Forest Plans are developed on one set of data while other data sets at Forest and District levels work off of others. Most Forests recognize this problem and have taken or are taking corrective action.

To complicate matters further, the forest inventory process is coordinated Regionally and is designed to support the forest plan efforts. These inventories, while coordinated, have not been consistent between Forests and are rarely implemented as base information for use in project level planning. The Pacific Northwest and Southwest Regions have made considerable effort in standardizing inventory mapping and data collection techniques, but again, these data may or may not form the basis of planning at all levels within the Forests themselves or between Forests, even between those with coincident boundaries.

Bureau of Land Management - Oregon State Office

The Bureau of Land Management, since 1986, has been developing the Western Oregon Digital Database in support of its Resource Management planning process on 2.4 million acres. Bureau of Land Management Districts are analogous to the Forest Service National Forests in terms of administrative hierarchy but resource planning is coordinated, including database development, at the State Office for areas in Western Oregon. While this database covers only western Oregon, it does provide a set of consistent data for forested lands administered by the Bureau of Land Management in all of Oregon. Issues of coding, scale detail, etc. only had to be dealt with once for lands within the Oregon State Office database. However, little data were available on Bureau of Land Management administered lands within California and eastern Oregon and Washington, which presents the same problems encountered with Forest Service data.

The Western Oregon Digital Database and the Bureau of Land Management's planning process represent a commendable effort in developing resource management plans based on geographic information system-based spatial analysis. It is based on a database containing information regarding more than 65,000 forest stand polygons collected over the past 30 years. While the Western Oregon Digital Database project is not a prototype example of building a database for ecosystem management, it is an excellent example of an integrated spatial database. It is good because it is the repository of information that the field professionals must use. They have a direct interest in maintaining and updating this information. If geographic information systems and other information technologies are to be a timely and informative tools for ecosystem management, the data collected must be integral to the daily work of the professionals responsible for the resources at the project level. The same data should be integrated into planning and analysis processes at broader scales.

Because the Bureau developed a coordinated Resource Management Plan for all of western Oregon, the same issues regarding consistency in planning efforts within the Forest Service are not as acute. However, no substantive efforts have been made to provide consistencies between the agencies even though ownership is mingled and information needs are nearly identical. The issue is not purely one belonging to the individual agencies. There has been little direction provided from either Congress or the Administration in past years to pursue this activity, and often past direction has precluded any efforts initiated by either agency.

Consistency in natural resource information is not an issue applicable to just the Forest Service and Bureau of Land Management. All land management or regulatory agencies with interest in the forests of the Pacific Northwest have responsibility for this issue. Finally, none of the federal agencies have any significant data available to them on private lands intermixed or surrounding their own. In many cases, laws and regulations prevent federal agencies from collecting data on lands other than those they manage. While it may be a more difficult issue than with public lands, ecosystem management concepts in their purest form, like species, do not usually distinguish public from private lands. It would be useful to be able to assess the entire landscape, at least in analyzing existing conditions.

Survey of Agency Personnel

For this project, it was desirable to determine what information standards exist or are under development and to find out what recognition of need exists within the federal land management and regulatory agencies. To that end, approximately 100 individuals representing a cross section of agencies, specialties, and organizational levels were surveyed. Questions regarding existing and impending standards, the need for standards, the scope of standards, etc. were sent to personnel in the Forest Service, Bureau of Land Management, National Marine Fisheries Service, U.S. Fish and Wildlife Service, National Park Service, and the Environmental Protection Agency. The responses were used in the development of the Implementation and Adaptive Management chapter and this appendix and are available for further review. The range of responses was large and somewhat, though not always, predictable and are certainly a useful tool in assessing the current situation and validating ideas contained here.

In short, there is an almost unanimous agreement on the need for standardization of basic resource information, but a variety of opinion exists on what degree of standardization is needed at various levels. There is also varying opinion on how to achieve that objective and whether it should be mandated. About half believed that standards must be mandated and the other half didn't believe that a mandate would work or was necessary. There was general agreement that standardization should build on efforts already under way or established with some recognition that not everyone would be satisfied. One of the largest concerns expressed related to allowing sufficient flexibility to accommodate local needs. This is, perhaps, an artificial barrier. Standards should be hierarchical with careful consideration given to precisely identifying what information needs to be standardized at what level. In general, as one moves through the hierarchy of analysis needed at any given level, the detail of information required should increase (e.g., detail needed is less at the regional level than at the project level).

It would be impractical to determine standards for all data collected at every level and would significantly impact the time required to develop them.

Issues and Opportunities

Common Data

One of the key issues then in establishing ecosystem management as an overriding policy is the establishment of this core of information. While not a new issue to any of the federal agencies, discussions between agencies have occurred several times over the last few years regarding issues and opportunities to identify common information structures and collection processes. These efforts have rarely come to fruition except when clear direction has been established or where standards and methodologies exist or where one agency took a lead role and others simply built on what was started.

A good example of an agency taking a lead role involves the collection of elevation data. The U.S. Geologic Survey has responsibility for these data, and for several years the agencies involved in land management have been working cooperatively to collect and maintain a single set of elevation data. The cost savings to the agencies and ultimately to the taxpayer are significant because there are no redundant efforts now in place to collect elevation data for the same land areas. This cooperation is now being extended to include state agencies, and soon Region-wide availability of elevation data collected to the same standard and maintained in the same format will be available. This type of effort is clearly needed for other data as well.

Another type of cooperative effort exists in the Pacific Northwest as well as in other parts of the country. In 1989, in the Pacific Northwest, the U.S. Geological Survey established an interagency group known as the Northwest Land Information System Network. At the heart of this group is an interagency memorandum of understanding that has been signed by the regional heads of over a dozen federal and state agencies. The primary benefit to date has been an ongoing effort to share information about relevant activities of the member agencies. Through this group, a database containing information on spatial data available from each of the member agencies has been designed and is now being implemented through the respective states. While not complete, there is tremendous opportunity and need for this resource. Another extremely valuable outcome of this effort is an agreement between member agencies to share information. Through the network, member organizations are able to acquire information from others with little or no cost except where mandatory by agency regulation or law.

Maintenance of Data Versus the Short-Term Approach

Another issue is the establishment of databases without a commitment to maintain them. Several times over the past few years, databases have been assembled to meet some objective or direction with no accompanying direction or funding to maintain them. Databases have been established by the Forest Service, Bureau of Land Management, and the U.S. Fish and Wildlife Service specifically dealing with the northern spotted owl and related information. However, no clearly defined strategic plan has been established for any of these efforts to update, maintain, and share these resources even though it is fairly clear that it would be advantageous to do so. For example, the Forest Service, Bureau of Land Management, and the U.S. Fish and Wildlife Service all maintain databases on northern spotted owls including location information. The agency with responsibility for determining which of the owl locations is in the "official" data set, is the Fish and Wildlife Service, yet the "official" data set is not routinely shared with the land management agencies. The inefficiencies and potential problems this can cause are easy to imagine.

In 1989, Congress directed the Forest Service to inventory old-growth forests in the Pacific Northwest on National Forest System and National Park Service lands because there was no definitive information on the issue. It would have been extremely efficient to include Bureau of Land Management lands in this inventory, which would have provided a consistent information source for nearly all federally owned forest lands – but the budget direction precluded this opportunity. Also, there was no direction on the long-term maintenance of the information even though, 4 years later, the issue is far from resolved. Appropriation legislation and other governing laws and implementing regulations are so specific and have so many requirements that even if the motivation were high to establish more cooperative efforts, the barriers to doing so are often insurmountable.

Technology Versus Information

In solving some of the information puzzles facing us, it is often tempting to focus on the technology rather than the information. Responses to the survey indicated a number of managers, researchers, specialists and technologists felt that common tools were key in achieving an ecosystem management. However, many others recognized that the real key is not the lack of similar hardware and software, but rather having consistent information. While it would certainly simplify matters if everyone had the same technology available, it would be of little benefit if information from the different agencies remains incompatible. So long as acquisitions adhere to established federal information processing standards, differences in hardware, software, communications, and data formats can be resolved. Differences in information standards, however, require huge investments in time to resolve, if they can be resolved at all. Even where differences in information can be resolved, the effort often requires a significant loss of information in the process.

Artificial Barriers/Agency Culture

In an environment with inadequate national, regional, and agency policies regarding the establishment of information resources and confusing laws and regulations having an effect on information standards, it's hardly surprising that field managers find it difficult to support agency and interagency efforts to establish them. Resource managers and specialists have been collecting and maintaining information for years. Many have done a remarkable job considering that most of these people have had little, if any, training related to information management, geographic information systems, remote sensing, and other information technologies. An artifact of this situation, however, is that many resource specialists and managers are reluctant to give up processes that have met their local needs. This approach was adequate when resource issues were primarily local. Over the past decade, issues of local concern have shifted to ones of regional or national scope. Districts and Forests are no longer in a position to analyze many of these issues because the scale and scope has changed. It does not mean the issues no longer concern them. Rather, they can no longer resolve them independently of other land holders, administrative units, or agencies. Ecosystem management recognizes this situation and can provide a framework for dealing with them.

Often land managers' performances are measured by how well targets are met, usually for commodity items (e.g., timber volume) that are ultimately set by Congress and signed into law by the President. This process is clearly defined and accountability is established from the top down. Everyone involved understands what is expected and the measures used to monitor performance. Rarely are these people held accountable for the efficiency with which they manage information or how compatible it is with data collected by other managers either horizontally or vertically within an agency. Similarly, agencies are not generally held accountable for how well information from their agency compares with those with similar interests.

Conclusion

The collection, maintenance, analysis, and sharing of information is an integral part in virtually everything the resource management and regulatory agencies do. This will especially be the case in ecosystem management. The degree of effectiveness with which land managers perform this task has significant implications on the quality of the work they perform and the cost effectiveness with which they do it. It is hoped that the conclusions and recommendations will serve to highlight the issues and at least provide a starting point for all concerned to begin to work together and resolve the critical issues related to resource information management.

IX

Glossary

Chapter IX
GLOSSARY

Most of the terms in this glossary were taken from, or adapted from, the glossaries of the following reports:

- A Conservation Strategy for the Northern Spotted Owl, by the Interagency Scientific Committee, May 1990.
- Alternatives for Management of Late-Successional Forests of the Pacific Northwest, by the Scientific Panel on Late-Successional Forest Ecosystems, October 1991.
- Draft Resource Management Plan and Environmental Impact Statement (for six Districts in western Oregon), by the Bureau of Land Management, August 1992.
- Final Draft Recovery Plan for the Northern Spotted Owl, by the Northern Spotted Owl Recovery Team, December 1992.
- Viability Assessments and Management Considerations for Species Associated with Late-Successional and Old-Growth Forests of the Pacific Northwest, by the Scientific Analysis Team, March 1993.

Any remaining terms have been defined by the Forest Ecosystem Management Assessment Team.

Accretion - The process, driven by plate tectonics, whereby the continental margin grows by addition of ocean crust and sediments at a subduction zone.

Activity plan - A Bureau of Land Management document that describes management objectives, actions, and projects to implement decisions of the resource management plan or other planning documents. Usually prepared for one or more resources in a specific area.

Adaptive management - The process of implementing policy decisions as scientifically driven management experiments that test predictions and assumptions in management plans, and using the resulting information to improve the plans.

Adaptive management areas - Landscape units designated for development and testing of technical and social approaches to achieving desired ecological, economic, and other social objectives.

Adjacency requirements - Management restrictions to regulate the creation of harvest openings. An opening created by harvest must "close" through a new timber stand growing to a certain height before another harvest unit can be placed next to it. This requirement has led to the "staggered setting" approach to timber harvest in which clearcut units, usually of 20-60 acres, are scattered over the landscape. (See Staggered setting.)

Administratively Withdrawn Areas - Areas removed from the suitable timber base through agency direction and land management plans.

Administrative units - The organizational unit used in this report for divisions in the Forest Service, the Bureau of Land Management, and the Fish and Wildlife Service.

Age class - A management classification using the age of a stand of trees.

Age specific survival rate - The average proportion of individuals in a particular age group that survive for a given period.

Airshed - A geographic area that shares the same air mass due to topography, meteorology, and climate.

Allee effect - A depression in the encounter rate between male and female owls resulting from low population densities. The probability of finding a mate drops below that required to maintain the reproductive rates necessary to support the population.

Allowable cut effect (ACE) - The expected change in the allowable sale quantity resulting from future management decisions.

Allowable sale quantity (ASQ) - The gross amount of timber volume, including salvage, that may be sold annually from a specified area over a stated period in accordance with management plans of the Forest Service or Bureau of Land Management. Formerly referred to as "allowable cut."

Alluvial - Originated through the transport by and deposition from running water.

Alternative - One of several policies, plans, or projects proposed for making decisions.

Anadromous fish - Fish that are born and rear in freshwater, move to the ocean to grow and mature, and return to freshwater to reproduce. Salmon, steelhead, and shad are examples.

Analysis of the management situation (AMS) - A document that summarizes important information about existing resource conditions, uses, and demands as well as existing management activities. It provides the baseline for subsequent steps in the planning process, such as the design of alternatives and affected environment.

Analytical watershed - For planning purposes, a drainage basin subdivision used for analyzing cumulative impacts on resources.

Animal damage - Physical damage to forest tree seed, seedlings, and young trees through seed foraging, browsing, cutting, rubbing, or trampling, by mammals and birds.

Animal unit month (AUM) - The amount of forage necessary for the sustenance of one cow or its equivalent for 1 month.

Aquatic ecosystem - Any body of water, such as a stream, lake or estuary, and all organisms and nonliving components within it, functioning as a natural system.

Aquatic habitat - Habitat that occurs in free water.

Arboreal - Living in the canopies of trees.

Archaeological site - A geographic locale that contains the material remains of prehistoric and/or historic human activity.

Area of critical environmental concern (ACEC) - Bureau of Land Management lands where special management attention is needed to protect and prevent irreparable damage to important historic, cultural, or scenic values, fish, and wildlife resources or other natural systems or processes or to protect life and provide safety from natural hazards. (See Potential ACEC.)

Area of critical mineral potential - An area nominated by the public as having mineral resources or potential importance to the local, regional, or national economy.

Area regulation - A method of scheduling timber harvest based on dividing the total acres by an assumed rotation.

Aspect - The direction a slope faces with respect to the cardinal compass points.

Associated species - A species found to be numerically more abundant in a particular forest successional stage or type compared to other areas.

At-risk fish stocks - Stocks of anadromous salmon and trout that have been identified by professional societies, fish management agencies, and in the scientific literature as being in need of special management consideration because of low or declining populations.

Automated resource data (ARD) - Computerized map data used for the management of resources.

Available forest land - That portion of the forested acres for which timber production is planned and included within the acres contributing to the allowable sale of quantity. This includes both lands allocated primarily to timber production and lands on which timber production is a secondary objective.

Awarded sales - Federal timber sales that have been let to the successful bidder through a formal contract.

Back country byway - A road segment designated as part of the National Scenic Byway System.

Basal area - The area of the cross section of a tree stem including the bark, near its base, generally at breast height, or 4.5 feet above the ground.

Baseline - The starting point for analysis of environmental consequences. This may be the conditions at a point in time (e.g., when inventory data are collected) or may be the average of a set of data collected over a specified period of years.

Basic resource unit (BRU) - A term used in TRIM-PLUS for the smallest unit of timberland that has been identified in the inventory.

Basin programs - State administrative rules that establish types and amounts of water uses allowed in the state's major river basins and that form the basis for issuing water rights.

Beneficial use - In water use law, reasonable use of water for a purpose consistent with the laws and best interest of the people of the state. Such uses include, but are not limited to, the following: instream, out of stream, and ground water uses, domestic, municipal, industrial water supply, mining, irrigation, livestock watering, fish and aquatic life, wildlife, fishing, water contact recreation, aesthetics and scenic attraction, hydropower, and commercial navigation.

Best management practices (BMP) - Methods, measures, or practices designed to prevent or reduce water pollution. Not limited to structural and nonstructural controls, and procedures for operations and maintenance. Usually, BMPs are applied as a system of practices rather than a single practice.

Big game - Large mammals that are hunted by humans. Big game include elk, black tailed deer, and black bear.

Biological corridor - A habitat band linking areas of similar management and/or habitat type.

Biological diversity - The variety of life forms and processes, including a complexity of species, communities, gene pools, and ecological functions.

Biological growth potential - The average net growth of trees in a fully stocked natural forest stand.

Biological legacies - Large trees, down logs, snags, and other components of the forest stand left after harvesting for the purpose of maintaining site productivity and providing structures and ecological functions in subsequent stands.

Biological opinion - The document resulting from formal consultation that states the opinion of the Fish and Wildlife Service or National Marine Fisheries Service as to whether or not a federal action is likely to jeopardize the continued existence of listed species or results in destruction or adverse modification of critical habitat.

Biological unit management - Forest Service usage. Any unit for management of a particular species or any unit of intensive or special management. The term includes any big-game management unit as recognized by a cooperating state, even though it may not be strictly a herd unit. For fisheries management, the term may include a drainage system.

Biomass - The total quantity (at any given time) of living organisms of one or more species per unit of space (species biomass), or of all the species in a biotic community (community biomass).

Birth-pulse population - A population assumed to produce all of its offspring at an identical and instantaneous point during the annual cycle.

Block (of forest, habitat) - Geographic area of trees or vegetation that is distinct from surrounding conditions. Block size may vary greatly.

Blowdown - Trees felled by high winds.

Board foot (BF) - Lumber or timber measurement term. The amount of wood contained in an unfinished board 1 inch thick, 12 inches long, and 12 inches wide.

Breast height - A standard height from ground level for recording diameter, girth, or basal area of a tree, generally 4.5 feet.

Broadcast burn - Allowing a prescribed fire to burn over a designated area within well defined boundaries for reduction of fuel hazard or as a silvicultural treatment, or both.

Buffer - Used in the context of marbled murrelet standards and guidelines, a forested area located adjacent to suitable (nesting) marbled murrelet habitat that reduces dangers of having sharply contrasting edges of clearcuts next to such habitat. Dangers include risk of wind damage to nest trees and young, increased predation, and loss of forest interior conditions.

Bureau assessment species - Plant and animal species on list 2 of the Oregon Natural Heritage Data Base, or those species on the Oregon List of Sensitive Wildlife Species (OAR 635-100-040), which are identified in Bureau of Land Management Instruction Memo No. OR-91-57, and are not included as federal candidate, state listed, or Bureau sensitive species.

Bureau of Indian Affairs (BIA) - A division within the U.S. Department of the Interior.

Bureau of Land Management (BLM) - A division within the U.S. Department of the Interior.

Bureau sensitive species - Plant or animals species eligible for federal listed, federal candidate, state listed, or state candidate (plant) status, or on list 1 in the Oregon Natural Heritage Data Base, or approved for this category by the state director.

Cambium - The layer of tissue between the bark and wood in a tree or shrub. New bark and wood originate from this layer.

Candidate Species - Those plants and animals included in Federal Register "Notices of Review" that are being considered by the Fish and Wildlife Service for listing as threatened or endangered. Two categories that are of primary concern:

Category 1. Taxa for which there is substantial information to support proposing the species for listing as threatened or endangered. Listing proposals are either being prepared or have been delayed by higher priority listing work.

Category 2. Taxa information indicates that listing is possibly appropriate. Additional information is being collected.

Canopy - A layer of foliage in a forest stand. This most often refers to the uppermost layer of foliage, but it can be used to describe lower layers in a multistoried stand.

Canopy closure - The degree to which the canopy (forest layers above one's head) blocks sunlight or obscures the sky. It can only be accurately determined from measurements taken under the canopy as openings in the branches and crowns must be accounted for.

Capability - The potential of an area of land to produce resources, supply goods and services, and allow resource uses. Capability depends upon current vegetation conditions and site conditions such as climate, slope, landform, soils, and geology.

Capture history - A record of the recaptures or resightings of a marked individual.

Carrying capacity - The maximum number of organisms that can be supported in a given area of habitat at a given time.

Casual use - Activities ordinarily resulting in negligible disturbance of federal lands and resources.

Catastrophic event - A large-scale, high-intensity natural disturbance that occurs infrequently.

Cavity excavator - A wildlife species that digs or chips out cavities in wood to provide a nesting, roosting, or foraging site.

Cavity nester - Wildlife species, most frequently birds, that require cavities (holes) in trees for nesting and reproduction.

Center of activity - The nest site of a breeding pair of owls or primary roost area of a territorial individual owl.

Characteristic landscape - The established landscape within an area being viewed. This does not necessarily mean a naturalistic character. It could refer to an agricultural setting, an urban landscape, a primarily natural environment, or a combination of these types.

Checkerboard ownership - A land ownership pattern in which every other section (square mile) is in federal ownership as a result of federal land grants to early western railroad companies.

Cirque - A steep-headed, semicircular basin at the head of a channel of and created by a former valley glacier.

Class E (fire) - A fire that extends over an area ranging from 300 to 1,000 acres.

Class I (air quality) areas - Special areas (e.g., National Parks, certain wilderness areas) protected for their air quality related values.

Classic old growth - Forest stands with unusually old and large trees that also meet criteria for old-growth forests (See Old-growth forest.)

Clearcut - A harvest in which all or almost all of the trees are removed in one cutting.

Clearcut harvest - A timber harvest method in which all trees are removed in a single entry from a designated area, with the exception of wildlife trees or snags, to create an even-aged stand.

Climax - The culminating stage in plant succession for a given site where the vegetation has reached a highly stable condition.

Closed discretionary - Areas closed to mineral exploration and development by authority of law or regulation, but where such lands can be opened by action of the Bureau of Land Management without legislation, regulation change, Secretarial decision or Executive Order.

Closed nondiscretionary - Areas specifically closed to mineral exploration and development by authority of law, regulation, Secretarial decision (including public land orders), or Executive Order.

Closed sapling pole - Sapling and pole stand that are characterized by a closed tree canopy and minimal little ground cover. Tree closure will exceed 60 percent and often reaches 100 percent.

Closely associated species - A species is designated as "closely associated" with a forest successional stage if the species is found to be significantly more abundant in that forest successional stage compared to the other successional stages, if it is known to occur almost exclusively in that successional stage, or if it uses habitat components that are usually produced at that stage.

Cluster - An area that contains habitat capable of supporting three or more breeding pairs of spotted owls with overlapping or nearly overlapping home ranges.

Coarse woody debris (CWD) - Portion of a tree that has fallen or been cut and left in the woods. Usually refers to pieces at least 20 inches in diameter.

Coastal Oregon Productivity Enhancement Program (COPE) - A cooperative research and education program to identify and evaluate existing and new opportunities to enhance long-term productivity and economic/social benefits derived from the forest resources of coastal Oregon.

Code of Federal Regulations (CFR) - A codification of the general and permanent rules published in the Federal Register by the Executive departments and agencies of the federal government.

Cohort - Individuals all resulting from the same birth-pulse, and thus all of the same age.

Colonization - The establishment of a species in an area not currently occupied by that species. Colonization often involves dispersal across an area of unsuitable habitat.

Commercial forest land - Land declared suitable for producing timber crops and not withdrawn from timber production for other reasons.

Commercial thinning - The removal of generally merchantable trees from an even-aged stand, usually to encourage growth of the remaining trees. (See Even-aged silviculture.)

Commercial tree species - Conifer species used to calculate the commercial forest land allowable sale quantity. They are typically utilized as saw timber and include species such as Douglas-fir, hemlock, spruce, fir, pine, and cedar. (See Noncommercial tree species.)

Commodity resources - Goods or products of economic use or value.

Community - Pertaining to plant or animal species living in close association and interacting as a unit.

Community stability - The capacity of a community (incorporated town or county) to absorb and cope with change without major hardship to institutions or groups within the community.

Community water system - See Public water system.

Concern - A topic of management or public interest that is not well enough defined to become a planning issue, or does not involve controversy or dispute over resource management activities or land use allocations or lend itself to designating land use alternatives. A concern may be addressed in analysis, background documents, or procedures or in a noncontroversial decision.

Conferencing - Informal discussion or correspondence consultation that takes place between the U.S. Fish and Wildlife Service and another federal agency when it is determined that a proposed federal action may jeopardize the continued existence of a species proposed as threatened or endangered or result in adverse modification of proposed critical habitat.

Confidence interval - An interval that is calculated from a series of samples intended to estimate the value of a parameter. The confidence level is the probability that the true value of the parameter falls within the confidence interval.

Confidence level - The probability that the true value for a parameter is included within the confidence interval calculated for a sample of that parameter.

Congressionally Withdrawn Areas - Areas that require Congressional enactment for their establishment, such as National Parks, Wild and Scenic Rivers, National Recreation Areas, National Monuments, and Wilderness.

Conifer - A tree belonging to the order Gymnospermae, comprising a wide range of trees that are mostly evergreens. Conifers bear cones (hence, coniferous) and needle-shaped or scalelike leaves.

Connectivity - A measure of the extent to which conditions among LS/OG forest areas provide habitat for breeding, feeding, dispersal, and movement of LS/OG-associated wildlife and fish species. (See LS/OG forest.)

Conservation - The process or means of achieving recovery of viable populations.

Conservation area - Designated land where conservation strategies are applied for the purpose of attaining a viable plant or animal population.

Conservation recommendations - Suggestions by the Fish and Wildlife Service or National Marine Fisheries Service in biological opinions regarding discretionary measures to minimize or avoid adverse effects on a proposed action of federally listed threatened or endangered species or designated critical habitat.

Conservation strategy - A management plan for a species, group of species, or ecosystem that prescribes standards and guidelines that if implemented provide a high likelihood that the species, groups of species, or ecosystem, with its full complement of species and processes, will continue to exist well-distributed throughout a planning area, i.e., a viable population.

Consistency - Under the Federal Land Policy and Management Act, the adherence of Bureau of Land Management resource management plans to the terms, conditions, and decisions of officially approved and adopted resource related plans or, in their absence, with policies and programs of other federal agencies, state and local governments and Indian tribes, so long as the plans are also consistent with the purposes, policies, and programs of federal laws and regulations applicable to Bureau of Land Management lands. Under the Coastal Zone Management Act, the adherence to approved state management programs, to the maximum extent practicable, of federal agency activities affecting the defined coastal zone.

Constrained Timber Production Base - Acreage managed for timber production at less than full intensity in consideration of nontimber resource management objectives.

Consultation - A formal interaction between the U.S. Fish and Wildlife Service and another federal agency when it is determined that the agency's action may affect a species that has been listed as threatened or endangered or its critical habitat.

Contiguous habitat - Habitat suitable to support the life needs of species that is distributed continuously or nearly continuously across the landscape.

Coos Bay Wagon Road (CBWR) lands - Public lands granted to the Southern Oregon Company and subsequently reconveyed to the United States.

Core area - That area of habitat essential in the breeding, nesting and rearing of young, up to the point of dispersal of the young.

Corridor - A defined tract of land, usually linear, through which a species must travel to reach habitat suitable for reproduction and other life-sustaining needs.

Cost efficiency - The usefulness of species inputs (costs) to produce specified outputs (benefits). In measuring cost efficiency some outputs, including environmental, economic, or social impacts, are not usually assigned monetary values, but are achieved at specified level in the least costly manner. Cost efficiency usually is measured using present net value, although use of benefit-cost ratios and rates-of-return may be appropriate.

Cover - Vegetation used by wildlife protection from predators, or to mitigate weather conditions, or to reproduce. May also refer to the protection of the soil and the shading provided to herbs and forbs by vegetation.

Critical habitat - Under the Endangered Species Act, critical habitat is defined as (1) the specific areas within the geographic area occupied by a federally listed species on which are found physical and biological features essential to the conservation of the species, and that may require special management considerations or protection; and (2) specific areas outside the geographic area occupied by a listed species, when it is determined that such areas are essential for the conservation of the species.

Critical link - In this report; geographic areas between physiographic provinces that represent most likely avenues for dispersing spotted owls provided habitat conditions are favorable for such movement.

Crown - The upper part of a tree or other woody plant that carries the main system of branches and the foliage.

Crown cover - The degree to which the crowns of trees are nearing general contact with one another. Generally measured as the percentage of the ground surface that would be covered by a downward vertical projection of foliage in the crowns of trees.

Crucial habitat - Habitat that is basic to maintaining viable populations of fish or wildlife during certain seasons of the year or specific reproduction periods.

Crude density - The number of individuals in an area.

Cubic foot - A unit of solid wood, 1 foot square and 1 foot thick.

Cull - A tree or log that does not meet merchantable specifications.

Culmination of mean annual increment (CMAI) - The peak of average yearly growth in volume of a forest stand (total volume divided by age of stand).

Cultural resource - Any definite location of past human activity identifiable through field survey, historical documentation, or oral evidence. This includes archaeological or architectural sites, structures, or places, and places of traditional cultural or religious importance to specified groups whether or not represented by physical remains.

Cultural site - Any location that includes prehistoric and/or historic evidence of human use or that has important sociocultural value.

Cumulative effects - Those effects on the environment that result from the incremental effect of the action when added to the past, present, and reasonably foreseeable future actions regardless of what agency (federal or nonfederal) or person undertakes such other actions. Cumulative effects can result from individually minor but collectively significant actions taking place over a period of time.

Debris flow (debris torrent) - A rapid moving mass of rock fragments, soil, and mud, with more than half of the particles being larger than sand size.

Debris slide - A slow to rapid slide, involving downslope translation of relatively dry and predominantly unconsolidated materials, with more than half of the particles being larger than sand size.

Debris torrent - Rapid movement of a large quantity of materials (wood and sediment) down a stream channel during storms or floods. This generally occurs in smaller streams and results in scouring of streambed.

Decommission - To remove those elements of a road that reroute hillslope drainage and present slope stability hazards. Another term for this is "hydrologic obliteration."

Defoliators - Insects that feed on foliage and act to remove some or all of the foliage from a tree, shrub, or herb.

Demographic model - A model that predicts the future state of an animal population based on its birth and death rates.

Demographic stochasticity - Random fluctuations in birth and death rates.

Demography - The quantitative analysis of population structure and trends; population dynamics.

Density, biological population - The number or size of a population in relation to some unit of space. It is usually expressed as the number of individuals or the population biomass per unit area or volume.

Density-dependent - A process, such as fecundity, whose value depends on the number of animals in the population per unit area.

Density management - In Bureau of Land Management draft planning documents of 1992, the cutting of trees for the primary purpose of widening their spacing so that growth of remaining trees can be accelerated. The Bureau also plans to use density management to improve forest health, to open the forest canopy, or to accelerate the attainment of old-growth characteristics if maintenance or restoration of biological diversity is the objective.

Density study area - An area in which the objective is to count all individuals that are present, thereby monitoring population trend over time.

Departure (from even flow) - A timber sale level that deviates from sustainable sale levels through a planned temporary increase or decrease in the allowable sale quantity. Must be economically and biologically justified.

Depauperate - Poorly developed. In biology, it usually refers to an area that has relatively few plant and animal species.

Designated area - An area identified in the Oregon Smoke Management Plan as a principal population center requiring protection under state air quality laws or regulations.

Designated conservation area (DCA) - A contiguous area of habitat to be managed and conserved for spotted owls under the Final Draft Recovery Plan for the Northern Spotted Owl. This general description can be applied to two DCA categories:

DCA 1 - Category intended to support at least 20 pairs of spotted owls.

DCA 2 - Category intended to support one to 19 pairs of spotted owls.

Desired future condition - For this report, an explicit description of the physical and biological characteristics of aquatic and riparian environments believed necessary to meet fish, aquatic ecosystem, and riparian ecosystem objectives.

Developed recreation site - A site developed with permanent facilities designed to accommodate recreation use.

df - Degree of freedom, which is usually the sample, n, minus 1 (i.e., n-1)

Diameter at breast height (DBH) - The diameter of a tree 4.5 feet above the ground on the uphill side of the tree.

Dispersal - The movement, usually one way and on any time scale, of plants or animals from their point of origin to another location where they subsequently produce offspring.

Dispersal capability - The ability of members of a species to move from their area of birth to another suitable location and subsequently breed.

Dispersal distance - A straight-line distance that an individual travels from its birth place until it stops dispersing (assumed to be a breeding site) or dies.

Dispersal habitat - Habitat that supports the life needs of an individual animal during dispersal. Generally satisfies needs for foraging, roosting, and protection from predators.

Dispersed recreation - Outdoor recreation in which visitors are diffused over relatively large areas. Where facilities or developments are provided, they are primarily for access and protection of the environment rather than comfort or convenience of the user.

Dissected - Cut by erosional processes into hills and valleys, or into flat interstream areas and valleys.

Distribution (of a species) - The spatial arrangement of a species within its range.

Disturbance - A force that causes significant change in structure and/or composition through natural events such as fire, flood, wind, or earthquake, mortality caused by insect or disease outbreaks, or by human-caused events, e.g., the harvest of forest products.

Diversity - The variety, distribution, and abundance of different plant and animal communities and species within an area. (See Biological diversity.)

Down log - Portion of a tree that has fallen or been cut and left in the woods. Particularly important as habitat for some LS/OG-associated species.

Domestic water supply - Water used for human consumption.

Dominant use - The guiding principle for the management of all O&C (Oregon and California Railroad) lands inventoried as "suitable commercial forest land" whereby such lands are to be managed primarily for timber production on a sustained yield basis with due consideration for the other forest uses identified in the O&C Act and subject to any relevant requirements specified in subsequent legislation. (Examples of such subsequent legislation are the Endangered Species Act and the Federal Water Pollution Control Act).

Draft environmental impact statement (DEIS) - The draft statement of environmental effects that is required for major federal action under Section 102 of the National Environment Policy Act, and released to the public and other agencies for comment and review.

Drainage - An area (basin) mostly bounded by ridges or other similar topographic features, encompassing part, most, or all of a watershed and enclosing some 5,000 acres. (See Subdrainage and Forest watershed.)

Duff layer - The layer of loosely compacted debris underlying the litter layer on the forest floor.

Early seral stage forests - Stage in forest development that includes seedling, sapling, and pole-sized trees.

Earthflow - A mass-movement landform and slow to rapid process characterized by downslope translation of soil and weathered rock over a discrete shear zone at the base, with most of the particles being smaller than sand.

East-side forests - The 12 National Forests in Washington, Oregon, and California that lie partly or wholly east of the Cascade Mountain Range crest: Colville, Deschutes, Fremont, Klamath, Malheur, Ochoco, Okanogan, Shasta-Trinity , Umatilla, Wallowa-Whitman, Wenatchee, and Winema National Forest.

Ecological health - The state of and ecosystem in which processes and functions are adequate to maintain diversity of biotic communities commensurate with those initially found there.

Ecologically significant - Species, stands, and forests considered important to maintaining the structure, function, and processes of particular ecosystems.

Economically feasible - Having costs and revenues with a present net value greater than zero.

Ecosystem - A unit comprising interacting organisms considered together with their environment (e.g., marsh, watershed, and lake ecosystems).

Ecosystem diversity - The variety of species and ecological processes that occur in different physical settings.

Ecosystem management - A strategy or plan to manage ecosystems to provide for all associated organisms, as opposed to a strategy or plan for managing individual species.

Edge - Where plant communities meet or where successional stages or vegetative conditions with plant communities come together.

Edge contrast - A qualitative measure of the difference in structure of two adjacent vegetated areas (e.g., "low," "medium," or "high" edge contrast).

Edge effects - The drastically modified environmental conditions along the margins, or "edges," of forest patches surrounded partially or entirely by harvested lands. These conditions may extend 600 feet or more into the forest from the harvest boundary. Only forested areas at substantial distances from the edge (generally, the center of a forest patch of 100 acres or more) provide unmodified interior forest conditions.

Effective old-growth-habitat - Old-growth forest largely unmodified by external environmental influences (e.g., wind, temperature, encroachment of nonresident species) from nearby, younger forest stands. Also referred to as interior habitat. For purposes of analysis, assumed to be at least 400 feet from an edge with an adjacent stand younger than age class 70.

Eligible river - A river or river segment found, through interdisciplinary team and, in some cases, interagency review, to meet Wild and Scenic River Act criteria of being free-flowing and possessing one or more outstandingly remarkable values.

Emigration - Permanent movement of individuals of a species from a population.

Employment effect - The estimated total number of jobs that will be lost or gained because of a change in the harvest level, including timber-industry jobs and other manufacturing and nonmanufacturing jobs dependent on timber harvest.

Endangered species - Any species of plant or animal defined through the Endangered Species Act as being in danger of extinction throughout all or a significant portion of its range, and published in the Federal Register.

Endemic - A species that is unique to a specific locality.

Environmental analysis - An analysis of alternative actions and their predictable short-term and long-term environmental effects, incorporating physical, biological, economic, and social considerations.

Environmental assessment (EA) - A systematic analysis of site-specific activities used to determine whether such activities have a significant effect on the quality of the human environment and whether a formal environmental impact statement is required; and to aid an agency's compliance with the National Environmental Policy Act when no environmental impact statement is necessary.

Environmental impact - The positive or negative effect of any action upon a given area or resource.

Environmental impact statement (EIS) - A formal document to be filed with the Environmental Protection Agency that considers significant environmental impacts expected from implementation of a major federal action.

Environmental Protection Agency - An independent agency of the U.S. government (cabinet-level status is pending).

Environmental stochasticity - Random variation in environmental attributes such as temperature, precipitation, and fire frequency.

Ephemeral streams - Streams that contain running water only sporadically, such as during and following storm events.

Epiphyte - A plant that grows upon another plant and that is nonparasitic. Most of the plant's necessary moisture and nutrients are derived from the atmosphere.

Established stand - A reforestation unit of suitable trees that are past the time when considerable juvenile mortality occurs. The unit is no longer in need of measures to ensure survival but is evaluated for measures to enhance growth.

Even-aged forest - A forest stand comprising trees with less than a 20-year difference in age.

Even-aged silviculture - Manipulation of a forest stand to achieve a condition in which trees have less than a 20-year age difference. Regeneration in a particular stand is obtained during a short period at or near the time that a stand has reached the desired age or size for harvesting. Clearcut, shelterwood, or seed tree cutting methods produce even-aged stands.

Experimental forests - Forest tracts, generally on National Forests, designated as areas where research and experiments involving forestry, wildlife, and related disciplines can be conducted.

Existing stand condition (ESC) - An artificial classification that groups forest stands with similar management potential into categories matched to tables expressing yield at various stand ages under various combinations of silvicultural treatment.

Extended rotation - A period of years that is longer than the time necessary to grow timber crops to a specified condition of maturity. (See Rotation).

Extended rotation age - A point in time when trees are harvested or planned to be harvested that is beyond the age when harvest ordinarily would occur. (See Rotation age.)

Extensive recreation management areas (ERMA) - All Bureau of Land Management lands outside special recreation management areas. These areas may include developed and primitive recreation sites with minimal facilities.

Extinct species - A species that no longer exists.

Extirpation - The elimination of a species from a particular area.

Extirpation risk species - Those species that were generally ranked as having a medium-low or low viability over a 50-year period. Extirpation related to local extinction of a species from one or more National Forests within the range of the northern spotted owl.

Fault - A break or shear in the continuity of a body of rock on which there has been an observable displacement of the two parts.

Fecundity - Number of female young produced per adult female in the population of interest.

50-11-40 rule - One of the standards and guidelines of the Interagency Scientific Committee strategy designed to provide dispersal habitat for northern spotted owls on lands outside reserves. Calls for maintaining 50 percent of forested land within each quarter township (9 square miles) in forested condition with stands of trees averaging at least 11 inches diameter at breast height and with a stand canopy closure of at least 40 percent.

Final Draft Recovery Plan for the Northern Spotted Owl - A management plan developed under the authority of the Endangered Species Act that sets forth management standards and population or other biological objectives for listed species. Implementation of such plans has a high likelihood that the species population and/or distribution will improve to the point listing is no longer appropriate.

Final environmental impact statement (FEIS) - The final report of environmental effects of proposed action on an area of land. This is required for major federal actions under Section 102 of the National Environmental Policy Act. It is a revision of the draft environmental impact statement to include public and agency responses to the draft.

Fire regime - The characteristic frequency, extent, intensity, severity, and seasonality of fires in an ecosystem.

Fire severity - The degree to which a site has been altered or disrupted by fire. Severity reflects fire intensity and residence time.

Fire suppression - The practice of controlling and extinguishing wild fires.

Fire-tolerant species - Plant species that have evolved to survive low-intensity ground fires.

Fish and Wildlife Service (F&WS) - A division within the U.S. Department of the Interior.

Floaters - Nonbreeding adults and subadults that move and live within a breeding population, often replacing breeding adults that die; nonterritorial individuals.

Floodplain - Level lowland bordering a stream or river onto which the flow spreads at flood stage.

Food chain - Organisms that are interrelated in their feeding habits, each feeding upon organisms that are lower in the chain and in turn being fed on by organisms higher in the chain.

Forest canopy - The cover of branches and foliage formed collectively by the crowns of adjacent trees and other woody growth.

Forest fragmentation - The change in the forest landscape, from extensive and continuous forests of old-growth to a mosaic of younger stand conditions.

Forest land - Land that is now, or is capable of becoming, at least 10 percent stocked with forest trees and that has not been developed for nontimber use.

Forest landscape - Land presently forested or formerly forested and not currently developed for nonforest use.

Forest matrix - Forest lands between designated areas managed primarily for spotted owl habitat.

Forest not suitable for timber production - Forest withdrawn from commercial timber production. (See Reserved land.)

Forest plan - A land management plan designed and adopted to guide forest management activities on a National Forest or Bureau of Land Management District.

Forest succession - The orderly process of change in a forest as one plant community or stand condition is replaced by another, evolving toward the climax type of vegetation.

Forest suitable for timber production - Forest identified as appropriate for commercial timber production. Generally, this area equals the forest tentatively suitable for timber production minus further withdrawals to protect fish and wildlife, watersheds, and other resources, to pursue multiple-use objectives reflecting scenic quality, dispersed recreation, and other values, or to avoid situations in which the benefits of timber production are less than the costs.

Forest Service - A division within the U.S. Department of Agriculture.

Forest Ecosystem Management Assessment Team - As assigned by President Clinton, the team of scientists, researchers, and technicians from seven federal agencies who created this report.

Forest tentatively suitable for timber production - Total forest minus forests (1) legally withdrawn from production (e.g., Wilderness) or (2) judged too unstable for timber harvest, too difficult to regenerate, or too unproductive.

Forest watershed - The forested drainage area contributing water, organic matter, dissolved nutrients, and sediments to a lake or stream.

Fractured - A rock mass separated into distinct fragments.

Fragile nonsuitable - A classification indicating forest land having fragile conditions, and harvesting such lands would result in reduced future productivity even if special harvest or restrictive measures were applied. These fragile conditions are related to soils, geological structure, topography, and ground water.

Fragmentation - The process of reducing size and connectivity of stands that compose a forest.

Fragmentation (of LS/OG stands) - The process of reducing the size and connectivity of LS/OG areas.

Fuel loading - The amount of combustible material present per unit of area, usually expressed in tons per acre.

Full log suspension - Suspension of the entire log above the ground during yarding operations.

Functional LS/OG network - A connected series of blocks of late-successional and/or old-growth forest that, because of their size, their distribution, and the presence of certain environmental conditions, provide habitat for viable populations of associated plant and animal species.

Genetic diversity - The variety within populations of a species.

Geomorphic - Pertaining to the form or shape of and those processes that affect the surface of the earth.

Geographic information system (GIS) - A computer system capable of storing and manipulating spatial (i.e., mapped) data.

Granitic - Any light-colored, coarse-grained rock formed at considerable depth by crystallization of molten rock.

Green tree - A live and growing tree.

Green tree retention - A stand management practice in which live trees as well as snags and large down wood are left as biological legacies within harvest units to provide habitat components over the next management cycle. There are two levels:

High level - A regeneration harvest designed to retain the highest level of trees possible while still providing enough disturbance to allow regeneration and growth of the naturally occurring mixture of tree species. Such harvest should allow for the regeneration of intolerant and tolerant species. Harvest design would also retain cover and structural features necessary to provide foraging and dispersal habitat for mature and old-growth dependant species.

Low level - A regeneration harvest designed to retain only enough green trees and other structural components (snag, coarse woody debris, etc.) to result in the development of stands that meet old-growth definitions within 100 to 120 years after harvest entry, considering overstory mortality.

Gross yarding - Removal of all woody material of specified size from a logging unit to a landing.

Group selection cutting - Removal of groups of trees ranging in size from a fraction of an acre up to about 2 acres. Area cut is smaller than the minimum feasible under even-aged management for a single stand.

Guideline - A policy statement that is not a mandatory requirement (as opposed to a standard, which is mandatory).

Habitat - The place where a plant or animal naturally or normally lives and grows.

Habitat capability - The estimated number of pairs of spotted owls that can be supported by the kind, amount, and distribution of suitable habitat in the area. As used in the Final Draft Recovery Plan for the Northern Spotted Owl, this means the same as capability to support spotted owl pairs.

Habitat conservation area (HCA) - As proposed by the Interagency Scientific Committee, a contiguous block of habitat to be managed and conserved for breeding pairs, connectivity, and distribution of owls. Application may vary throughout its range according to local conditions.

Habitat conservation plan (HCP) - An agreement between the Secretary of the Interior and either a private entity or a state that specifies conservation measures that will be implemented in exchange for a permit that would allow taking of a threatened or endangered species.

Habitat diversity - The number of different types of habitat within a given area.

Habitat fragmentation - The breaking up of habitat into discrete islands through modification or conversion of habitat by management activities.

Hamilton Report - A federal assessment of the economic impact of the Interagency Scientific Committee strategy.

Hard snag - A recently dead standing tree that typically still has an intact top, a high degree of bark cover, and most limbs. Hard snags are required by a number of wildlife species, including cavity nesters.

Hardwood site - A forest site occupied by hardwoods that is unsuitable for the production of conifer species.

Harvest cutting method - Methods used to harvest trees. Harvest cutting methods are classified as even-aged and uneven-aged.

Harvest scheduling analysis - An analysis of the harvest level possible over time under assumptions about the land available for timber production, land productivity, management intensity, and fluctuation in harvest level permitted from period to period.

Hazardous Materials - Anything that poses a substantive present or potential hazard to human health or the environment when improperly treated, stored, transported, disposed of, or otherwise managed.

Helicopter logging - Use of helicopters to transport logs from where they are felled to a landing.

Hiding cover - Generally, any vegetation used by wildlife for security or to escape from danger. More specifically, any vegetation capable of providing concealment (e.g., hiding 90 percent of an animal) from human view at a distance of 200 feet or less.

High-grading - Timber removal that focuses on the largest, most commercially valuable trees. This practice often leaves a stand composed of trees in poor condition and may result in a change in tree species' composition.

High-lead cable system - A harvest technology where cut logs are suspended above the ground and transported to a landing.

High severity fire - A wildfire event with acute ecological impacts; usually, but not always of high intensity.

High viability risk species - In this report, those species that were generally ranked as less than high or medium-high viability over a 50-year period.

Historic site - A cultural resource resulting from activities or events dating to the historic period, generally post 1830 AD in western Oregon.

Home range - The area that an animal traverses in the scope of normal activities. This is not to be confused with territory, which is the area an animal defends.

Home range of a pair - The sum of the home ranges of each member of a pair minus the area of home range overlap.

Horizontal diversity - The distribution and abundance of plant and animal communities and successional stages across an area of land. The greater the number of communities, the higher the degree of horizontal diversity.

Hummocky - A landscape characterized by small, well-drained areas rising above the general level of poorly drained land.

Hybrid - An offspring that results from the mating of individuals of different races or species.

Hybridization - The crossing or mating of two different varieties of plants or animals.

Hyporheic zone - The area under the stream channel and floodplain that contributes to the stream.

Immigration - Movement of individuals into a population.

Impact - A spatial or temporal change in the environment caused by human activity.

Improved seed - Seed originated from a seed orchard or selected tree(s) whose genetic superiority in one or more characteristics important to forestry has been proven by tests conducted in specific environments.

Inbreeding - Mating or crossing of individuals more closely related than average pairs in the population.

Incidental take - "Take" of a threatened or endangered species that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. (See Take.)

Income effect - The estimated total amount of personal income that will be lost or gained because of a change in the harvest level, including income from displaced workers and workers employed at lower wages as well as the impact of "cooling" the labor market through increased labor supplies. (See Employment effect.)

Infiltration (soil) - The movement of water through the soil surface into the soil.

Ingrowth - The period after successional growth of a forest stand when it reaches a specified age or structure class. For instance, spotted owl foraged habitat.

Inholding - Land belonging to one landowner that occurs within a block of land belonging to another. For example, small parcels of private land that occur inside National Forest.

Inner gorge - A stream reach bounded by steep valley walls that terminate upslope into a more gentle topography. Common in areas of rapid stream downcutting or uplift, such as northern California and southwestern Oregon.

Instant study area - A natural area formally identified by the Bureau of Land Management for accelerated wilderness review by notice published before October 21, 1975.

Integrated pest management (IPM) - A systematic approach that uses a variety of techniques to reduce pest damage or unwanted vegetation to tolerable levels. IPM techniques may include natural predators and parasites, genetically resistant hosts, environmental modifications, and when necessary and appropriate, chemical pesticides or herbicides.

Integrated vegetation management - See Integrated pest management.

Intensive forest management practices - The growth-enhancing practices of release, precommercial thinning, commercial thinning, and fertilization, designed to obtain a high level of timber volume or quality.

Intensively managed timber stands - Forest stands managed to obtain a high level of timber volume or quality through investment in growth-enhancing practices, such as precommercial thinning, commercial thinning, and fertilization. Not to be confused with the allocations of "lands available for intensive management of forest products."

Intensive timber production base - All commercial forest land allocated to timber production and intensively managed to obtain a high level of timber volume or quality.

Interagency Northern Spotted Owl Conservation Group (INSOCG) - A committee formed under a 1990 interagency agreement to cooperate on the management and conservation of the northern spotted owl. It includes the U.S. Forest Service, U.S. Fish and Wildlife Service, Bureau of Land Management, National Park Service, and states of California, Oregon, and Washington.

Interagency Scientific Committee (ISC) - A committee of scientists that was established by the federal government agencies -- Forest Service, Bureau of Land Management, Fish and Wildlife Service, and National Park Service to develop a conservation strategy for northern spotted owls.

Interagency Spotted Owl Subcommittee - A subcommittee of the Oregon-Washington Interagency Wildlife Committee that was formed to recommend guidelines to federal land management agencies for the protection of the northern spotted owl.

Interdisciplinary team - A group of individuals with varying areas of specialty assembled to solve a problem or perform a task. The team is assembled out of recognition that no one scientific discipline is sufficiently broad enough to adequately analyze the problem and propose action.

Interim (short-term) solution - Actions to be taken in a 2- to 4-year period.

Intermittent stream - Any nonpermanent flowing drainage feature having a definable channel and evidence of scour or deposition. This includes what are sometimes referred to as ephemeral streams if they meet these two criteria.

Interspecific - Occurring among members of different species.

Interspecific competition - The condition of rivalry that exists when a number of organisms of different species use common resources that are in short supply; or, if the resources are not in short supply, the condition that occurs when the organisms seeking that resource nevertheless harm one or another in the process. Competition usually is confined to closely related species that eat the same sort of food or live in the same sort of place. Competition typically results in ultimate elimination of the less effective organism from that ecological niche.

Intraspecific - Occurring among members of a single species.

Inventory river - A potential wild, scenic, or recreational river identified in the 1982 National Rivers Inventory (NRI) published by the National Park Service.

Irreversible or irretrievable commitment of resources - Effect of an action or inaction that cannot be reversed within a reasonable time.

ISC strategy - The set of management standards and guidelines, and associated monitoring and research studies, proposed by the Interagency Scientific Committee to address conservation of the northern spotted owl. This strategy ensures a high probability of long-term persistence of viable owl populations on federal lands in the Pacific Northwest.

ISODATA clustering - Iterative self-organizing data analysis technique, a statistical clustering technique that assigns spectral reflectance values to groups based on spectral distance between pairs of observations. This technique operates in an iterative fashion to optimize the statistical separation between groups.

Isolate - A population that is isolated.

Isolation - Absence of genetic crossing among populations because of distance or geographic barriers.

Issue - A matter of controversy or dispute over resource management activities that is well defined or topically discrete. Addressed in the design of planning alternatives.

Jamison strategy - A spotted owl conservation strategy adopted by the Bureau of Land Management that included some but not all of the major provisions of the Interagency Scientific Committee strategy.

Jeopardy - A finding made through consultation under the Endangered Species Act that the action of a federal agency is likely to jeopardize the continued existence of a threatened or endangered species.

Jolly seber models - A group of mathematical models designed to estimate survival rates of organisms that are marked and then recaptured or reobserved on subsequent occasions.

Juvenile - For spotted owls, a juvenile is normally considered to be any bird that is less than 1 year old.

Key watershed - As defined by National Forest and Bureau of Land Management District fish biologists, a watershed containing (1) habitat for potentially threatened species or stocks of anadromous salmonids or other potentially threatened fish, or (2) greater than 6 square miles with high-quality water and fish habitat.

Kuchler vegetative types - Potential natural vegetation of the coterminous United States, classified by Kuchler.

Lambda - The finite rate of population change (population size in year 2 divided by the population size in year 1).

Land allocation - The specification in forest plans of where activities, including timber harvest, can occur on a National Forest or Bureau of Land Management District.

Landing - Any place on or adjacent to the logging site where logs are assembled for further transport.

Landsat - A satellite that provides imagery used in remote sensing of forests. Analysis of this imagery produces maps of vegetation condition.

Landsat Multispectral Scanner (Landsat MSS) - A satellite-borne sensor, first launched in 1972, capable of recording reflected energy from the surface of Earth in four wavelength "bands" or divisions of the visible and infrared spectrum. The sensor records reflectance in the green, red, and near infrared portions of the spectrum as numeric "reflectance values" for a 180 x 180 km scene that is useful for mapping natural resources.

Landsat Thematic Mapper - An improved version of the Landsat MSS satellite sensor capable of recording reflected and emitted energy from the surface of Earth in seven "bands" or divisions of the visible and infrared spectrum. First launched in 1982, this sensor has improved spatial resolution and finer tuning of the spectral wavelengths for specific application to forestry, geology, agriculture, and water resource studies.

Landscape - A heterogenous land area with interacting ecosystems that are repeated in similar form throughout.

Landscape diversity - The size, shape, and connectivity of different ecosystems across a large area.

Landscape features - The land and water form, vegetation, and structures that compose the characteristic landscape.

Large woody debris - Pieces of wood larger than 10 feet long and 6 inches in diameter, in a steam channel.

Large woody material - Logs on the forest floor in pieces at least 24 inches in diameter at the large end.

Late seral stage forest - Stage in forest development that includes mature and old-growth forest. (See Seral stages.)

Late-Successional Reserve - A forest in its mature and/or old-growth stages that has been reserved under each option in this report. (See Old-growth forest and Succession.)

Lava flow - A congealed stream of lava.

Leasable minerals - Minerals that may be leased to private interests by the federal government. Includes oil, gas, geothermal resources, and coal.

Leave strips - Generally narrow bands of forest trees that are left along streams and rivers to buffer aquatic habitats from upslope forest management activities.

Litter layer - The loose, relatively undecomposed organic debris on the surface of the forest floor made up typically of leaves, bark, small branches, and other fallen material.

Locatable minerals - Minerals subject to exploration, development, and disposal by staking mining claims as authorized by the Mining Law of 1872 (as amended). This includes valuable deposits of gold, silver, and other uncommon minerals not subject to lease or sale.

Log decomposition class - Any of five stages of deterioration of logs in the forest. Stages range from essentially sound (class 1) to almost total decomposition (class 5).

Long-term - Here, 50 to 100 years and sometimes beyond.

Long-term soil productivity - The ability of a soil to sustain a nondeclining yield of a timber crop in perpetuity and retain the potential for the targeted species to be grown at the same stocking level and growth rate after each rotation.

Long-term sustained yield (LTSY) - Estimated timber harvest that can be maintained indefinitely, once all stands have been converted to a managed state under a specific management intensity.

LS/OG forest (or stands) - Late-successional and/or old growth. Forests or stands consisting of trees and structural attributes and supporting biological communities and processes associated with old-growth and/or mature forests.

Lumber and wood products, except furniture - An industrial classification that includes logging contractors engaged in cutting timber and pulpwood: merchant sawmills, lath mills, shingle mills, planing mills, plywood mills, and veneer mills engaged in producing lumber and wood basic materials; and establishments engaged in manufacturing finished articles made entirely or mainly of wood or wood substitutes. Certain types of establishments producing wood products are classified elsewhere (e.g., furniture and office and store fixtures are in a different classification).

Major plant grouping - An aggregation of plant associations with similar management potential and with the same dominant late seral conifer species and the same major early seral species. Late seral rather than climax species are used because late seral species are usually present rather than climax communities and because most old-growth plant communities on Bureau of Land Management lands are made up of late seral species rather than climax species in the upper canopy.

Managed forest - Any forestland that is treated with silvicultural practices and/or harvested. Generally applied to land that is harvested on a scheduled basis and contributes to an allowable sale quantity.

Managed Late-Successional Areas - Selected harvest areas and managed pair areas.

Managed pair areas - In some portions of the northern spotted owl's range it is necessary to provide additional protection in the matrix for pairs of owls and territorial singles. This consists of delineating a core habitat area, plus additional acreage of suitable habitat around the core. The acreage to be delineated around the core varies throughout the range, based on data for pairs in that area. The suitable acreage must be delineated in an area equal to the mean home range for that physiographic province. Appropriate silvicultural treatment is encouraged in suitable and unsuitable habitat in the acreage around the core.

Management activity - An activity undertaken for the purpose of harvesting, traversing, transporting, protecting, changing, replenishing, or otherwise using resources.

Management framework plan (MFP) - A land use plan that established coordinated land use allocations for all resource and support activities for a specific land area within a Bureau of Land Management District. It established objectives and constraints for each resource and support activity and provided data for consideration in program planning. This process has been replaced by the resource management planning process.

Management intensity (MI) - An expression of a potential type of management for a group resource unit in TRIM-PLUS, expressed as a yield table.

Management prescription - The management practices and intensity selected and scheduled for application on a specific area to attain multiple-use and other goals and objectives.

Marbled murrelet - A small robin-sized seabird *(Brachyramphus marmoratus)* that nests in old-growth forests within 50 miles of marine environments. Proposed for listing as a threatened species by the U.S. Fish and Wildlife Service.

Marbled murrelet habitat - Primarily late-successional/old-growth forest with trees that are large enough and old enough to develop broad crowns and large limbs, which provide substrates for nests. Also includes some younger stands in which tree limbs are deformed by dwarfmistletoe, creating broad platforms.

Marbled murrelet zone 1 - A 10 to 40 mile-wide zone adjacent to marine areas in which the majority of marbled murrelet detections and nests are located.

Marbled murrelet zone 2 - An inland zone that abuts marbled murrelet zone 1. Numbers of murrelet detections in zone 2 indicate that it is used by only a small fraction of the breeding population.

Marginal spotted owl habitat - Vegetative communities, usually forest stands, that may provide for spotted owl life needs at least intermittently. Other times, depending on other environmental factors, the life needs of spotted owls would not be met. A landscape with a predominance of marginal habitat would not be thought to sustain a viable population of spotted owls.

Mass movement - The downslope movement of earth caused by gravity. Includes but is not limited to landslides, rock falls, debris avalanches, and creep. It does not, however, include surface erosion by running water. It may be caused by natural erosional processes, or by natural disturbances (e.g., earthquakes or fire events) or human disturbances (e.g., mining or road construction).

Mature seral stage - See Seral stages.

Matrix - Federal lands outside of reserves, withdrawn areas, and Managed Late-Successional areas.

Mature stand - A mappable stand of trees for which the annual net rate of growth has peaked. Stands are generally greater than 80-100 years old and less than 180-200 years old. Stand age, diameter of dominant trees, and stand structure at maturity vary by forest cover types and local site conditions. Mature stands generally contain trees with a smaller average diameter, less age class variation, and less structural complexity than old-growth stands of the same forest type. Mature stages of some forest types are suitable habitat for spotted owls. However, mature forests are not always spotted owl habitat, and spotted owl habitat is not always mature forest.

Maximum likelihood classification - A statistical classification technique that assigns reflectance values to groups based on the probability that an observation belongs to a particular class.

Merchantable trees, stands, timber - Trees or stands that people will buy for the wood they contain.

Mesic - Pertaining to or adapted to an area that has a balanced supply of water; neither wet nor dry.

Meta-analysis - A method or analysis that simultaneously examines multiple sets of data from different subsets of a population to determine if there are any general trends in the population.

Meta-population - A population comprising local populations that are linked by migrants, allowing for recolonization of unoccupied habitat patches after local extinction events.

Microenvironment - The sum total of all the external conditions that may influence organisms and that come to bear in a small or restricted area.

Microhabitats - A restricted set of distinctive environmental conditions that constitute a small habitat, such as the area under a log.

Mid seral stage - See Seral stages.

Mineral estate - The ownership of the minerals at or beneath the surface of the land.

Mineral potential classification system - Method for assessing the potential for the presence of a concentration of one or more energy and/or mineral resources.

Minimum harvest age - The lowest age of a forest stand to be scheduled for final harvest.

Minimum stocking - Reforestation level lower than target stocking. Does not achieve full site occupancy in young stands but is capable of achieving optimal final harvest yield and reduced commercial thinning yield.

Minimum streamflow - The quantity of water needed to maintain the existing and planned in-place uses of water in or along a steam channel or other water body and to maintain the natural character of the aquatic system and its dependent systems.

Minimum viable population - The low end of the viable population range.

Mining claims - Portions of public lands claimed for possession of locatable mineral deposits, by locating and recording under established rules and pursuant to the 1872 Mining Law.

Mitigating measures - Modifications of actions that (1) avoid impacts by not taking a certain action or parts of an action; (2) minimize impacts by limiting the degree or magnitude of the action and its implementation; (3) rectify impacts by repairing, rehabilitating, or restoring the affected environment; (4) reduce or eliminate impacts over time by preservation and maintenance operations during the life of the action; or (5) compensate for impacts by replacing or providing substitute resources or environments.

Mixed conifer - Here, this term refers to stands of trees, made up of pine, Douglas-fir, and true firs, that are generally found east of the Cascades.

Mixed-conifer forest - A forest community that is dominated by two or more coniferous species.

Mixed-evergreen forest - A forest community that is dominated by two or more species of broad-leaved hardwoods whose foliage persists for several years. Important western species include madrone, tanoak, chinquapin, canyon live oak, and California-laurel.

Model - An idealized representation of reality developed to describe, analyze, or understand the behavior of some aspect of it; a mathematical representation of the relationships under study. The

Model (continued) - term model is applicable to a broad class of representations, ranging from a relatively simple qualitative description of a system or organization to a highly abstract set of mathematical equations.

Modified ISC strategy - In this report, an alternative based on the Interagency Scientific Committee's strategy for conserving the northern spotted owl but having smaller and fewer habitat conservation areas than the original strategy and not employing the 50-11-40 rule.

Monitoring - The process of collecting information to evaluate if objective and anticipated or assumed results of a management plan are being realized or if implementation is proceeding as planned.

Monitoring program - The administrative program used for monitoring.

Mortality salvage - The harvest of dead and dying timber.

Most significant LS/OG forests (LS/OG1s) - The largest, most strategically located blocks of existing LS/OG stands, often at lower elevations, that provide for spotted owls, marbled murrelets, other late-successional forest plant and animal species, sensitive fish species and stocks, and other important ecosystem processes and functions. (See Significant LS/OG forests.)

Movement - Shifts in locations of animals, which may be two-way such as seasonal movements, or one-way as in a shift to a new breeding territory.

Multiaged stand - A forest stand that has more than one distinct age class arising from specific disturbance and regeneration events at various times. These stands normally will have multilayered structure.

Multilayered canopy - Forest stands with two or more distinct tree layers in the canopy; also called multistoried stands.

Multiple use - Management of the public lands and their various resource values so that they are utilized in the combination that will best meet the present and future needs of the American people. Making the most judicious use of the land for some or all of these resources or related services over areas large enough to provide sufficient latitude for periodic adjustments in use to conform to changing needs and conditions. The use of some land for less than all of the resources. A combination of balanced and diverse resource uses that takes into account the long-tern needs of future generations for renewable and nonrenewable resources, including, but not limited to, recreation, range, timber, minerals, watershed, wildlife and fish, and natural scenic, scientific, and historic values. Harmonious and coordinated management of the various resources without permanent impairment of the productivity of the land and the quality of the environment. This combination is not necessarily the one that will give the greatest dollar return or greatest unit output.

Multistoried - Forest stands that contain trees of various heights and diameter classes and therefore support foliage at various heights in the vertical profile of the stand.

Multivariate analysis - A field of statistics in which multiple variables are used to compare sample groups. Multivariate analysis contrasts with univariate analysis, in which single variables are used to compare sample groups.

Mycorrhizal fungi - Fungi with a symbiotic relationship with the roots of certain plants.

Natal area - The location where an animal was born.

National ambient air quality standards (NAAQS). Standards designed to protect public health and welfare, allowing an adequate margin of safety. For particulate matter less than 10 microns in size (PM_{10}), 50 micrograms per cubic meter annual average and 150 micrograms per cubic meter, 24-hour average, not to be exceeded more than once per year.

National Environmental Policy Act (NEPA) - An act passed in 1969 to declare a national policy that encourages productive and enjoyable harmony between humankind and the environment, promotes efforts that will prevent or eliminate damage to the environment and biosphere and stimulate the health and welfare of humanity, enriches the understanding of the ecological systems and natural resources important to the nation, and establishes a Council on Environmental Quality (The Principal Laws Relating to Forest Service Activities, Agric. Handb. 453. USDA Forest Service, 359p.).

National Forest Management Act (NFMA) - A law passed in 1976 as an amendment to the Forest and Rangeland Renewable Resources Planning Act, requiring the preparation of forest plans and the preparation of regulations to guide that development.

National Marine Fisheries Service (NMFS) - A division within the U.S. Department of Commerce.

National Park Service (NPS) - A division within the U.S. Department of the Interior.

National Register of Historic Places - A formal list established by the National Historic Preservation Act of 1966 of cultural resources worthy of preservation. The Register is maintained by the National Park Service and lists archaeological, historic, and architectural properties.

Nesting, roosting, and foraging habitat - The forest vegetation with the age class, species of trees, structure, sufficient area, and adequate food source to meet some or all of the life needs of the northern spotted owl.

Nexus - A means of connection. Often used in a legal context to refer to the legal connection between one action and another.

Nocturnal - Referring to organisms that are active or functional at night.

Nominal resolution - The stated limit to the level of detail a given sensor can record. Usually this refers to spatial resolution or the smallest land area or object that can be discerned from satellite imagery.

Nonattainment - Failure of a geographic area to attain or maintain compliance with National Ambient Air Quality Standards (NAAQS) as defined by the Clean Air Act (1990 revision).

Nonattainment area - A geographic area that has failed to attain or maintain compliance with air quality standards. Nonattainment area boundaries are commonly the same as city, standard metropolitan statistical area, or county boundaries.

Nonchargeable volume - Timber harvest not included in the allowable sale quantity calculations.

Noncommercial forest land - Land incapable of yielding at least 20 cubic feet of wood per acre per year of commercial species; or land that is capable of producing only noncommercial tree species.

Noncommercial tree species - Minor conifer and hardwood species whose yields are not reflected in the commercial conifer forest land allowable sale quantity. Some species may be managed and sold under a suitable woodland allowable sale quantity and, therefore, may be commercial as a woodland species.

Nonfederal cluster - A cluster of three or more spotted owl activity centers on nonfederal lands. An area that contains habitat capable of supporting three or more breeding pairs of spotted owls with overlapping or nearly overlapping home ranges.

Nonforest land - Land developed for nontimber uses or land incapable of being 10 percent stocked with forest trees.

Nongame wildlife - All wild vertebrate and invertebrate animals not subject to sport hunting.

Nonmarket - Products derived from resources that do not have a well-established market value; for example, recreation, wilderness, wildlife.

Nonpoint source pollution - Water pollution that does not result from a discharge at a specific, single location (such as a single pipe) but generally results from land runoff, precipitation, atmospheric deposition, or percolation, and normally is

Nonpoint source pollution (continued) - associated with agricultural, silvicultural, and urban runoff, runoff from construction activities, etc. Such pollution results in the human-made or human-induced alteration of the chemical, physical, biological, radiological integrity of water.

Nonsuitable commercial forest land - Sites that would take longer than 15 years to meet or exceed minimum stocking levels of commercial species. Further classified as suitable woodland.

Nonsuitable woodland - All fragile nonsuitable forest land.

Northern spotted owl - One *(Strix occidentalis caurina)* of three subspecies of the spotted owl that ranges from southern British Columbia, Canada, through western Washington and Oregon, and into northwestern California. Listed as a threatened species by the U.S. Fish and Wildlife Service.

Noxious plant - A plant specified by law as being especially undesirable, troublesome, and difficult to control.

Noxious weed - See Noxious plant.

Nutrient cycling - Circulation or exchange of elements such as nitrogen and carbon between nonliving and living portions of the environment. Includes all mineral and nutrient cycles involving mammals and vegetation.

Nutrient depletion - Detrimental changes on a site in the total amount of nutrients and/or their rates of input, uptake, release, movement, transformation, or export.

O&C Lands - Public lands granted to the Oregon and California Railroad Co. and subsequently revested to the United States.

Obligate species - A plant or animal that occurs only in a narrowly defined habitat such as tree cavity, rock cave, or wet meadow.

Occupancy rate - In reference to spotted owls, the percentage of inventoried spotted owl habitat that is estimated to be occupied by breeding pairs of spotted owls.

Off-road vehicle (ORV) - Any motorized track or wheeled vehicle designed for cross-country travel over natural terrain (e.g., motorcycles, all-terrain vehicles, four-wheeled drive vehicles, and snowmobiles).

Off-road vehicle designation -

Open: Designated areas and trails where off-road vehicles may be operated subject to operating regulations and vehicle standards set forth in manuals.

Limited: Designated areas and trails where off-road vehicles are subject to restrictions limiting the number or types of vehicles, date, and time of use; limited to existing or designated roads and trails.

Closed: Areas and trails where the use of off-road vehicles is permanently or temporarily prohibited. Emergency use is allowed.

Old-growth associated species - Plant and animal species that exhibit a strong association with old-growth forests.

Old-growth conifer stand - Older forests occurring on western hemlock, mixed conifer, or mixed evergreen sites that differ significantly from younger forests in structure, ecological function, and species composition. Old growth characteristics begin to appear in unmanaged forests at 175-250 years of age. These characteristics include (1) a patchy multilayered canopy with trees of several age classes, (2) the presence of large living trees, (3) the presence of larger standing dead trees (snags) and down woody debris, and (4) the presence of species and functional processes that are representative of the potential natural community. Definitions are from the Forest Service's Pacific Northwest Experiment Station Research Note 447 and General Technical Report 285, and the 1986 interim definitions of the Old-Growth Definitions Task Group.

Old-growth dependent species - An animal species so adapted that it can exist only in old growth forests.

Old-growth emphasis areas (OGEA) - In Bureau of Land Management draft planning documents of 1992, areas where management emphasis will be given to providing for old-growth associated species and biological diversity. Management would provide for timber production when consistent with local and landscape level diversity.

Old-growth forest - A forest stand usually at least 180-220 years old with moderate to high canopy closure; a multilayered, multispecies canopy dominated by large overstory trees; high incidence of large trees, some with broken tops and other indications of old and decaying wood (decadence); numerous large snags; and heavy accumulations of wood, including large logs on the ground.

Old-growth stand - A mappable area of old-growth forest.

Old-growth seral stage - See Seral stages.

100-year floodplain - The area adjacent to a stream that is on average inundated once a century.

Open additional restrictions - Areas open to mineral exploration and development subject to additional restrictions that can be legally required by Bureau of Land Management pursuant to law, regulation, or other legal authority such as off-road vehicle or other closure order or community pit designation.

Open standard requirements - Areas open to mineral exploration and development subject only to requirements over which the Bureau of Land Management has no discretionary control such as the Clean Air/Clean Water Acts, National Environmental Policy Act, Resource Conservation and Recovery Act, Coastal Zone Management Act, Endangered Species Act, or National Historic Preservation Act.

Operations inventory (OI) - An intensive, site-specific forest inventory of forest stand location, size, silviculture needs, and recommended treatment based on individual stand conditions and productivity.

Operations inventory unit - An aggregation of trees occupying an area that is sufficiently uniform in composition, age, arrangement, and condition to be distinguishable from vegetation on adjoining areas.

Optimal cover - For elk, cover used to hide from predators and avoid disturbances, including humans. It consists of a forest stand with four layers and an overstory canopy that can intercept and hold a substantial amount of snow, yet has dispersed, small openings. It is generally achieved when the dominant trees average 21 inches diameter at breast height or greater and have 70 percent or greater crown closure.

Opportunity cost - Benefit that could result from a course of action but that is foregone when that course of action is not pursued.

Oregon-Washington Interagency Wildlife Committee - A committee composed of administrators from federal and state agencies including the U.S. Forest Service, U.S. Fish and Wildlife Service, U.S. Bureau of Land Management, Oregon Department of Fish and Wildlife, and Washington Department of Game.

Outstanding natural area (ONA) - An area that contains unusual natural characteristics and is managed primarily for educational and recreational purposes.

Outstandingly remarkable values (ORV) - Values among those listed in Section 1 (b) of the Wild and Scenic Rivers Act: "scenic, recreational, geological, fish and wildlife, historical, cultural, or other similar values..." Other similar values that may be considered include ecological, biological or botanical, paleontological, hydrological, scientific, or research.

Overstory - Trees that provide the uppermost layer of foliage in a forest with more than one roughly horizontal layer of foliage.

Owl additions - See Spotted owl additions.

Owl forests - In this report, the National Forests and Bureau of Land Management Districts supporting populations of northern spotted owls.

Owl region - The geographic area within the range of the northern spotted owl.

Owl site - Any site where there has been a recent or historic observation of a single spotted owl or a pair of owls.

Overmature stands - Trees of an age at which they decline in vigor and soundness.

Overstory removal - The final stage of cutting where the remaining overstory trees are removed to allow the understory to grow. Overstory removal is generally accomplished 3 to 5 years after reforestation and when adequate stocking has been achieved.

Packing - A temporary influx of organisms of various sex and age classes into remaining suitable habitat as previously available habitat is changed to unsuitable conditions.

Pair site - An amount of habitat that is considered capable of supporting one pair of spotted owls.

Paper and allied products - An industrial classification that includes establishments primarily engaged in the manufacture of pulps from wood and other cellulose fibers, and from rags; the manufacture of paper and paperboard into converted products, such as paper coated off the paper machine, paper bags, paper boxes, and envelopes.

Partial cutting - Removal of selected trees from a forest stand.

Partial log suspension - During yarding operations, suspension of one end of the log above the ground.

Particulates - Finely divided solid or liquid (other than water) particles in the air.

Patch - A small (20-60 acre) part of the forest. This tern is often used to indicate a type of clearcutting (patch cuts) associated with the "staggered setting" approach to distributing harvest units across landscape.

Peak flow - The highest amount of stream or river flow occurring in a year or from a single storm event.

Perennial stream - A stream that typically has running water on a year-round basis.

Personal income - The income received by all individuals in the economy from all sources. Made up of wages and salaries, proprietors income, rental income, dividends, personal interest income, and the difference between transfer payments (payouts) and personal contributions for social insurance.

Phenology - The annual recurrence of plant and animal phenomena that is influenced by seasonal and other environmental changes (e.g., flowering of plants, ripening of fruit).

Phi - The annual probability of survival of adult females.

Physiographic province - A geographic area having a similar set of biophysical characteristics and processes due to effects of climate and geology which result in patterns of soils and broad-scale plant communities. Habitat patterns, wildlife distributions, and historical land use patterns may differ significantly from those of adjacent provinces.

Pixel - Abbreviated form of "Picture Element," or the smallest division of a picture or image, usually used in relation to satellite imagery.

Plan amendment - A change in the terms, conditions, or decisions of a resource management plan.

Plan maintenance - Any documented minor change that interprets, clarifies, or refines a decision within a resource management plan but does not change the scope or conditions of that decision.

Planning area - All of the lands within a federal agency's management boundary addressed in land management plans.

Plan revision - A new resource management plan prepared by following all steps required by the regulations for preparing an original resource management plan.

Plant association - A plant community type based on land management potential, successional patterns, and species composition.

Plant community - An association of plants of various species found growing together in different areas with similar site characteristics.

Plantation maintenance - Actions in an unestablished forest stand to promote the survival of desired crop trees.

Plantation release - All activities associated with promoting the dominance and/or growth of desired tree species within an established forest stand.

Plateau - A table-land of flat-topped region of considerable extent and elevation.

Platform nest - A relatively flat nest constructed on a supporting structure such as a broad branch.

Pool/riffle ratio - The ratio of surface area or length of pools to the surface area or length of riffles in a given stream reach; frequently expressed as the relative percentage of each category. Used to describe fish habitat rearing quality.

Population - A collection of individual organisms of the same species that potentially interbreed and share a common gene pool. Population density refers to the number of individuals of a species per unit area, population persistence to the capacity of the population to maintain sufficient density to persist, well distributed, over time. (See Viable population.)

Population density - Number of individuals of a species per unit area.

Population dynamics - The aggregate of changes that occur during the life of a population. Included are all phases of recruitment and growth, senility, mortality, seasonal fluctuation in biomass, and persistence of each year class and its relative dominance, and the effects that any or all of these factors exert on the population.

Population viability - Probability that a population will persist for a specified period across its range despite normal fluctuations in population and environmental conditions.

Population viability model - A model that predicts the future state of an animal population based on its birth and death rates, habitat conditions, and other environmental factors.

Population viability models - A mathematical abstraction of a system that is designed to predict the likelihood of persistence of a population under different conditions.

Potential ACEC - An area of Bureau of Land Management land that meets the relevance and importance criteria for designation as an area of critical environmental concern (ACEC), as follows:

> **Relevance** - There shall be present a significant historic, cultural, or scenic value; a fish or wildlife resource or other natural system or process; or natural hazard.
>
> **Importance** - The above described value, resource, system, process, or hazard shall have substantial significance and values. This generally requires qualities of more than local significance and special worth, consequence, meaning, distinctiveness, or cause for concern. A natural hazard can be important if it is a significant threat to human life or property.

Potential habitat - A stand of trees of a vegetation type used by spotted owls that is not currently suitable but is capable of growing or developing into suitable habitat in the future. In general, potential habitats are stands in the earlier successional stages of forest types used by spotted owls.

Potential natural community - The community of plants and wild animals that would become established if all successional sequences were completed without interference by people under present environmental conditions. For forest communities, the potential natural community is an old-growth conifer stand.

Precommercial thinning - The practice of removing some of the trees less than merchantable size from a stand so that remaining trees will grow faster.

Predator - Any animal that preys externally on others by hunting, killing, and generally feeding on a succession of hosts, i.e., the prey.

Prescribed burning - Controlled fire deliberately set to meet various resource objectives.

Prescribed fire - A fire burning under specified conditions that will accomplish certain planned objectives. The fire may result from planned or unplanned ignitions.

Presuppression - Activities organized in advance of fire occurrence to ensure effective suppression action and/or to minimize risk to humans and resource damage.

Protective management - Measures taken by nonfederal entities to conserve spotted owls and their habitat. Measures may include participation in conservation planning (as defined in Endangered Species Act, Section 10) or other actions that benefit owls. Entities may be states, private landowners, Indian tribes, or others.

Preventive strategy(ies) - The amelioration of conditions that cause or favor the presence of competing or unwanted vegetation.

Priority animal taxa - Species or subspecies having special significance for management. They include endangered, threatened, and special status species

Priority habitats - Aquatic, wetland, and riparian habitats, and habitats of priority animal taxa.

Probable sale level - The annual amount of sawtimber likely to be sold outside of Reserves on a sustainable basis under an option.

Progeny test site - A test area for evaluating parent seed trees by comparing the growth of their offspring seedlings.

Proposed threatened or endangered species - Plant or animal species proposed by the U.S. Fish and Wildlife Service to be biologically appropriate for listing as threatened or endangered, and published in the Federal Register. It is not a final designation.

Province - See Physiographic province.

Public domain lands - Original holdings of the United States never granted or conveyed to other jurisdictions, or reacquired by exchange for other public domain lands.

Public water system - A system providing piped water for public consumption. Such a system has at least 15 service connections or regularly serves at least 25 individuals.

Quarter-township - An area approximately 3 miles square containing nine sections of land.

Radio-telemetry - Automatic measurement and transmission of data from remote sources via radio to a receiving station for recording and analysis. In this report, it refers to the tracking of spotted owls by means of small radio transmitters attached to them.

Random - Being or relating to a set or to an element of a set each of whose elements has equal probability of occurrence; also characterized by procedures to obtain such sets or elements.

Range (of a species) - The area or region over which an organism occurs.

Rearing habitat - Areas in rivers or streams where juvenile salmon and trout find food and shelter to live and grow.

Reasonable and prudent measures - Actions the Fish and Wildlife Service or the National Marine Fisheries Service believe are necessary and appropriate to minimize the impacts (amount or extent) of incidental take. These are communicated to a federal agency in a biological opinion.

Record of decision - A document separate from but associated with an environmental impact statement that states the management decision, identifies all alternatives including both the environmentally preferable and preferred alternatives, states whether all practicable means to avoid environmental harm from the preferred alternative have been adopted, and if not, why not.

Recovery - Action that is necessary to reduce or resolve the threats that caused a species to be listed as threatened or endangered.

Recreational river - See Wild and Scenic River System.

Recruitment - The addition to a population from all causes (i.e., reproduction, immigration, and stocking). Recruitment may refer literally to numbers born or hatched or to numbers at a specified stage of life such as breeding age or weaning age.

Recruitment habitat - In this report pertaining to marbled murrelet mitigation younger forest stands that presently do not have the attributes, (large old-growth trees) of suitable marbled murrelet habitat but are expected to gain them through time. Protection of these stands will preserve the option to include them in a conservation strategy or Final Draft Recovery Plan for the Northern Spotted Owl for marbled murrelets.

Rectification - The process of making imagery conform to a map projection system, usually to assign real world coordinates to image data.

Reforestation - The natural or artificial restocking of an area with forest trees; most commonly used in reference to artificial stocking.

Refugia - Locations and habitats that support populations of organisms that are limited to small fragments of their previous geographic range (i.e., endemic populations).

Regeneration - The actual seedlings and saplings existing in a stand; or the act of establishing young trees naturally or artificially.

Regeneration cut or harvest - Timber harvest conducted with the partial objective of opening a forest stand to the point where favored tree species will be reestablished.

Regeneration period - The time it takes to reforest an area to adequate stocking following a timber sale.

Region - A Forest Service administrative unit. The two regions affected by this proposed action are the Pacific Northwest (Region 6), which includes National Forests in Oregon and Washington, and the Pacific Southwest Region (Region 5), which includes National Forests in California.

Region 5 - The National Forests of California; the Forest Service's Pacific Southwest Region.

Region 6 - The National Forests of Washington and Oregon; the Forest Service's Pacific Northwest Region.

Regional guide - The guide developed to meet the requirements of the Forest and Rangeland Renewable Resources Planning Act of 1974, as amended (National Forest Management Act). Regional guides provide standards and guidelines for addressing major issues and management concerns that need to be considered at the regional level to facilitate National Forest planning.

Regulated forest - A forest that comprises an even distribution of age classes or tree sizes, when the growth equals the cut (at the highest level sustainable) and when the level of growing stock remains relatively constant.

Regulations - Generally refers to the Code of Federal Regulations.

Representative timber management scenario - A set of assumed timber harvest units, road locations, average annual levels of associated practices, and intensive management practices for the decade of the expected life of the plan.

Rescue effect - Immigration of new individuals sufficient to maintain a population that might otherwise decline toward extinction.

Research natural area (RNA) - An area set aside by a public or private agency specifically to preserve a representative sample of an ecological community, primarily for scientific and educational purposes. In Forest Service usage, research natural areas are areas designated to ensure representative samples of as many of the major naturally occurring plant communities as possible.

Reserved federal mineral estate - Land on which the federal government has ownership of minerals but the surface estate is private or other nonfederal ownership.

Reserved land - Federal lands that have been withdrawn from acreage used for timber yields. These lands often have a preservation or protection status. Wildernesses, Research Natural Areas, and National Recreation Areas are examples of reserved lands.

Reserved pair areas - In those portions of the species' range where habitat and owl populations were inadequate to apply the criteria creating designated conservation areas, then individual pair areas were also reserved. These are areas of suitable habitat identified for pairs and territorial single owls. The acreage of these areas varies throughout the range, based on data for pairs in each physiographic province. All suitable habitat is reserved in an area equal to the mean home range for that province.

Residual habitat area - A 100-acre of nesting, roosting, and foraging habitat encompassing the activity center for a pair of owls or a territorial single owl in the matrix.

Residual stand - The trees that remain standing after some event such as selection cutting.

Resource management plan (RMP) - A land use plan prepared by an agency under current regulations in accordance with the Federal Land Policy and Management Act.

Respending effects - The jobs and income generated by the purchase of goods and services by businesses or employees in the sector being examined. Example: Purchases of legal services by wood products companies and their employees is a respending effect that creates jobs and income for lawyers.

Restoration and retention blocks - Ecological reserves managed to restore or retain old-growth communities and respective plant communities.

Right-of-way - A permit or an easement that authorizes the use of public lands for specified purposes, such as pipelines, road, telephones lines, electric lines, reservoirs, and the lands covered by such an easement or permit.

Riparian area - A geographic area containing an aquatic ecosystem and adjacent upland areas that directly affect it. This includes floodplain, woodlands, and all areas within a horizontal distance of approximately 100 feet from the normal line of high water of a steam channel or from the shoreline of a standing body of water.

Riparian habitat conservation area - Portions of a watershed that contribute to the creation and maintenance of fish habitat.

Riparian management area - An area allocated in a plan primarily to protect the riparian and/or streamside zone.

Riparian Reserves - Designated riparian areas found outside the Late-Successional Reserves.

Riparian zone - Those terrestrial areas where the vegetation complex and microclimate conditions are products of the combined presence and influence of perennial and/or intermittent water, associated high water tables, and soils that exhibit some wetness characteristics. Normally used to refer to the zone within which plants grow rooted in the water table of these rivers, streams, lakes, ponds, reservoirs, springs, marshes, seeps, bogs, and wet meadows.

Ripping - The process of breaking up or loosening compacted soil (e.g., skid trails or spur roads) to better assure penetration of roots of young tree seedlings.

Risk analysis - A qualitative assessment of the probability of persistence of wildlife species and ecological systems under various alternatives and management options; generally also accounts for scientific uncertainties.

Risk-analysis scale - A continuum of values (from very low through very high) describing the likelihood that habitat for associated wildlife species and fish will persist.

Roost - The resting behavior of an animal,

Roost sites - Sites where an animal roosts. Can refer to daytime and nighttime roosting. Sites often provide protection from environmental conditions and from predators.

Rotation - The planned number of years between regeneration of a forest stand and its final harvest (regeneration cut or harvest). A forest's age at final harvest is referred to as rotation age. In this report, an extended rotation is 120-180 years, a long rotation 180 years.

Rotation age - The age of a stand when harvested at the end of a rotation.

Rural interface areas - Areas where Bureau of Land Management lands are adjacent to or intermingled with privately owned lands zoned for lots of 1-20 acres or that already have residential development.

Salable minerals - High volume, low value mineral resources including common varieties of rock, clay, decorative stone, sand, and gravel.

Sanitation - The removal of dead or damaged trees, or trees susceptible to insect and disease attack such as intermediate and suppressed trees, essentially to prevent the spread of pest or pathogens and to promote forest health.

Sapling - A loose term for a young tree no longer a seedling but not yet a pole. It is generally a few feet high and 2-4 inches diameter at breast height, typically growing vigorously and without dead bark or more than an occasional dead branch.

Scarification - Mechanical removal of competing vegetation or interfering debris prior to planting.

Scenic quality - The relative worth of a landscape from a visual perception.

Scenic river - See Wild and Scenic River System.

Scribner short-log - A log measurement rule constructed from diagrams that show the number of 1-inch boards that can be drawn in a circle representing the small end of a 10-foot-long log. This assumes a 0.25-inch saw kerf groove, makes a liberal allowance for slabs, and disregards log taper.

Second-growth - Relatively young forests that have developed following a disturbance (e.g., wholesale cutting, serious fire, or insect attack) of the previous old-growth forest.

Section 7 - The section of the Endangered Species Act that specifies the roles of interagency coordination in accomplishing the objective of species recovery.

Section 9 - See Take.

Sediment yield - The quantity of soil, rock particles, organic matter, or other dissolved or suspended debris is transported through a cross-section of stream in a given period. Measured in dry weight or by volume. Consists of dissolved load, suspended load, and bed load.

Seed tree cutting method - An even-aged reproductive cutting method in which all mature timber from an area is harvested in one entry except for a small number of trees left as a seed source for the harvested area.

Seed orchard - A plantation of clones or seedlings from selected trees; isolated to reduce pollination from outside sources, weeded of undesirables, and cultured for early and abundant production of seed.

Selection cutting - A method of uneven-aged management involving the harvesting of single trees from stands (single-tree selection) or in groups (group selection) without harvesting the entire stand at any one time.

Senescence - The process of aging. In demographic studies the usual concern is whether demographic rates change as organisms grow older.

Sensitive fish species and stocks - Fish species and stocks (genetically distinct populations) of anadromous salmonids identified by the America Fisheries Society's Endangered Species Committee as needing special management considerations to avoid extinction.

Sensitive species - Those species that (1) have appeared in the Federal Register as proposed for classification and are under consideration for official listing as endangered or threatened species or (2) are on an official state list or (3) are recognized by the U.S. Forest Service or other management agency as needing special management to prevent their being placed on federal or state lists.

Sensitivity analysis - A process of examining specific tradeoffs that would result from making changes in single elements of a plan alternative.

Sensitivity levels - Measures (e.g., high, medium, and low) of public concern for the maintenance of scenic quality.

Seral stages - The series of relatively transitory planned communities that develop during ecological succession from bare ground to the climax stage. There are five stages:

Early seral stage - The period from disturbance to crown closure of conifer stands managed under the current forest management regime. Grass, herbs, or brush are plentiful.

Mid-Seral stage - The period in the life of a forest stand from crown closure to first merchantability, usually ages 15-40. Due to stand density, brush, grass, or herbs rapidly decrease in the stand. Hiding cover may be present.

Late-Seral stage - The period in the life of a forest stand from first merchantability to culmination of mean annual increment. This is under a regime including commercial thinning, or to 100 years of age, depending on wildlife habitat needs. During this period, stand diversity is minimal, except that conifer mortality rates will be fairly rapid. Hiding and thermal cover may be present. Forage is minimal.

Mature seral stage - The period in the life of a forest stand from culmination of mean annual increment to an old-growth stage or to 200 years. This is a time of gradually increasing stand diversity. Hiding cover, thermal cover, and some forage may be present.

Serpentine soils - Soils developed on altered ultramafic rocks.

Serpentinite/peridotite - The association of dark-colored, coarse-grained, iron and magnesium-rich igneous rock (peridotite) with the products of hydrothermal alteration and faulting of these rocks (serpentinite).

Old-growth - This stage constitutes the potential plant community capable of existing on a site given the frequency of natural disturbance events. For forest communities, this stage exists from approximately age 200 until when stand replacement occurs and secondary succession begins again. Depending on fire frequency and intensity, old-growth forests may have different structures, species composition, and age distributions. In forests with longer periods between natural disturbance, the forest structure will be more even-aged at late mature or early old-growth stages.

Sexual dimorphism - The differences in size, weight, color, or other morphological characteristics that are related to the sex of the animal.

Shade-tolerant species - Plant species that have evolved to grow well in shade.

Shelterwood - A regeneration method under an even-aged silvicultural system. A portion of the mature stand is retained as a source of seed and/or protection during the period of regeneration. The mature stand is removed in two or more cuttings.

Short-term - For this report, usually 10 years.

Significant LS/OG forests (LS/OG2) - Blocks of existing mature and old-growth forest stands, sometimes fragmented or small in size, that help connect most significant LS/OG forests and that contribute to the viability of LS/OG-associated plant and animal species and other important ecosystem processes and function (See Most significant LS/OG forests.)

Silvicultural practices (or treatments or system) - The set of field techniques and general methods used to modify and manage a forest stand over time to meet desires conditions and objectives.

Silvicultural prescription - A professional plan for controlling the establishment, composition, constitution, and growth of forests.

Silviculture - The science and practice of controlling the establishment, composition, and growth of the vegetation of forest stands. It includes the control or production of stand structures such as snags and down logs, in addition to live vegetation.

Simulation - The use of a computer or mathematical model to predict effects from a management option given different sets of assumptions about population vital rates.

Sink - Population whose average reproductive rate is less than its average rate of morality. Such a population attracts immigrants that are not expected to contribute significantly to future populations. (See Source.)

Site class - A measure of an area's relative capacity for producing timber or other vegetation.

Site index - A measure of forest productivity expressed as the height of the tallest trees in a stand at an index age.

Site-potential tree - A tree that has attained the average maximum height possible given site conditions where it occurs.

Site preparation - Any action taken in conjunction with a reforestation effort (natural or artificial) to create an environment favorable for survival of suitable trees during the first growing season. This environment can be created by altering ground cover, soil or microstate conditions, using biological, mechanical, or manual clearing, prescribed burns, herbicides, or a combination of methods.

Site productivity - The ability of a geographic area to produce biomass, as determined by conditions (e.g., soil type and depth, rainfall, temperature) in that area.

Skid trail - A path created by dragging logs to a landing (gathering point).

Skid yarding - A cable yarding system using one of the cables to support a carriage from which logs are suspended and then pulled to a landing.

Slope failure - See Mass movement.

Slope stability - The resistance of a natural or artificial slope or other inclined surface to failure by landsliding (mass movement).

Smoke management - Conducting a prescribed fire under suitable fuel moisture and meteorological conditions with firing techniques that keep smoke impact on the environment within designated limits.

Smoke management program - A program designed to ensure that smoke impacts on air quality from agricultural or forestry burning operations are minimized; that impacts do not exceed, or significantly contribute to, violations of air quality standards or visibility protection guidelines; and that necessary open burning can be accomplished to achieve land management goals.

Smoke sensitive area - An area identified by the Oregon Smoke Management Plan that may be negatively affected by smoke but is not classified as a designated area.

Snag - Any standing dead, partially dead, or defective (cull) tree at least 10 inches in diameter at breast height and at least 6 feet tall. A hard snag is composed primarily of sound wood, generally merchantable. A soft snag is composed primarily of wood in advanced stages of decay and deterioration, generally not merchantable.

Snag dependent species - Birds and animals dependent on snags for nesting, roosting, or foraging habitat.

Socioeconomic - Pertaining to, or signifying the combination or interaction of, social and economic factors.

Soil compaction - An increase in bulk density (weight per unit volume) and a decrease in soil porosity resulting from applied loads, vibration, or pressure.

Soil displacement - The removal and horizontal movement of soil from one place to another by mechanical forces such as a blade.

Soil productivity - Capacity or suitability of a soil, for establishment and growth of a specified crop or plant species, primarily through nutrient availability.

Soil series - A group of soils developed from a particular type of parent material having naturally developed horizons that, except for texture of the surface layer, are similar in differentiating characteristics and in arrangement of the profile.

Source - An actively breeding population that has an average birth rate that exceeds its average death rate; produces an excess number of juveniles that may disperse to other areas.

Spatially explicit model - A model that predicts the future state of an animal population based on mapped locations of organisms and their habitat.

Special areas - Areas that may need special management, which may include management as an area of critical environmental concern, research natural area, environmental education area, or other special category.

Special habitat features - Habitats of special importance due to their uniqueness or high value.

Special recreation management area (SRMA) - An area where a commitment has been to provide specific recreation activity and experience opportunities. These areas usually require a high level of recreation sites but recreation sites alone do not constitute SRMA's.

Special status species - Plant or animal species falling in any of the following categories (see separate glossary definitions for each):

- Threatened or endangered species
- Proposed threatened or endangered species
- Candidate species
- State listed species
- Bureau sensitive species
- Bureau assessment species

Species - (1) A group of individuals that have their major characteristics in common and are potentially interfertile. (2) The Endangered Species Act defines species as including any species or subspecies of plant or animal. Distinct populations of vertebrates also are considered to be species under the act.

Species diversity - The number, different kinds, and relative abundance of species.

Spectral class - A statistical grouping of similar spectral reflectance values from a satellite sensor that can be associated with a specific land cover class (i.e., forest, agriculture, water).

Spectral signature - Specific combinations of wavelengths of light energy reflected or radiated from a land surface, or, in forestry, a wavelength combination that more or less characterizes a specific forest condition or successional stage.

Split estate - An area of land where the surface is nonfederally owned and the subsurface mineral resources are federally owned, or vice versa.

Spotted owl additions - Areas of LS/OG or suitable spotted owl habitat or potential owl habitat added to most significant LS/OG forest (LS/OG1) to ensure compliance with the Interagency Scientific Committee strategy.

Spotted owl habitat area (SOHA) - An area reserved from timber harvesting to provide forest habitat for one pair of northern spotted owls; the current spotted-owl management system described in forest plans for National Forest and Bureau of Land Management Districts.

Spotted owl habitat sites - Sites monitored by Bureau of Land Management for spotted owl occupancy during some or all of the years 1985 through 1988, in accordance with the Bureau's spotted owl monitoring guidelines. These sites are known to have been inhabited by spotted owls at some time since 1980, but not necessarily during the 1985-1988 period.

Spotted owl management area (SOMA) - An area designated to support three pairs of owls with home ranges separated by no more than 1.5 miles. Such areas have been prescribed in some plans for northern spotted owl conservation.

Stage classes - Any distinguishable phase of growth or development of an organism.

Staggered setting - An approach to timber harvesting in which harvest units, separated by uncut units of at least the same size, are scattered across the landscape.

Stand (tree stand) - An aggregation of trees occupying a specific area and sufficiently uniform in composition, age, arrangement, and condition so that it is distinguishable from the forest in adjoining areas.

Stand condition - A description of the physical properties of a stand such as crown closure or diameters.

Stand density - An expression of the number and size of trees on a forest site. May be expressed in terms of numbers of tree per acre, basal area, stand density index, or relative density index.

Stand-replacement wildfire - A wildfire that kills nearly 100 percent of the stand.

Stand-replacing event - A disturbance that is severe enough over a large enough area (e.g., 10 acres) to virtually eliminate an existing stand of trees and initiate a new stand.

Standards and guidelines - The primary instructions for land manager. Standards address mandatory actions, while guidelines are recommended actions necessary to a land management decision.

State historic preservation offices (SHPO) - The state official authorized to act as a liaison to the Secretary of the Interior for purposes of implementing the National Historic Preservation Act of 1966.

State implementation plan (SIP) - A state document, required by the Clean Air Act. It describes a comprehensive plan of action for achieving specified air quality objectives and standards for a particular locality or region within a specified time, as enforced by the state, and approved by the Environmental Protection Agency.

State listed species - Plant or animal species listed by the state of Oregon as threatened or endangered pursuant to ORS 496.004, ORS 498.026, or ORS 564.040.

Statewide comprehensive outdoor recreation plan (SCORP) - A plan prepared by the state that describes and analyzes the organization and function of the outdoor recreation system of the state. The plan provides an analysis of the roles and responsibilities of major outdoor recreation suppliers; an analysis of major outdoor recreation suppliers; an analysis of demand, supply and needs; issue discussions; an action program to address the issues; and a project selection process.

Stochastic - Random, uncertain; involving a random variable.

Stochastic model - A model that includes representation of random events.

Stocked/stocking - The degree an area of land is occupied by trees as measured by basal area or number of trees.

Stream order - A hydrologic system of stream classification. Each small unbranched tributary is a first order stream. Two first order streams join to make a second order stream. A third order stream has only first and second order tributaries, and so forth.

Stream reach - An individual first order stream or a segment of another stream that has beginning and ending points at a stream confluence. Reach end points are normally designated where a tributary confluence changes the channel character or order. Although reaches identified by the Bureau of Land Management are variable in length, they normally have a range of 0.5 to 1.5 miles in length unless channel character, confluence distribution, or management considerations require variance.

Structural discontinuity - A surface separating two unrelated groups of rocks, created by faulting.
Structural diversity - The diversity of forest structure, both vertical and horizontal, that provides for a variety of forest habitats for plants and animals. The variety results from layering or tiering of the canopy and the die-back, death, and ultimate decay of trees. In aquatic habitats, the presence of a variety of structural features such as logs and boulders that create a variety of habitat.

Structural retention - Harvest practices that leave physical elements (e.g., green trees, snags, down logs) of LS/OG forests on site after harvest.

Structure - The various horizontal and vertical physical elements of the forest.

Stumpage - The value of standing timber.

Subadult - A young spotted owl that has dispersed but not yet reached breeding age. Subadults are in their second, or in some cases, third year of life.

Subdrainage - A land area (basin) bounded by ridges or similar topographic features, encompassing only part of a watershed, and enclosing on the order of 5,000 acres; smaller than, and part of, a watershed. (See Drainage and Forest watershed.)

Subpopulation - A well-defined set of interacting individuals that compose a proportion of a larger, interbreeding population.

Subspecies - A population of a species occupying a particular geographic area, or less commonly, a distinct habitat, capable of interbreeding with other populations of the same species.

Succession - A series of dynamic changes by which one group of organisms succeeds another through stages leading to potential natural community or climax. An example is the development of series of plant communities (called seral stages) following a major disturbance.

Successional stage - A stage or recognizable condition of a plant community that occurs during its development from bare ground to climax. For example, coniferous forests in the Blue Mountains progress through six recognized stages: grass-forb, shrub-seedling, pole-sapling, young, mature, old-growth. (See also Seral.)

Suitable commercial forest land - Commercial forest land capable of sustained long-term timber production.

Suitable habitat - In the Final Draft Recovery Plan for the Northern Spotted Owl, an area of forest vegetation with the age-class, species of trees, structure, sufficient area, and adequate food source to meet some or all of the life needs of the northern spotted owl. (See also Nesting, roosting, and foraging habitat.)

Suitable river - A river segment found, through administrative study by an appropriate agency, to meet the criteria for designation as a component of the National Wild and Scenic Rivers system, specified in Section 4(a) of the Wild and Scenic Rivers Act.

Suitable woodland - Forest land occupied by minor conifer and hardwood species not considered in the commercial forest land allowable sale quantity determination and referred to as noncommercial species. These species may be considered commercial for fuelwood, etc. under woodland management. Also included are low site and nonsuitable commercial forest land. These lands must be biologically and environmentally capable of supporting a sustained yield of forest products.

Superior habitat - In the Final Draft Recovery Plan for the Northern Spotted Owl, habitat selected in excess of availability by the majority of individual northern spotted owls.

Superspecies - Two closely related species that are believed to have diverged relatively recently.

Supplemental pair areas - Habitat delineated and maintained on nonfederal lands to support spotted owl pairs or territorial singles. Habitat may be managed or reserved from timber harvest; size of the areas varies by province.

Suppression - The action of extinguishing or confining a fire.

Surface erosion - The detachment and transport of soil particles by wind, water, or gravity. Surface erosion can occur as the loss of soil in a uniform layer (sheet erosion), in many rills, or by dry ravel.

Surface erosion - A group of processes whereby soil materials are removed by running water, waves and currents, moving ice, or wind.

Suspended sediment - Sediment suspended in a fluid by the upward components of turbulent currents or by colloidal suspension.

Sustainable harvest - A harvest volume that can be maintained through time without decline.

Sustained yield - The yield that a forest can produce continuously at a given intensity of management.

Sustained yield unit (SYU) - An administrative division for which an allowable sale quantity is calculated.

Survival rate - The average proportion of individuals in a sample or a population that survive for a given period.

Survivorship - The proportion of newborn individuals that are alive at a given age.

Sustained yield or production - The amount of timber that a forest can produce continuously from a given intensity of management. This implies continuous production. A primary goal is to achieve a balance between incremental growth and cutting.

Take - Under the Endangered Species Act, take means to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect an animal, or to attempt to engage in any such conduct.

Taking - Under Endangered Species Act, Section 7, taking is an action that results in take.

Talus - A slope landform, typically covered by coarse rock debris forming a more or less continuous layer that may or may not be covered by duff and litter.

Target stocking - The desirable number of well-spaced trees per acre at age of first commercial thinning.

Taxon - A category in scientific classification system, such as class, family, or phylum.

Territorial single - An unpaired owl that is defending a territory.

Territory - The area that an animal defends, usually during breeding season, against intruders of its own species.

Texture (soil) - The relative proportion of sand, silt, and clay in a soil; grouped into standard classes and subclasses in the Soil Survey Manual of the U.S. Department of Agriculture.

Texture of an ecosystem - Relative surface smoothness of an ecosystem determined by remote sensing technology, or the distinctiveness of the transition between two distinct ecosystems.

Thermal cover - Cover used by animals to lessen the effects of weather. For elk, a stand of conifer trees that are 40 feet or more tall with an average crown closure of 70 percent or more. For deer, cover may include saplings, shrubs, or trees at least 5 feet tall with 75 percent crown closure.

Thermoregulation - The physiological and biological process whereby an animal regulates its body temperature.

Threatened species - Those plant or animal species likely to become endangered species throughout all or a significant portion of their range within the foreseeable future. A plant or animal identified and defined in accordance with the 1973 Endangered Species Act and published in the Federal Register.

Threshold phenomenon - Pattern or trend in population growth rate that exhibits relatively long periods of slow change followed by precipitous increase or response to an environmental gradient.

Timber classification - The following are definitions of timber classifications:

1. Nonforest - Land that has never supported forests, and land formerly forested where use for timber production is precluded by development or other uses.

2. Forest - Land at least 10 percent stocked (based on crown cover) by forest trees of any size, or formerly having had such tree cover and not currently developed for nonforest use.

3. Suitable - Commercial forestland identified as appropriate for timber production.

4. Unsuitable - Forestland withdrawn from timber utilization by statue or administrative regulation (e.g., wilderness), or locally identified as not appropriate for timber production.

Timber harvest schedule - The quantity of timber planned for sale and harvest, by time period, from the area of land administered by a federal agency. The first period, usually a decade, of the selected harvest schedule provides the allowable sale quantity.

Timber management plan - An activity plan that specifically addresses procedures related to the offering and sale of timber volume consistent with the approved allowable sale quantity.

Timber production - The purposeful growing, tending, harvesting, and regeneration of regulated crops of trees to be cut into logs, bolts, or other round sections for industrial or consumer use other than for fuelwood.

Timber production capability classification (TPCC) - The process of partitioning forest land into major classes indicating relative suitability to produce timber on a sustained yield basis.

Timber stand - See Stand.

Timber stand improvement - Measures such as thinning, pruning, release cutting, prescribed fire, girdling, weeding, or poisoning of unwanted trees aimed at improving growing conditions for the remaining trees.

Total suspended particulates - All solid or semisolid material found in the atmosphere.

Transition period - A period of environmental change during which a population increases or decreases to a new stable equilibrium level.

Transportation system - Network of roads used to manage Bureau of Land Management lands. Includes Bureau-controlled roads and some privately controlled roads. Does not include Oregon Department of Transportation, county, and municipal roads.

Travel corridor - A route used by animals along a belt or band of suitable cover or habitat.

Trophic level - The level in the food chain at which an organism sustains itself.

T-test - A statistical test that compares the value of a test statistic, t-value, to the student's t distribution.

Underburning - Prescribed burning of the forest floor or understory for botanical or wildlife habitat objectives, hazard reduction, or silvicultural objectives.

Understocked - The condition when a plantation of trees fails to meet the minimum requirements for number of well spaced trees per acre.

Understory - The trees and other woody species growing under the canopies of larger adjacent trees and other woody growth.

Uneven-aged management - A combination of actions that simultaneously maintains continuous tall forest cover, recurring regeneration of desirable species, and the orderly growth and development of trees through a range of diameter or age classes. Cutting methods that develop and maintain uneven-aged stands are single-tree selection and group selection.

Unique ecosystems - Ecosystems embracing special habitat features such as beaches and dunes, talus slopes, meadows, and wetlands.

Unnecessary or undue degradation - Surface disturbance greater than what would normally result when regulated mineral exploration or development is done by a prudent operator in usual, customary, and proficient operations and taking into consideration the effects of those operations on other resources and land uses, outside the area of operations. Failure to initiate and complete reasonable mitigation measures, including reclamation of disturbed areas; or failure to prevent the creation of a nuisance, which may constitute unnecessary or undue degradation. Failure to comply with applicable environmental protection statutes and regulations thereunder will constitute unnecessary or undue degradation.

Ultramafic - Dark-colored igneous rocks composed of minerals which are enriched in iron and magnesium. (See Serpentinite/peridotite.)

Unconsolidated deposits - Sediments that are loosely arranged, with particles that are not cemented together. Includes alluvial, glacial, volcanic, and landslide deposits.

Unstable and potentially unstable areas - Lands that need protection to maintain natural disturbance patterns and functions, prevent increased landslide distribution in time and space (rate and frequency), prevent increased delivery of sediment, and maintain landslide-delivered supply of large woody material over several rotations. On-site delineation of unstable and potentially unstable areas considers the probability of landslide-triggering storms within the period of minimum root strength and elevated groundwater (as well as slope adjustment to piping changes), and the probability of channel adjustments that trigger streambank and toeslope failures.

Unsuitable habitat - Forested lands that currently do not meet the habitat needs of spotted owls for nesting, roosting, or foraging, but are ecologically capable of doing so. This habitat is deficient in tree size, canopy closure, and/or stand decadence. It results from timber harvest or natural disturbance. Also referred to as "potential habitat."

Unsupervised classification - A computer-automated technique of pattern recognition that attempts to find statistically similar groups of reflectance values in satellite image data.

Uplift - A structurally high area in the earth's crust, produced by positive movements that raise or upthrust the rocks.

U.S. Department of Agriculture (USDA) - Federal land management agency whose main mission is multiple use of lands under its jurisdiction.

U.S. Department of the Interior (USDI) - Federal land management agency whose main mission is multiple use of lands under its jurisdiction.

Utility corridor - A linear strip of land identified for the present or future location of utility lines within its boundaries.

Vagility - Capacity of any organism to become widely dispersed.

Verified pair - A pair of spotted owls of specified breeding status identified according to a standard field survey procedure.

Vertical diversity - The diversity in a stand that results from the complexity of the aboveground structure of the vegetation. The more tiers of vegetation or the more diverse the species makeup (or both), the higher the degree of vertical diversity. (See also Horizontal diversity.)

Viability - The ability of a wildlife or plant population to maintain sufficient size so that it persists over time in spite of normal fluctuations in numbers; usually expressed as a probability of maintaining a specific population for a specified period.

Viable population - A wildlife or plant population that contains an adequate number of reproductive individuals appropriately distributed on the planning area to ensure the long-term existence of the species.

Viewshed - The landscape that can be directly seen from a viewpoint or along a transportation corridor.

Visibility protection plan - A plan that implements the requirements of the Clean Air Act by establishing programs for visibility monitoring short-term and long-term control strategies, and procedures for program review, coordination, and consultation.

Visual resource - The visible physical features of a landscape.

Visual resource management (VRM) - The inventory and planning actions to identify values and establish objectives for managing those values and the management actions to achieve those objectives.

Visual resource management classes - Categories assigned to public lands based on scenic quality, sensitivity level, and distance zones. There are four classes. Each class has an objective that prescribes the amount of modification allowed in the landscape.

Vital rates - Rates of key demographic functions within a population, such as the birth rate and survival rate.

Water quality - The chemical, physical, and biological characteristics of water.

Watershed - The drainage basin contributing water, organic matter, dissolved nutrients, and sediments to a stream or lake.

Watershed analysis - A systematic procedure for characterizing watershed and ecological processes to meet specific management and social objectives. Watershed analysis is a stratum of ecosystem management planning applied to watersheds of approximately 20 to 200 square miles.

Watershed restoration - Improving current conditions of watersheds to restore degraded fish habitat and provide long-term protection to aquatic and riparian resources.

Water yield - The quantity of water derived from a unit area of watershed.

Well distributed - A geographic distribution of habitats that maintains a population throughout a planning area and allows for interaction of individuals through periodic interbreeding and colonization of unoccupied habitats.

Western Oregon Digital Data Base (WODDB) - A very high resolution (1 inch = 400 feet) geographic digital (computer) data base derived from aerial photography for Bureau of Land Management lands in western Oregon.

West side forests - The 11 National Forests within the range of the northern spotted owl in Washington, Oregon, and California that lie west of the Cascade crest. They are the Gifford Pinchot, Mendocino, Mt. Baker-Snoqualmie, Mt. Hood, Olympic, Rouge River, Siskiyou, Siuslaw, Six Rivers, Umpqua, and Willamette National Forests.

Wetlands - Areas that are inundated by surface water or ground water with a frequency sufficient to support, and under normal circumstances do or would support, a prevalence of vegetative or aquatic life that require saturated or seasonally saturated soil conditions for growth and reproduction (Executive Order 11990). Wetlands generally include, but are not limited to, swamps, marshes, bogs, and similar areas.

Wet meadows - Areas where grasses predominate. Normally waterlogged within a few inches of the ground surface.

Wild and Scenic River System - Those rivers or section of rivers designated as such by Congressional action under the Wild and Scenic River Act (Public Law 90-542, 1968), as supplemented and amended, or those sections of rivers designated as wild, scenic, or recreational by an act of the legislature of the state or states through which they flow. Each designated river may be classified and administered under one or more of the following categories:

1. Wild River Areas - Those rivers or section of rivers that are free of impoundments and generally inaccessible except by trail, with watersheds or shorelines essentially primitive and waters unpolluted. These represent vestiges of primitive America.

2. Scenic River Areas - Those rivers or sections of rivers that are free of impoundments with watersheds still largely primitive and shorelines largely undeveloped, but accessible in places by roads.

Wild and Scenic River System (continued) -

3. Recreation River Areas - Those rivers or sections of rivers that are readily accessible by road or railroad, that may have some development along their shorelines. and that may have undergone some impoundment or diversion in the past.

Wilderness - Areas designated by Congressional action under the 1964 Wilderness Act. Wilderness is defined as undeveloped federal land retaining its primeval character and influence without permanent improvements or human habitation. Wilderness areas are protected and managed to preserve their natural conditions, which generally appear to have been affected primarily by the forces of nature, with the imprint of human activity substantially unnoticeable; have outstanding opportunities for solitude or for a primitive and confined type of recreation; include at least 5,000 acres or are of sufficient size to make practical their preservation, enjoyment, and use in an unimpaired condition; and may contain features of scientific, education, scenic, or historical value as well as ecologic and geologic interest.

Wilderness study area (WSA) - A roadless area inventoried and found to be wilderness in character, having few human developments and providing outstanding opportunities for solitude and primitive recreation, as described in Section 603 of the Federal Land Policy and Management Act and in Section 2(c) of the Wilderness Act of 1964.

Wildfire - Any wildland fire that is not a prescribed fire.

Wildlife tree - A live tree retained to become future snag habitat.

Wild River - See Wild and Scenic River System.

Windfall - Trees or parts of trees felled by high winds. (See also Blowdown and Windthrow.)

Windthrow - A tree or trees uprooted or felled by the wind.

Withdrawal - A designation that restricts or closes public lands from the operation of land mineral disposal laws.

Woodland - Forest land producing trees not typically used as saw timber products and not included in calculation of the commercial forest land allowable sale quantity.

Yarding - The moving of logs from the stump to a central concentration area or landing.

Yarding of unmerchantable material (YUM) - Moving unmerchantable portions of trees from the stump to a central concentration area.

Yield table - A table of timber volumes expected to be produced under a certain set of conditions.

Young stands - Forest stands not yet mature, generally, less than 50-80 years old; typically 20-40 years old.

Z-test - A statistical test that compares the value of a test statistic (z-value) to the standard normal distribution.

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