United States Department of Agriculture

National Forest System

Forest Service Research

March 1993

Viability Assessments and Management Considerations for Species Associated with Late-Successional and Old-Growth Forests of the Pacific Northwest

The Report of the Scientific Analysis Team

OG	Old Growth
OR	Oregon
RHCA	Riparian Habitat Conservation Area
SAT	Scientific Analysis Team
S&G's	Standards and Guidelines
SPP	Species
T&E	Threatened and Endangered (Species)
USDA	United States Department of Agriculture
USDI	United States Department of the Interior
USFWS	United States Fish and Wildlife Service (USDI)
WA	Washington

In this report, any reference to "owl" or "spotted owl" refers to the northern spotted owl (*Strix occidentalis caurina*) unless specifically identified as another species or subspecies.

United States Department of Agriculture

Forest Service Washington Office

Spotted Owl EIS Team
P.O. Box 3623
Portland, OR 97208-3623

Reply To: 1950/2630

Date: March 1993

Dear Recipients of the Report

Enclosed is a copy of a report of the Scientific Analysis Team commissioned by the Chief of the Forest Service on July 30, 1992 to examine several issues related to the environmental impact statement for management of the northern spotted owl in the National Forests.

The report addresses three issues raised by Judge Dwyer in a recent lawsuit concerning spotted owl management. The first issue involves the exemption of 13 BLM timber sales from the requirements of the Endangered Species Act. The second issue concerns new information about the science and biology of the northern spotted owl. And the third issue concerns the effects of managing the National Forests under the direction of alternatives present in the final environmental impact statement and whether this would challenge the viability of other old growth associated species within the range of the northern spotted owl.

This report does not represent any official position of the Forest Service. Rather, the biological analyses of specific alternatives in the report represent the collective judgment of a panel of distinguished Forest Service scientists and biologists. The report also presents one set of management proposals, based upon various scientific, legal, political and administrative assumptions, that the scientific panel believes would raise the viability rating to "high" for the northern spotted owl and all other native vertebrate species associated with late-successional forests in northern spotted owl habitat.

The Scientific Analysis Team report will be considered by the Forest Service in its preparation of the draft supplemental environmental impact statement (DSEIS), and the report will comprise an appendix to the DSEIS, but the report itself is not an alternative for the DSEIS as it has not been developed by an interdisciplinary team as required by Forest Service planning regulation. The report is being released in advance of the DSEIS to allow the public additional time to become familiar with the contents. Comments on this report may be submitted along with comments on the DSEIS after it is released.

I encourage you to familiarize yourself with these key documents and share your ideas.

James C. Overbay

JAMES C. OVERBAY
Deputy Chief

Viability Assessments and Management Considerations for Species Associated With Late-Successional and Old-Growth Forests of the Pacific Northwest

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David M. Solis

Viability Assessments and Management Considerations for Species Associated with Late-Successional and Old-Growth Forests of the Pacific Northwest

Table of Contents

Table of Contents (continued)

Table of Contents (Continued)

Chapter 1

Introduction, Synthesis of the Scientific Analysis Team Report, and Observations

". . . All aspects of such a decision should be weighed in the balance. The issues are not limited to questions of owls and timber supply, as important as those are. The matter is not that simple – it never has been . . ." The Interagency Scientific Committee.

CHAPTER 1

Introduction, Synthesis of the Scientific Analysis Team Report, and Observations

Table of Contents

Table of Contents (Continued)

Note: There is limited use of acronyms and abbreviations in the text of this report. However, in an effort to make tables and figures easier to read and compare, some acronyms and abbreviations were used. See the list of acronyms and abbreviations on the inside front cover of this report.

CHAPTER 1

Introduction, Synthesis of the Scientific Analysis Team Report, and Observations

THE ASSIGNMENT

The Scientific Analysis Team - Personnel and Assignments

The Scientific Analysis Team was formed by the Chief of the Forest Service to respond to questions and concerns expressed by U.S. District Court Judge William L. Dwyer regarding the Forest Service's Final Environmental Impact Statement on Management for the Northern Spotted Owl in the National Forests (USDA 1992)(hereafter referred to as the Final Environmental Impact Statement). The following persons were assigned to the team.

Name	Title
Jack Ward Thomas, Ph.D	Team Leader and Chief Research Wildlife Biologist, Forest Service, Pacific Northwest Research Station, Forestry and Range Sciences Laboratory, La Grande, Oregon
Martin G. Raphael, Ph.D	Associate Team Leader, Principal Research Wildlife Biologist, Forest Service, Pacific Northwest Research Station, Forestry Sciences Laboratory, Olympia, Washington
Eric D. Forsman, Ph.D	Research Wildlife Biologist, Forest Service, Pacific Northwest Research Station, Forestry Sciences Laboratory, Corvallis, Oregon
A. Grant Gunderson	Threatened, Endangered, and Sensitive Species Program Manager, Forest Service, Pacific Northwest Region, Portland, Oregon
Richard S. Holthausen	National Wildlife Ecologist, Forest Service, Pacific Northwest Research Station, Forestry Sciences Laboratory, Corvallis, Oregon
Bruce G. Marcot, Ph.D	Wildlife Ecologist, Forest Service, Pacific Northwest Research Station, Ecological Framework for Management, Research, Development and Application Program, Portland, Oregon

Gordon H. Reeves, Ph.D	Research Fish Biologist, Forest Service, Pacific Northwest Research Station, Forestry Sciences Laboratory, Corvallis, Oregon
James R. Sedell, Ph.D	Principal Research Ecologist, Forest Service, Pacific Northwest Research Station, Forestry Sciences Laboratory, Corvallis, Oregon
David M. Solis	Spotted Owl Program Manager, Forest Service, Pacific Southwest Region, San Francisco, California

In addition, the team leaders recruited one additional team member who had done extensive work with the Northern Spotted Owl Recovery Team (USDI) on the subject of species of plants and animals that are likely associated with late-successional forests. This was invaluable assistance proved to be great asset to the Scientific Analysis Team. He is:

Robert G. Anthony, Ph.D	Assistant Leader, Oregon Cooperative Wildlife Research Unit, Fish and Wildlife Service (USDI), Corvallis, Oregon

In addition, the Scientific Analysis Team recruited 13 experts to assist in the completion of the work assigned. These persons contributed so significantly to the Scientific Analysis Team effort that we considered them as Associate Scientific Analysis Team Members. They are as follows:

Scientific Analysis Team: Associate Team Members

Bruce Bingham, Ph.D	Research Plant Ecologist, Forest Service, Pacific Southwest Forest and Range Experiment Station, Redwood Sciences Laboratory, Arcata, California
Amedee Brickey	District Wildlife Biologist, Forest Service, Sierra National Forest, Pine Ridge Ranger District, Shaver Lake, California
Gordon E. Grant, Ph.D	Research Hydrologist, Forest Service, Pacific Northwest Research Station, Forestry Sciences Laboratory, Corvallis, Oregon
Patricia Greenlee	Threatened and Endangered Species Coordinator, Forest Service, Willamette National Forest, Eugene, Oregon
R. Dennis Harr, Ph.D	Principal Research Hydrologist, Forest Service, Pacific Northwest Research Station, Forestry Sciences Laboratory, Seattle, Washington
Mauragrace Healey	Writer/Editor, Forest Service, National Forest System, Northern Spotted Owl Environmental Impact Statement Team, Portland, Oregon
Barbara Hill	Zone Wildlife Biologist, Forest Service, Gifford Pinchot National Forest, Amboy, Washington

Robin Lesher	Botanist, Forest Service, Mount Baker-Snoqualmie National Forest, Seattle, Washington
Kadonna Pennell	Administrative Officer, Forest Service, National Forest System, Northern Spotted Owl Environmental Impact Statement Team, Portland, Oregon
Frances Schmechel	Zone Wildlife Biologist, Forest Service, Gifford Pinchot National Forest, Vancouver, Washington
Marilyn Stoll	Wildlife Biologist, Forest Service, Olympic National Forest, Olympia, Washington
James Valenti	Computer Assistant, Forest Service, Olympic National Forest, Olympia, Washington
John A. Young	Geographer, Forest Service, Pacific Northwest Research Station, Forestry Sciences Laboratory, Olympia, Washington
Joan Ziegltrum, Ph.D.	Forest Botanist, Forest Service, Olympic National Forest, Olympia, Washington
Robert R. Ziemer, Ph.D	Principal Research Hydrologist, Forest Service, Pacific Southwest Forest and Range Experiment Station, Redwood Sciences Laboratory, Arcata, California

While we consider this report a joint effort and collectively stand behind the entire report, the team members were given individual assignments and were primarily responsible for developing various sections of this report. These assignments were as follows:

Section of the Report	Title	Team Member Assigned
Chapter 1	Introduction, Synthesis of the Scientific Analysis Team Report, and Observations	Thomas
Chapter 2	Effects of Exempting Thirteen Bureau of Land Management Timber Sales From the Requirements of the Endangered Species Act on the Viability Assessments in the Final Environmental Impact Statement	Gunderson and Solis
Chapter 3	Effects of Bureau of Land Management Implementing Preferred Alternatives in Draft Resource Management Plans on the Viability Assessments in the Final Environmental Impact Statement	Gunderson and Solis

Chapter 4	New Information on the Northern Spotted Owl	Forsman and Marcot
Chapter 5	Risk Analysis of Species in Old-Growth Forests of the Pacific Northwest: Viability Assessment and Mitigation Measures in National Forests	Marcot, Raphael Anthony, and Holthausen
Appendix 5-K	Strategy for Managing Habitat of At-Risk Fish Species and Stocks in National Forests Within the Range of the Northern Spotted Owl	Sedell and Reeves
Chapter 6	Requirements for Successful Implementation	Raphael and Gunderson

The Scientific Analysis Team was assigned three distinct and very different tasks to accomplish. Although these tasks are all related in the sense that all contribute to strengthening the information to be used in the Forest Service's Final Environmental Impact Statement, they do not produce an integrated whole. The approach taken by the Scientific Analysis Team was to develop chapters responsive to the particular assigned tasks. Each chapter, therefore, stands alone. There was, and could be, no "flow" between chapters.

The report covers complex natural resource issues, many of which have a unique "jargon". There are also many technical terms which are associated with the general subject area. We have attempted to avoid the jargon and limit our use of the technical terms. A glossary has been included to assist the reader. Common names of the species we address have been used in the text except where none were available. For a complete listing of the common and scientific names of the species see the List of Common and Scientific Names.

It must be noted that in fulfilling our tasks we have reached many conclusions. We have based these conclusions and recommendations on conversations with experts, extant literature, and professional judgement. All conclusions in this report are those of the Scientific Analysis Team alone, unless otherwise noted.

An Historical Perspective on the Issue of Management of Late-Successional Forests

To fully comprehend the situation that has led, seemingly inexorably, to the commissioning of the Scientific Analysis Team to address the specific questions described below, it may be important to examine the history of how land managers can deal with threatened or endangered species, the welfare of other terrestrial species associated with late-successional forests, and the maintenance of habitat for sensitive fish species or stocks or both. This historical perspective is presented in detail in Appendix 1-A.

This chronology of events can be logically interpreted as increasing philosophical, scientific, legal, legislative, and societal concern with retaining biodiversity through a process of managing land

and resources. These concerns are related to retaining the processes and functions of ecosystems. If so, it apprears that a significant objective of land management (particularly that of the National Forests) can now be described as the preservation of biodiversity.

It is difficult not to accept this, if the regulations issued pursuant to National Forest Management Act of 1976 that calls for maintenance of *viable* populations of native and desired non-native vertebrates *well distributed* within the planning areas (interpreted by the Scientific Analysis Team as National Forests within the range of the northern spotted owl) are to be taken seriously. And the Federal courts have said that the Act is to be so considered.

The consequence of the Forest Service not meeting that objective is that not only will the agency be in violation of the National Forest Management Act, the species in question will likely be listed as "threatened" or "endangered" under the mandates of the Endangered Species Act of 1973 as amended. It may be increasingly significant to Forest Service managers that the Endangered Species Act declares its purpose to be the preservation of the *ecosystems* on which a threatened or endangered species depend.

Eight revisions to the original 1973 Endangered Species Act have been enacted (two in 1976, 1977, 1978, 1979, 1982, 1984 and 1988). The most current (1988) version of that Act states, "The purpose of this Act is to provide a means whereby the ecosystem upon which endangered species and threatened species depend may be conserved..." This statement of purpose has been kept essentially intact through all seven revisions of the Act. This provision may become more significant to Federal land managers with increasing shifts toward "ecosystem management". The Federal courts have not hesitated to force Federal agencies into compliance with those laws – even to the point of closing down commodity production from Federal lands, such as timber cutting in late-successional forests. Is it possible, then, that only after these objectives of providing for the viability of species, especially those considered threatened or endangered (which can be viewed in the context of "biodiversity" or "ecosystem management"), can the production of goods and services from these lands proceed.

This trend toward ecosystem management was seemingly further advanced by the recent declaration by Chief of the Forest Service, Dale Robertson, in late 1992. He stated that the Forest Service would, henceforth, practice "ecosystem management" on the National Forests.

These events seem, at least to us, to be evolving in the cauldron of a mixture of laws and regulations, case law, and pronouncements by political leaders and agency leaders into a *de facto* policy for management of National Forests. However, it is not for scientists to determine policy. The Scientific Analysis Team does feel that it is appropriate to point out what seems to be occurring, as this directly affects how scientists must interact with natural resource managers. Much of the increasing confusion and acrimony surrounding the management of National Forests could be reduced or resolved through a clear statement of policy - either through the process of law or by edict by persons in authority.

Consideration by the Scientific Analysis Team of other species that are likely associated with late-successional forests on National Forests within the range of the northern spotted owl demonstrates how complex ecosystem management can be. And, this is the consideration of but one stage of forest land development in but one part of the United States. In addition, such an assessment represents the first of many steps needed to facilitate a true understanding of ecosystem management by a land management agency.

This process may give scientists, land managers, the courts, and the public some appreciation for the complexity of "ecosystem management" whether undertaken one species at a time or as a whole. We applaud the concept of ecosystem management and recognize the boldness that is required to commit to such a dramatic change in the paradigm that presently guides natural resource management. It is likely that continued total reliance on a species-by-species approach to preserve biodiversity will fail because of inefficiency and economics, and the associated direct and opportunity costs (Thomas et al. 1990).

Questions to be Answered by the Scientific Analysis Team

The Scientific Analysis Team was formed by the Chief of the Forest Service to respond to concerns expressed by U.S. District Court Judge William L. Dwyer on July 30, 1992, regarding the Forest Service's 1992 Final Environmental Impact Statement on Management for the Northern Spotted Owl in the National Forests (USDA 1992). The questions addressed to the Forest Service by the judge that were assigned to the Scientific Analysis Team for response were:

1. Does the May 15, 1992, decision by the Endangered Species Committee to allow cutting of 13 timber sales prepared by the Bureau of Land Management and judged by the Fish and Wildlife Service to cause "jeopardy" for the northern spotted owl necessitate changes in spotted owl viability assessments of the alternatives in the Final Environmental Impact Statement? If there are changes in the viability assessments, what mitigation options are recommended? These questions are addressed in Chapters 2 and 3.

2. Does any information that has become available since the publication of the Forest Service's Final Environmental Impact Statement necessitate revision of the standards and guidelines of the selected alternative in the Final Environmental Impact Statement or change the probabilities of maintaining viable populations of the northern spotted owl that were assigned to the alternatives in the Final Environmental Impact Statement? If a revision of the standards and guidelines of the selected alternative is warranted, what are the recommendations for mitigation measures? These questions are addressed in Chapter 4.

3. Would the Forest Service's implementation of the selected alternative in the Final Environmental Impact Statement (the Interagency Scientific Committee's Conservation Strategy) lead to the extirpation in Forest Service planning areas (National Forests) of any of the 32 species identified in the Final Environmental Impact Statement as being closely associated with late-successional and old-growth forests? In addition, the Chief of the Forest Service asked us that, if that is so, what mitigation options are recommended to assure that extirpation does not occur? These questions are addressed in Chapter 5.

Upon careful review of this assignment, it became apparent to the Scientific Analysis Team that additional assessments were required to fully respond to the concerns expressed by Judge Dwyer. These additional tasks were determined as described below (see Chapters 2 and 3).

Instructions to the Scientific Analysis Team from Forest Service administrators to analyze Bureau of Land Management's cutting of the 13 timber sales released by the Endangered Species Committee included the direction to assume that the Bureau of Land Management would continue to operate under current management plans after the sales were cut (see Chapter 2 for a more complete discussion). It is a much more likely situation that the Bureau of Land Management would operate under the preferred alternative in their Draft Resource Management

Plans released in August 1992. Therefore, the Scientific Analysis Team also analyzed the effect on spotted owl viability of the Bureau of Land Management acting under their preferred alternative coupled with the various alternatives in the Final Environmental Impact Statement.

Examination of Assumptions Made in the Forest Service's Final Environmental Impact Statement

1. In the Final Environmental Impact Statement, it was assumed that Bureau of Land Management would adopt a forest management strategy for the northern spotted owl that would be at least equal to the Interagency Scientific Committee's Conservation Strategy in maintaining viability of the subspecies.

2. In the Final Environmental Impact Statement, it also was assumed that consultation between the Bureau of Land Management and the Fish and Wildlife Service under Section 7 of the Endangered Species Act regarding proposed timber sales would produce a *de facto* spotted owl habitat management plan that would be equal or superior to the Interagency Scientific Committee's Conservation Strategy in providing for viability of the spotted owl. Our confidence in that this assumption was reduced by the Fish and Wildlife Service's decision to not call "jeopardy" on Bureau of Land Management timber sales that were in conflict with Interagency Scientific Committee Strategy guidelines on dispersal habitat in areas currently deficient in such habitat. Because we could not determine precisely on what basis jeopardy calls can be made in a consistent fashion in keeping with applicable regulations, our confidence that such a process will produce a *de facto* plan was eroded.

This conclusion was reinforced when the Bureau of Land Management appealed the Fish and Wildlife Service's "jeopardy" decision on 44 proposed timber sales. And, when the Endangered Species Committee exempted 13 of the 44 sales from the requirements of the Endangered Species Act, this assumption was further eroded. In addition, the Endangered Species Committee invited the Bureau of Land Management, if a jeopardy call on Bureau of Land Management's forest management plan was made by the Fish and Wildlife Service, to appeal for exemption of the entire forest management plan rather than on a timber sale-by-timber sale basis.

Our discussions with Fish and Wildlife Service personnel reinforced our opinion that Section 7 consultation on proposed actions between Federal land management agencies and the Fish and Wildlife Service that might effect spotted owls will not cause those agencies to conform with Interagency Scientific Committee guidelines or bring about the implementation of a fully coordinated plan for Federal lands.

Expansion of the Number of Species Closely Associated with Old-Growth Forests to be Assessed

Instructions from Judge Dwyer were to determine if the adoption of the Interagency Scientific Committee's Conservation Strategy by the Forest Service would cause extirpation, by planning area (which was interpreted by the Scientific Analysis Team as National Forests within the range of the northern spotted owl), of any of 32 species identified in the Final Environmental Impact Statement (USDA 1992) as closely associated with late-successional or old-growth forests. During the preliminary stages of our analysis it became obvious to us that there were numerous other species likely associated with such forests. Accordingly, it seemed logical to fully address the concern for other species (vertebrates, invertebrates, vascular, and nonvascular plants). Therefore, an assessment of the status of a much broader array of species thought to be associated with old-growth forests was conducted in concert with members of the Northern Spotted Owl Recovery Team.

Peer Review of the Scientific Analysis Team's Report

The Deputy Chief of the Forest Service's National Forest System (J. Overbay pers. comm.) directed that the Scientific Analysis Team's report be submitted for peer review. The Scientific Analysis Team welcomed that instruction. Further, the Scientific Analysis Team concluded that the peer reviewers should be selected by other fully qualified persons outside the Scientific Analysis Team. Therefore, six professional societies were contacted to provide names of qualified reviewers. These reviewers were contacted by the Scientific Analysis Team's Administrative Officer in the order that the names were listed until a reviewer was found that was available and willing to conduct the review under the prescribed timelines (response within three weeks). There was no contact between any member of the Scientific Analysis Team and the reviewers until after their reviews were submitted to the Scientific Analysis Team. The Scientific Analysis Team leader sent letters of instruction to the peer reviewers and did provide a missing appendix to the reviewers after the reviews were complete with the solicitation of additional comments, if such seemed appropriate. No additional comments were received.

The organizations that provided names of qualified peer reviewers were: (1) American Fishery Society, (2) The Wildlife Society, (3) Society of American Foresters, (4) Society for Conservation Biology, (5) Ecological Society of America, and (6) American Ornithologists' Union.

The Scientific Analysis Team collectively scrutinized each peer review in detail and revised the final report to satisfy peer review comments. Detailed notes were kept to document the team's reactions and responses to the peer reviews. These peer reviews and details of our response to peer review comments are on file at the Pacific Northwest Regional Office of the Forest Service, Portland, Oregon.

RESULTS

A brief synopsis of the answers to the three questions is presented in this chapter. There is a full discussion in the chapters that follow.

Question 1 - Does Exemption of 13 Bureau of Land Management Timber Sales From the Requirements of the Endangered Species Act Necessitate Changes in Viability Assessments in the Forest Service's Final Environmental Impact Statement?

See Chapters 2 and 3.

Criteria for Risk Management - Each evaluation of the risk of management plans to spotted owl viability was conducted through an assessment of the following criteria:

1. Potential change in the amount and size of blocks of habitat
2. Distribution of habitat
3. Capability of the habitat to support pairs of spotted owls
4. Dispersal habitat
5. Spacing between Habitat Conservation Areas
6. Patch size of habitat
7. Clustering of spotted owl pairs

The information from the evaluation of each of these items pointed out shortcomings that could be addressed through mitigation measures.

Evaluation of Bureau of Land Management Management Scenarios - Three scenarios for Bureau of Land Management management were examined.

<u>Exemption of 13 Bureau of Land Management Timber Sales as a One-Time Action</u>. See Chapter 2. This scenario assumes that the exemption by the Endangered Species Committee of the 13 Bureau of Land Management timber sales from the requirements of the Endangered Species Act is a one-time action. It is further assumed that Bureau of Land Management will, thereafter, comply with the Interagency Scientific Committee's Conservation Strategy or some other strategy that provides an equally high likelihood of viability for the northern spotted owl. The Scientific Analysis Team found that: 1) such action would cause only a slight increase in risk to spotted owl viability across its range and 2) such action would not warrant a change in the overall viability assessment presented in the Final Environmental Impact Statement. Therefore, the Scientific Analysis Team did not deem it necessary to suggest any mitigation measures to the Forest Service's selected alternative in the Final Environmental Impact Statement to compensate for this slight increase in risk to spotted owl viability.

<u>Exemption of 13 Bureau of Land Management Timber Sales With Compliance Thereafter With Current Management Plans</u>. See Chapter 2. According to this scenario, if the Bureau of Land Management continues the management of its forested lands in Oregon under current plans which provide for 109 reserved areas for northern spotted owls (called Bureau of Land Management/Oregon Department of Fish and Wildlife Agreement Areas) and Management Framework Plans prepared in the 1980's, the amounts and quality of spotted owl habitat will continue a precipitous decline. This decline will ultimately reduce the likely contribution of the

Bureau of Land Management's lands to supporting a viable population of spotted owls to near zero. If such a management scheme were followed, dramatic increases in Habitat Conservation Areas would be required for lands managed by the Forest System to attain an overall "high" viability rating for the northern spotted owl.

Mitigation Measures Recommended. Given this scenario, we estimated that approximately 1,134,000 acres would need to be added to the network of Habitat Conservation Areas on National Forests. This only partially compensates for the lack of contribution to spotted owl habitat by Bureau of Land Management administered lands, but does result in a high viability rating for the preferred alternative in the Final Environmental Impact Statement.

The Scientific Analysis Team, however, considered that the chances of the Bureau of Land Management following such a strategy in the future are not likely. We only addressed this scenario because it was specifically assigned to us.

<u>Adoption of Bureau of Land Management's Preferred Alternative in the Draft Resource Management Plans</u>. See Chapter 3. After detailed examination of Bureau of Land Management's preferred alternative in their Draft Resource Management Plans, the Scientific Analysis Team concluded that adoption of those plans has a high probability of not providing a level of management of spotted owl habitat equal or superior to that provided by the Interagency Scientific Committee's Conservation Strategy. This increased risk can be attributed to: (1) allowing 40-50 years to pass before meeting provisions for dispersal habitat; (2) conducting precommercial and commercial thinning in younger developing stands in management areas with emphasis on maintaining and producing old-growth forest characteristics; and (3) lack of provisions for protection of all territorial owl pairs in the Oregon Coast Range. This area is of special concern due to loss of habitat and severe fragmentation of extant late-successional forests. The period of high risk for the Bureau of Land Management's preferred alternative is expected to occur most dramatically during the same period over which the spotted owl is at some additional risk across its range under the Interagency Scientific Committee's Conservation Strategy. This risk to the owls' viability under the Interagency Scientific Committee's Conservation Strategy results from continued habitat loss to the point that the rate of loss matches the rate of gain (i.e., equilibrium is attained); and the possibility of increasing isolation of the Oregon Coast Range spotted owl population. With participation by all Federal agencies, though, the Interagency Scientific Committee's Conservation Strategy was deemed adequate to provide for the northern spotted owl.

Mitigation Measures Recommended. The Scientific Analysis Team concluded that the Bureau of Land Management's action in adopting the preferred alternative of their Draft Resource Management Plans, which is likely to be less effective than the Forest Service's selected alternative (the Interagency Scientific Committee's Conservation Strategy), would change the likelihood of maintaining spotted owl viability across its range from "high" to "medium". This change in the overall viability rating would result if no mitigation measures were adopted for National Forests to compensate for increased risks on lands administered by the Bureau of Land Management.

The Scientific Analysis Team recommended mitigation measures be adopted on lands managed by the Forest Service to make up for significantly increased risks on lands administered by the Bureau of Land Management.

If the recommended mitigation measures are implemented, the probability of maintaining a viable population of spotted owls is increased from "moderate" to "high". This mitigation measure includes additions of approximately 418,000 acres to the Habitat Conservation Areas designated by the Interagency Scientific Committee and strategically located on National Forests (Siuslaw, Siskiyou, Umpqua, and Willamette) adjacent to lands administered by the Bureau of Land Management. This mitigation measure will protect enough habitat and additional pairs of spotted owls to compensate for pairs displaced on lands administered by the Bureau of Land Management *if* the higher-risk strategy proposed in the Bureau of Land Management Preferred Alternative in their Draft Resource Management Plans fails to perform as expected. We consider that to be a distinct probability.

The increased size of some Habitat Conservation Areas will also ensure that spotted owl territories contain enough owl pairs to maintain persistence of breeding pairs over several decades. Larger Habitat Conservation Area sizes will also result in decreasing distances between Habitat Conservation Areas, thereby increasing the chances of successful dispersal between Habitat Conservation Areas. For example, nearest-neighbor distances between Habitat Conservation Areas on lands managed by the Forest Service in the Oregon Coast Range is decreased from 8.2 to 2.8 miles with the additions. In combination, these mitigation measures may maintain a subpopulation in the Oregon Coast Range with enough numbers and adequate habitat to enhance the probability of maintenance of population persistence.

Question 2 – Does New Information Necessitate Changes in Management Proposed in the Forest Service's Final Environmental Impact Statement?

See Chapter 4. Since January 1992, a variety of new information has been released relative to the biology of the northern spotted owl, including new information on the demographics and population density of the owl, dispersal, and hybridization with the barred owl. We present summaries of new information that has been released since January 1992, including updated information for four of the five study areas described by David Anderson and Kenneth Burnham of the Fish and Wildlife Service. Implications of the new information are discussed relative to the selected alternative in the Final Environmental Impact Statement.

Demographic Studies - See Chapter 4. Between 1985 and 1987, researchers initiated five long-term demographic studies of spotted owls in Washington, Oregon, and northwestern California. These studies were designed to investigate demographic rates of spotted owls, including age-specific birth and death rates and population trends. Data from these five studies were analyzed in a workshop at Fort Collins, Colorado, in September 1991.

The Fort Collins workshop produced an analysis of each of five individual study areas as well as a "meta-analysis" in which data from all areas were examined in combination to determine any overall trends. A synopsis of the Fort Collins workshop was written by Anderson and Burnham and provided to the Northern Spotted Owl Recovery Team in November 1991 for inclusion in its Recovery Plan for the Northern Spotted Owl (USDI 1992a).

The analysis done at the Fort Collins workshop indicated that populations of territorial spotted owl females on all five study areas were declining. Estimated rates of decline on the individual study areas ranged from 6 to 16 percent per year, with an overall average of approximately 10 percent per year.

The demographic meta-analysis performed at the Fort Collins workshop indicated that not only were populations declining on the individual study areas, but female survival rates were declining over time at an increasing rate. This was probably the most troubling finding from the Fort Collins workshop because an accelerated decline in survival rates could be indicative of a population that has passed some sort of demographic threshold and is rapidly proceeding to extirpation or extinction.

Since the results of the Fort Collins workshop were released, there has been considerable discussion within the scientific community concerning possible biases in the demographic data on which the assessment relied. The primary concern was that emigration of juveniles and adults might cause survival rates to be underestimated. In the analysis technique used, undetected emigrants are considered to be dead when, in fact, some may still be alive. To the extent that birds emigrate, survive, and go undetected, the models used in the assessment overestimate recapture rates and underestimate survival. It is known that undetected emigration of juveniles and adults does occur, based on results of radio-telemetry studies.

Studies using radio-marking techniques of juvenile spotted owls in 1991-1992 indicated that 22, 44, and 45 percent of juveniles from the three study areas survived the first year of life, left the demographic study areas, and would not have been detected by banding alone had they not been wearing radio transmitters.

Although it is probable that some of these emigrants will be detected by conventional calling and banding techniques as they move around and acquire territories in future years, the high rates of first-year emigration from the demographic study areas do suggest that undetected emigration is causing a negative bias in juvenile survival estimates derived from banding data. Survival estimates based on the radio-marked samples of juveniles in the 1991-92 study were considerably higher than the average values estimated from demographic studies. Comparatively high survival of the radio-marked birds may reflect the reduction of bias caused by emigration, but could also be the result of a particularly mild fall, winter, and spring in 1991-92. We believe it will take several more years of study before essentially unbiased estimates of survival rates of juvenile spotted owls are available for all demographic study areas.

Although there is less evidence to indicate significant emigration by adult owls, there is a concern that demographic analyses can be biased by such emigration because estimates of population growth rates are most sensitive to changes in adult survival rates. If anything, emigration of adult owls will lead to underestimates of adult survival rates and a corresponding underestimate of the rate of change of population growth rate.

The parameter used to estimate age-specific birth rates at the Fort Collins workshop was fecundity (defined as the number of female young produced per year per territorial female). Estimates of fecundity from the demographic studies are believed to be reasonably accurate, although several sources of counteracting bias are possible.

The Scientific Analysis Team contacted research biologists working on the five demographic study areas from which the data was acquired that was examined by Anderson and Burnham at the Fort Collins workshop to see if they could update their individual demographic estimates with 1992 data. Researchers working on four of the five study areas provided updated estimates of survival and fecundity. Adding one more year of data resulted in only minor changes in estimates of average survival rates and fecundity. New estimates of population growth rates will be calculated from the 1992 data during 1993. Because our update of demographic rates on four of the five individual study areas indicates little change in survival and fecundity rates from the original Anderson and Burnham analysis, we do not anticipate that the revised population change estimates will differ appreciably from the original results reported by Anderson and Burnham (1992).

Population Density Studies - An alternative method of evaluating population trends is to examine actual changes in the number of territorial owls per unit area over time. The Scientific Analysis Team summarized density estimates for 12 density study areas. An analysis of these data indicated that of 10 areas with three or more years of data, only two areas near Medford, Oregon, appeared to be undergoing significant declines. Crude densities (number per total area considered) were essentially stable on seven areas, and increasing on one area. A meta-analysis of the combined data set indicated that the populations were declining at a rate of 3.2 percent per year. Although this analysis was based on relatively short time periods (2 to 8 years) of data collection, we concluded that there was little evidence of significant changes in crude density on most of the study areas.

Declines in Owl Populations Related to Declines in Habitat - An analysis of timber-cutting records on the five study areas indicated that spotted owl habitat on Federally administered lands was declining at 0.9 to 1.5 percent per year on Forest Service study areas and 1.3 to 3.1 percent per year on Bureau of Land Management study areas. Timber cutting records were not available for non-Federal (state and private) lands. Analysis of rates of habitat loss using Landsat data that covered all land ownerships indicated rates of habitat loss between 1.1 percent and 5.4 percent per year. Rates of habitat loss were lower than estimated rates of population decline from demographic studies and greater than rates of population decline based on changes in owl numbers on density study areas. The one exception was the Medford area where relatively high rates of decline based on changes in owl numbers matched high rates of decline in habitat estimated from Landsat analyses.

It is apparent to the Scientific Analysis Team that results from demographic analyses of data on territorial females and changes in owl density of territorial pairs suggest quite different relationships between habitat loss and population response. One method (demographic studies) suggests that territorial populations of owls are declining substantially faster than the rate of habitat loss. The other method (population density studies) indicates that populations of territorial owls are either stable or declining at about the same rate as habitat loss. It is not apparent, however, how floaters (non-territorial, non-breeding adult owls) may fill vacancies in the territorial populations.

Thresholds in the Metapopulation of Owls - After the release of the Anderson and Burnham (1992) report, some experienced scientists suggested that the declining survival rates of female spotted owls were indicative of a population that had dropped below a demographic threshold and was declining precipitously toward extinction. The Scientific Analysis Team concluded from an examination of all available data that it is highly unlikely the overall spotted owl population has fallen below such a demographic threshold. In fact, given the size of the population, the extent of the presently occupied range, stable fecundity rates, and the amount of habitat that still exists, we consider it highly unlikely that any thresholds have been passed with the possible exception of some subpopulations in highly isolated and heavily cutover areas, such as southwestern Washington.

Viability Ratings and Spatially Explicit Models - Viability ratings for spotted owl populations under the five alternatives in the Final Environmental Impact Statement were ranked using the seven criteria presented on page 11. Subsequently, the Forest Service was criticized for not using more quantitative, spatially explicit models to rank alternatives presented in the Final Environmental Impact Statement. Although the Scientific Analysis Team agrees that the use of quantitative, spatially explicit models to examine alternatives is a good idea, there are several reasons why the Forest Service has not done so. We consider those reasons as valid.

First, at the time the Final Environmental Impact Statement was released, the only spatially explicit owl/habitat model that we were aware of was still in the development stage and not fully tested. Second, and more importantly, the use of a spatially explicit model requires detailed, spatially explicit maps of present and anticipated future habitat and proposed logging areas (i.e., areas of habitat loss). Although digital maps of old-growth and mature forest have been produced, to some extent and to varying degrees of accuracy, by several agencies and private organizations, maps of most age classes younger than old growth are incomplete or lacking, making it difficult to use spatially explicit models to evaluate current, and especially future distribution of habitat of various kinds used by owls for dispersal, foraging, and nesting. Thus, use of a spatially explicit model at this point would involve many assumptions about the amount and distribution of habitat and harvest areas that are unsubstantiated by currently available data.

There has been considerable refinement of spatially explicit models designed to examine relationships between spotted owl populations and changes in habitat. Given that such models are available, the Scientific Analysis Team suggests that the Forest Service continue to acquire adequate Geographic Information System technology and develop maps of habitat and harvest alternatives that can be used to assess alternatives for the spotted owl and other species associated with late-successional forests. Whereas maps of old growth have been developed by the Forest Service and several other parties, these maps are based on different characteristics and are not generally compatible.

Hybridization Between Barred and Spotted Owls - Since 1989, crosses (hybrids) between barred owls and spotted owls have been confirmed at four widely separated locations within the range of the northern spotted owl. Although records of hybridization between barred owls and spotted owls are an interesting biological phenomenon, biologists do not know what the ultimate outcome will be. Hybridization is common in nature, having been recorded in about 10 percent of the nonmarine bird species in North America. In most species where it occurs, hybridization is an uncommon event, and thus has little effect on the parental species, that is, they still continue as distinct species.

The Scientific Analysis Team believes that hybridization between spotted and barred owls is rare because so few hybrids have been detected during the last 15 years, despite the fact that hundreds of observers have been conducting surveys for spotted owls. Nevertheless, the barred owl is rapidly extending its range into the range of the spotted owl, and the incidence of hybridization could possibly increase as the numbers of barred owls increase. We simply do not know what the outcome will be. Even in the absence of interbreeding, the barred owl may represent a threat to the spotted owl from either competition or displacement.

We conclude there is little the Forest Service or other forest management agencies can or should do to influence the eventual outcome of the extension of the barred owl range. It is not at all clear that this range extension is the result of forest management practices. It is equally unclear whether a change in management practices (e.g., saving all the old-growth forests or stopping all timber cutting) will have any effect on the rate or extent of the extension of the barred owl range. In light of this uncertainty and the evidence that hybridization is uncommon, we believe the most reasonable course of action is to continue to manage habitat for large clusters of spotted owls dispersed across the historical range of the species.

Surveys for Spotted Owls - Since the release of the Final Environmental Impact Statement, additional surveys of spotted owls have been completed. These surveys indicate that the population of spotted owls in British Columbia is probably less than 100 pairs. We believe that protection of the Canadian population of spotted owls is important, particularly from the standpoint of maintenance of a widely distributed population.

Between 1987 and 1992, pairs of owls were detected at 3,591 sites in Washington, Oregon, and northwestern California. As each of these sites was not always verified by searches in subsequent years, the occupied sites in 1992 would likely be less than that number by some unknown amount. Because there are still areas that have not been searched for owls, it is seems likely that the actual population is larger than the confirmed population. The increase in the number of confirmed owl pairs should not be interpreted as evidence of a population increase. Data from the density study areas and the demographic studies do not support such an interpretation.

The increase in the number of confirmed owl pairs results from greatly increased survey efforts during the last 10 years, including, (1) a greatly expanded effort to inventory owls, (2) the initiation of numerous demographic studies across the range of the owl, and (3) increased surveys associated with timber sales in order to comply with Section 7 consultation requirements of the Endangered Species Act. Given the dramatic increase in survey effort since 1985, we are not surprised that significantly more owls have been located.

The total number of owls that exist under current conditions is not particularly relevant – what is much more important is the total number of owls projected to occur when a final management plan is fully implemented and habitat levels stabilize. The plan proposed by the Interagency Scientific Committee assumed that most pairs of owls outside Habitat Conservation Areas would eventually disappear as habitat was removed and simultaneously fragmented, eventually resulting in a population of about 2,200 pairs of owls within the network of Habitat Conservation Areas. This estimate is largely independent of the size of the current population. What does change as a result of the size of the current population of spotted owls is that we can be somewhat more confident that the population will survive through the short-term transition period while the plan is being implemented.

Review of Literature Available Since Publication of the Forest Service's Final Environmental Impact Statement - As part of our process, we reviewed all the available literature concerning northern spotted owls published since the preparation of the Final Environmental Impact Statement. In addition, we reviewed progress reports and other unpublished information and interviewed research scientists who were conducting ongoing research. A complete annotated bibliography of this information was prepared and appears as Appendix 4-B of this report. The Scientific Analysis Team evaluated this information and concluded that such information did not alter the underlying construct of the Interagency

Scientific Committee's Conservation Strategy nor indicate any reason to alter the details of that strategy except as necessary to mitigate for Bureau of Land Management actions.

Evaluation of Whether New Information Warrants Changes in Proposed Management Schemes - The Scientific Analysis Team finds that the new information examined does not warrant proposing more restrictive measures for protecting northern spotted owl habitat. Assuming that the selected alternative in the Forest Service's Final Environmental Impact Statement is fully implemented, and our recommendations (see Chapter 3) for increased reserved areas for spotted owls on lands managed by the Forest Service to compensate for Bureau of Land Management management actions are initiated if that becomes necessary, the Scientific Analysis Team concludes that the preferred alternative of the Final Environmental Impact Statement will provide a high likelihood of maintaining a viable, well distributed population of northern spotted owls.

Question 3 – What Are The Risks To Other Species Associated With Old-Growth Forests? What Are Appropriate Mitigation Measures?

See Chapter 5.

The Rationale for Expanding the Assessment Beyond the 32 Species Identified in the Forest Service's Final Environmental Impact Statement - The Final Environmental Impact Statement identified 32 species of terrestrial vertebrates other than the northern spotted owl as closely associated with old-growth forests. We refined the basis for identifying these species and expanded the evaluation beyond terrestrial vertebrates (amphibians, reptiles, birds, and mammals) to include plants, invertebrates, and fish species/stocks. This assessment was conducted because: (1) a full examination is in keeping with the mandates of the regulations issued pursuant to the National Forest Management Act to maintain viable populations of all native species well distributed within the planning area(s); (2) such an assessment avoids "piecemeal" consideration of evolving concerns with individual species with the inherent potential of infinite delays in plan approval; and (3) such an approach is in keeping with the Forest Service's recent commitment to "ecosystem management." We caution, however, that the effort reported in this publication is not a complete ecosystem assessment; it is a significant step.

Methods - The Scientific Analysis Team expanded the evaluation of the risk of extirpation under the adoption of the Forest Service's Final Environmental Impact Statement Alternative B (the Interagency Scientific Committee's Conservation Strategy) to assess *all* species that have been identified as being associated with old-growth forests. This evaluation took place in three phases:

1. Identification of species associated with old-growth forests.
2. Evaluation of the viability status of each such species under the five management alternatives described in the Final Environmental Impact Statement. This evaluation included an estimate of the likelihood of extirpation from planning areas (interpreted by the Scientific Analysis Team as National Forests within the range of the northern spotted owl).
3. Identification of potential mitigation measures to ensure high viability of all species identified as closely associated with old-growth forests that were determined to have a medium or high rate of extirpation under the Interagency Scientific Committee's Conservation Strategy.

We compiled what came to be called the "long list" of all species associated with old-growth forests. These lists emerged from a review of literature, unpublished studies and data bases, Forest Service ecology data bases, and professional knowledge. A set of criteria was developed to help judge the degrees of the association of the species with old-growth forest ecosystems. These criteria were used to reduce the "long list" to a "short list" of species that seemed likely to actually be associated with late-successional, old-growth forests. We then set up evaluation panels of seven to eight recognized experts in each of five specialty areas: (1) fungi, lichens, and nonvascular plants; (2) vascular plants; (3) amphibians and reptiles; (4) birds; and (5) mammals. The panels assessed risks to viability and probabilities of extirpation of individual species within those groups. In a separate process, we consulted with experts on fish habitat to develop lists and viability ratings of sensitive fish stocks. We consulted with invertebrate specialists for the same purposes. Panelists and consultants were provided summary data, distribution maps, and other information to aid in their deliberations.

To determine the likelihood of viability of each species under various planning alternatives described in the Final Environmental Impact Statement, each panel reviewed the available information for those species on the "short list" that were within their area of expertise, by planning area where appropriate. From this evaluation emerged a viability assessment for each species at three levels. Those rated by the panels as having a "high" or "medium high" likelihood of overall viability were considered as being at low risk of extinction or extirpation from one or more planning areas (i.e., National Forests). Those having a "medium" likelihood of overall viability were considered as having a "medium" risk of extirpation. Those species ranked as having a "medium low" or "low" likelihood of overall viability were considered as having high risk of extirpation. Each species was evaluated for each alternative in the Final Environmental Impact Statement. The period of evaluation was 50 years. The Scientific Analysis Team considered that these categories of risk correspond to the population viability language presented in the regulations (36 CFR 219.19) issued pursuant to the National Forest Management Act.

Results - Details concerning the species identified as closely associated with old-growth forests are found in Chapter 5.

<u>Number of Species Associated With Late-Successional Forests</u> - The Scientific Analysis Team identified 667 species that have a high likelihood of being associated with old-growth forests. This total was made up of 35 species of mammals, 38 birds, 21 reptiles and amphibians, 112 fish stocks, 149 invertebrates, 122 vascular plants, and 190 nonvascular plants and fungi.

<u>Evaluation of the Provision of Habitat Needs of Species Associated With Late-Successional Forests by Increments of Protected Areas</u> - Building on the Interagency Scientific Committee's Conservation Strategy to provide mitigation measures for viability of species associated with old-growth forests requires some approach of "tiering" from one set of mitigation measures to the next. It should be remembered that the Interagency Scientific Committee's Conservation Strategy tiered off designated land allocations such as National Parks and congressionally designated Wilderness in extant Federal land use plans. The combination of the Land and Resource Management Plans for the National Forests and the Interagency Scientific Committee's Conservation Strategy provide for high viability of 280 of the identified at-risk species. The Scientific Analysis Team continued that process by next considering the mitigation measures suggested to deal with the 112 fish stocks considered to be at risk.

Mitigation measures for at-risk fish stocks were taken from the array of six management options for those at-risk fish stocks prepared by a panel of fish habitat and watershed experts for managing Pacific anadromous fish habitat on National Forests throughout the western states. This group is known as the Pacific Salmon Workgroup and Field Team (hereafter referred to as the Pacific Salmon Workgroup, also known as "PacFish").

Each management option developed by the Pacific Salmon Workgroup has a different risk rating for the fish stocks in question. The option we recommend in this report was deemed by the scientists of the Pacific Salmon Workgroup and by the Scientific Analysis Team as having a "high" probability of providing for the viability of the fish stocks in question only insofar as spawning, rearing, and migration habitat on National Forests is concerned. Other factors influencing the viability of these fish runs (such as ocean fishing, irrigation drawdown, or runoff from agricultural lands) is beyond the capability of the Forest Service to address.

The Pacific Salmon Workgroup presented one other option that yields a "high" probability of success, but at a greater impact to commodity resources. Two other options are rated at "moderately high" (i.e., somewhat better than 50/50) probability of viability. In selecting such an option, one would have to consider if such a risk is acceptable to the management agencies and to the courts in dealing with a critical habitat component for fish stocks that are very likely to be listed as either "threatened" or "endangered" under the Endangered Species Act.

The Scientific Analysis Team's aquatic and riparian mitigation measures involve four components: (1) a network of key watersheds containing at-risk fish species and stocks, good quality habitat and/or high potential for restoration; (2) establishment of Riparian Habitat Conservation Areas with minimum interim buffer widths for different sized streams and a set of standards and guidelines for operating within Riparian Habitat Conservation Areas; (3) conducting an intensive watershed analysis to establish final boundaries for Riparian Habitat Conservation Areas and watershed restoration priorities; (4) watershed restoration of degraded habitat for the long-term protection of aquatic and riparian habitats.

The minimum interim buffer widths for Riparian Habitat Conservation Areas consist of: 300 feet on each side of lakes and fish bearing streams; 150 feet on each side of permanent non-fish bearing streams; 150 feet of ponds and reservoirs and of wetlands larger than one acre; and 100 feet on each side of seasonal intermittent streams and wetlands less than one acre in size, as well as landslide and landslide-prone areas. Within these protection areas, timber management and other ground disturbing activities are prohibited unless a site-specific watershed analysis indicates such activities will accelerate meeting desired ecological conditions. Within key watersheds and inventoried roadless areas detailed watershed analysis must precede management activities.

The combination of reserves in National Parks and congressionally designated Wilderness, Land and Resource Management Plans, the Interagency Scientific Committee's Conservation Strategy, and Riparian Habitat Conservation Areas provide for protecting an additional 19 species at risk of high viability in addition to the 112 fish stocks the mitigation measures were designed to protect.

The next step in determining mitigation measures was the consideration of requirements for nesting habitat on lands managed by the Forest Service for the marbled murrelet. This species was listed as "threatened" under the authority of the Endangered Species Act on September 28, 1992. This listing ensures that a recovery plan for this species will be forthcoming eventually from the Fish and Wildlife Service. It is the Scientific Analysis Team's opinion that the prudent course of action is to reserve all marbled murrelet habitat on National Forests within 50 miles of marine habitats in Washington and most of Oregon, and within 35 miles in southern Oregon and California.

In addition, we recommend that habitat recruitment stands (i.e., stands that have capability to become marbled murrelet suitable nesting habitat) equal to 50 percent of the total extant suitable habitat also be selected and protected. The mitigation measures suggested are considered by the Scientific Analysis Team to be interim guides to preserve options until a recovery plan is prepared.

It seems likely that such a recovery plan for the marbled murrelet will build on the Recovery Plan for the Northern Spotted Owl (basically the Interagency Scientific Committee's Conservation Strategy) and some form of Riparian Habitat Conservation Areas will be designated to protect at-risk fish stocks. The Scientific Analysis Team estimates that 24 additional at-risk species can be assured viability by the combination of the above described actions. These actions will preserve a wide array of existing options for those preparing the recovery plan for the marbled murrelet. Further, it should be recognized that similar protection might well be imposed by the Fish and Wildlife Service even in a step-by-step series of Section 7 consultations, when any action is proposed that may disturb actual or potential nesting habitat. This proactive move is biologically appropriate and could save time and money over the long term.

There were another 17 at-risk species identified as rare or locally endemic. Mitigation measures vary for this group by species, but generally depend on surveys for occurrence of the species and protection on a site-specific basis. Another seven species that are more broadly distributed require some considerations in management of the forest matrix between protected late-successional old-growth forest areas. Such action includes leaving some large dead trees standing on site during silvicultural manipulations including logging, protection of talus areas, and buffering meadows and other natural openings, with areas of protected forests, use of prescribed fire, and minimizing the construction of roads.

For the remaining at-risk species, information was lacking to design specific mitigation options. Based on general life-history attributes of these species, we determined that habitat requirements of 23 species would likely be met by the combination of all the mitigation measures mentioned above. This left 149 species of invertebrates and 36 species of plants (9 nonvascular plants and fungi, 8 vascular plants) and vertebrates (9 mammals, all species of bats) of which so little is known that we were unable to assess their viability or the prescription of mitigation measures. Inability to assess viability does not imply that species would be at risk nor does it imply the opposite. Intuitively, the reservations of late-successional, old-growth forests in National Parks and congressionally designated Wilderness, and specified in land use plans, the Interagency Scientific Committee's Conservation Strategy, Riparian Habitat Conservation Areas, and marbled murrelet habitat reserves should provide significant resources of old-growth forest habitat for insuring the viability of such species. The additional mitigation measures described for rare or locally endemic species above should further add to the probability of maintaining viable populations. Yet, the state of knowledge about these species is such that their viability cannot be assessed.

The Scientific Analysis Team suggests that information necessary to evaluate viability of these species be obtained and evaluated. It is logical to assume that such a process would reveal that some of these species have a low risk of extirpation or extinction. For those species that are determined to be at risk, it is likely that specific mitigation measures can be developed to ensure a low risk. However, this cannot be done without additional information. We believe that the assessment we have completed is the best we could do with extant empirical information, expert opinion, and common sense. As new information is generated we recommend that it be considered through the adaptive management process.

We conclude that, with the institution of the Interagency Scientific Committee's Conservation Strategy and the implementation of the mitigation measures described above, that 482 of the 518 (93 percent) plants and vertebrates closely associated with old-growth forests can be considered to have a low risk for extirpation or extinction. The remaining risk to the other species is impossible to assess.

Requirements for Successful Implementation of Mitigation Measures for Species Associated With Old-Growth Forests

See Chapter 6.

The Scientific Analysis Team developed a step-wise approach for providing protection of habitat for species closely associated with old-growth forests adequate to sustain viability (see Chapter 5). There were six distinct steps involved in this process. These steps, collectively, comprised the mitigation measures necessary to assure viability for the 482 plant and animal species determined to be associated with late-successional forests. There were 36 species about which so little is known that assessment of risk to these species was not possible. Full implementation of the suggested mitigation steps consists of the following:

1. Retention of all land allocations and standards and guidelines in Forest Service Land and Resource Management Plans that provide protection for species closely associated with late-successional forests or the fish species/stocks considered to be at risk.

2. Implementation of the Interagency Scientific Committee's Conservation Strategy or the Department of the Interior's Recovery Plan for the Northern Spotted Owl. This may include additions to the Habitat Conservation Areas designated in the Interagency Scientific Committee's Conservation Strategy (as described in Chapter 3) to compensate for management of lands administered by the Bureau of Land Management.

3. Immediate implementation, on an interim basis, of the Scientific Analysis Team's recommended standards and guidelines for species closely associated with old-growth forests or components of old-growth forests and the fish species and stocks considered to be at risk. The Scientific Analysis Team recognizes that meeting the requirements of the National Environmental Policy Act must precede permanent implementation.

4. Ongoing activities involving contractual obligations for the Forest Service should be reviewed on a case-by-case basis to determine compatibility with the standards and guidelines. We do not believe blanket cancellation of timber sales under contract is warranted, rather, each sale must be individually evaluated and considered for cancellation or modification. Where Federally-listed species that are clearly associated with old-growth forests, such as the marbled murrelet, are effected we recommend that the conservation recommendations (discretionary suggestions by the Fish and Wildlife Service) offered in Biological Opinions issued through Section 7 consultation be followed until the adoption of a recovery plan or conservation strategy for the species.

5. Proposed or planned activities, regardless of their point in the planning process, must be immediately modified to be consistent with the standards and guidelines.

6. The Scientific Analysis Team recommends that the Forest Service develop a policy to address appropriate habitat management response following wildfires, wind storms, insect-induced tree kills, or other significant mortality factors. This policy should build upon the standards and guidelines of the Interagency Scientific Committee's Conservation Strategy for salvage and fuels management inside Habitat Conservation Areas.

7. Establishment of a formally prescribed oversight process for consistent interpretation and application of the standards and guidelines suggested by the Scientific Analysis Team.

8. Development of an adaptive management process that will foster and guide development of new information, as well as facilitate the review and interpretation of that information as it becomes available. Research and monitoring are critical elements of adaptive management and as such must be given high priority. It is likely that data generated by research and monitoring will be the information used in the adaptive management process. The adaptive management process will indicate where and when modification of the standards and guidelines is warranted.

9. Finally, the Scientific Analysis Team emphasizes the need for full interagency cooperation that will result in unified strategies to provide for species closely associated with old growth and old-growth components. The Interagency Scientific Committee recognized the lack of interagency and intergovernmental cooperation as a potential major obstacle to efforts to produce an effective, cost efficient northern spotted owl habitat management plan. This obstacle continues to exist as the issue increases in complexity.

Monitoring and Research

The Scientific Analysis Team identified monitoring and adaptive management as critical elements of their suggested management and mitigation measures. To be effective, such monitoring and adaptive management will require interagency cooperation, development of "trigger" points to signal needs for, or opportunities to, alter management direction, consistent execution and assessment of the results of monitoring, and the continuation of research efforts to fill critical gaps in knowledge.

Though such monitoring will be costly and time consuming, we consider it essential. The Scientific Analysis Team proposes an overall strategy of management and mitigation that, in the case of species of plants and animals associated with old-growth forests, is based to a large degree on expert opinion. The risk inherent in moving ahead in overall forest management with so little quantitative information for those plants and animals may be significant. We acknowledge that risk and consider it acceptable in the short term only if adequate research and monitoring are instituted and pursued vigorously in a coordinated, rigorous, and conscientious manner. We are cognizant that the monitoring plans in the Land and Resource Management Plans, which were designed to compensate partially for risk, have not, in general, been carried out in a manner consistent with this goal.

If the Scientific Analysis Team's recommendations for mitigation are accepted and instituted, monitoring and associated research will be essential to successful implementation. And, if, for whatever reason, no monitoring is instituted, the standards and guidelines we have suggested should be substantially enhanced to compensate for the risk of failure inherent in untested management strategies based to such a large extent on expert judgment.

The Effect of Suggested Standards and Guidelines of Altered Management by Other Land Holders

The attorneys for the Forest Service argued before Judge William Dwyer in the ongoing case of Seattle Audubon et al. vs. Moseley et al. that when a species is listed as "threatened", the requirements of the Endangered Species Act of 1973 supersede the necessity for the Forest Service to continue to be governed by the National Forest Management Act and the regulations promulgated pursuant to that Act (36 CFR 219; Planning Regulations for Implementing Section 6 of the National Forest Management Act) which deal with the management of habitat for that species. Of particular concern were the regulations requiring the Forest Service to maintain viable populations of vertebrates well distributed by planning area. The Court rejected that argument. We assumed in our assessments, therefore, that the requirements of both Acts must be simultaneously met.

The Scientific Analysis Team considered this ruling as particularly germane as we went about our assigned tasks. Because our task was to consider a series of questions dealing with the management of National Forests and development of management scenarios for consideration by decision makers, it was necessary to predicate our response on our interpretation of the requirements of the Endangered Species Act and the National Forest Management Act.

This process may be considered inappropriate to some (i.e., those who believe that scientists should deal strictly with science and leave interpretation of the law and policy to others). However, it is obvious, at least to us, that one cannot deal with science as applied to management without interpretation of the boundaries prescribed by law, regulations, policy, *and* science.

In the process of suggesting standards and guidelines to provide mitigation measures for risk to viability of species associated with old-growth forests (including the northern spotted owl, marbled murrelet, and sensitive fish species/stocks) the Scientific Analysis Team was faced with a number of situations in which only a portion of either the range or the overall habitat requirements, or both, of the individual species under consideration were met on lands managed by the Forest Service. An example of this situation is the case of stocks of anadromous fish whose best or only remaining spawning and rearing areas, or both, occur on National Forests. These fish stocks are subject to a myriad of debilitating factors that occur elsewhere, such as degraded riverine habitats between the spawning grounds and the ocean, the occurrence of catastrophic events, and the continued introduction of hatchery fish. Obviously, none of these debilitating influences on fish stocks of interest are within the control of the Forest Service.

It is, nonetheless, required that the Forest Service maintain that part of the habitat under its control in such a condition that any fish that do return to those spawning and rearing areas have a chance to reproduce and grow. This protection of the portion of the habitat under management by the Forest Service would be required regardless of management of other lands. In this case, if the spawning and rearing areas are lost, the fish stocks that are wholly or significantly dependent on those spawning and rearing areas are, likewise, lost.

When this concept is applied to all species dependent on late-successional forests, it begs a question. Do these standards and guidelines apply regardless of what other land managers, whose lands also harbor the species in question, do on their lands? Or, in other words, would added attention to the welfare of these species by other land managers reduce the stringency of the standards and guidelines set forth herein for those species? With the exception of the mitigation measures proposed for adoption by the Forest Service for the northern spotted owl to compensate for significant risks to that species in proposed plans of the Bureau of Land Management, the answer is "no." To satisfy the requirements of the regulations issued pursuant to the National Forest Management Act, the Scientific Analysis Team felt that the standards and guidelines (or replacements that are equal or superior in effect) must stay in place, regardless of activities on lands managed by others.

MANAGEMENT OPTIONS OTHER THAN THE SCIENTIFIC ANALYSIS TEAM'S SUGGESTIONS

Alternatives From the Scientific Panel's Report

The Agriculture Committee and the Merchant Marine Committee of the U.S. House of Representatives (Johnson et al. 1991) established the Scientific Panel on Late-Successional Forest Ecosystems (hereafter referred to as the Scientific Panel, also known as "The Gang of Four") which presented an array of 14 alternatives for management of late-successional and old-growth forests and intervening lands on the Federally managed lands of the Pacific Northwest within the range of the northern spotted owl. These 14 alternatives ranged from an alternative that maintained historic timber harvest levels to one in which essentially all late-successional old-growth forests would be preserved. The latter included additions necessary to produce a high probability of viability of the northern spotted owl, and protection of habitat for at-risk fish stocks.

A qualitative risk assessment was performed for each alternative that considered: (1) maintenance of a functional late-successional/old-growth forest network, (2) viable northern spotted owl populations, (3) habitat for nesting of marbled murrelets, (4) habitat for other late-successional old-growth forests associated species, and (5) spawning and rearing habitat for sensitive fish stocks.

The Scientific Analysis Team operated under instructions which evolved from the necessity to answer questions from the Federal Court on the Forest Service's Final Environmental Impact Statement and, therefore, approached the issue of protecting the late-successional forest ecosystem from a different angle than did the Scientific Panel.

The Scientific Analysis Team made the following assumptions: (1) the assessment was limited to Federal lands, specifically those managed by the Forest Service; (2) Land and Resource

Management Plans for each National Forest within the range of the northern spotted owl were considered to be in place, except as modified by adoption of the Interagency Scientific Committee's Conservation Strategy; (3) the Interagency Scientific Committee's Conservation Strategy was assumed to be the management alternative for the northern spotted owl; (4) maintenance of habitat for the marbled murrelet (listed September 28, 1992 as a "threatened" species by the Fish and Wildlife Service) was mandated; and (5) species associated with old-growth forests were to be identified and mitigation measures presented for protection.

The Scientific Panel classified late-successional/old-growth forests as those that were "most ecologically significant (LS/OG1)", "ecologically significant (LS/OG2)", and the remainder of such forests "LS/OG3." The criteria used to make these classifications were habitat block size, fragmentation, location, stand attributes, stand age, productivity, elevation, and the occurrence of spotted owls, marbled murrelets, and other late-successional/old-growth associated species.

In terms of risk, the cumulative result of the Scientific Analysis Team's efforts most closely resembles Alternative 10, Option A, of the Scientific Panel's report for the range of the northern spotted owl excluding the Oregon Coast Range. Alternative 14, Option A, is similar to the cumulative situation described by the Scientific Analysis Team for Federal lands in the Coast Ranges.

In addition, the Scientific Panel's report presented three options for the management of the matrix (forested areas between reserved areas). Option A, mentioned above, implements the Land and Resource Management Plan standards and guidelines for each National Forest. It also imposes the 50-11-40 rule (Thomas et al. 1990) with the addendum for retention on cutover areas of six green trees/acre exceeding the average diameter of other trees in the stand before cutting, two large snags/acre, and two large down logs/acre (Johnson et al. 1991). The 50-11-40 rule calls for the Federal land within each quarter-township to have 50 percent or more of the forested acres in a state where stands average at least 11 inches or more in diameter at breast height with at least 40 percent or more canopy closure (Thomas et al. 1990).

The Scientific Panel did not have the detailed information on the species associated with late-successional forest conditions that was developed during the Scientific Analysis Team effort. Yet, the overall outcome in the risk ratings between the alternatives described are, at least superficially, similar. We strongly recommend, however, that if options from the Scientific Panel's report are considered for implementation, that the mitigation measures for identified endemic, localized, or very specialized species developed by the Scientific Analysis Team and described herein are incorporated with that option.

Only a limited subset (4 of 14) of the alternatives presented by the Scientific Panel, however, provided a "high" probability of success for all of the following factors of concern: a functional network of late-successional/old-growth forests, viable spotted owl populations, habitat for marbled murrelet nesting, habitat for other species associated with late-successional/old-growth forests, and habitat for sensitive fish species/stocks.

If additional options are desired for management beyond or in addition to those in this report, the Scientific Analysis Team suggests consideration of the options presented in the report of the Scientific Panel on Late-Successional Forest Ecosystems.

Alternatives for Management of Habitat for At-Risk Fish Species/Stocks

Likewise, if appropriate decision makers desire other options for management of the habitat of sensitive fish species/stocks other than those presented in this report, we suggest careful consideration of all of the assessments and management alternatives which provide a "high" level of probability as proposed by the Pacific Salmon Workgroup. This team of experts on fish habitat and watersheds presented eight alternatives for management of fish habitat on Federal lands.

The Scientific Analysis Team presents, herein, one of the two alternatives developed by the Pacific Salmon Workgroup that was rated as having a "high" probability of success in protecting spawning and rearing habitat. It seemed to us prudent, if not essential, that when dealing with the numerous sensitive fish stocks that have a significant potential to be listed as threatened or endangered under the requirements of the Endangered Species Act, that a management scheme have a high probability of protection of critical habitat for those stocks. We note that there is one other option put forward by the Pacific Salmon Workgroup that also has a high probability of success. We consider this other option as an appropriate replacement for the one detailed in this report.

If it seems appropriate to decision makers to assume the increased risk of failure to maintain habitat for sensitive fish species/stocks, management scenarios presented by the Pacific Salmon Workgroup with chances of success of "moderate" or even less might be considered for adoption. However, we strongly emphasize that if any aspect of the package we put forward is altered, the overall assessment of the cumulative effect in terms of maintaining viable populations of species closely associated with old-growth forests should be redone.

RESTRICTIONS ON MANAGERS' DECISION SPACE

Restrictions Resulting From Compliance With the Endangered Species Act and "Viability Regulations" of the National Forest Management Act

Land managers are concerned with what some refer to as accumulating constraints on management prerogatives. These constraints are perceived as causing increasing loss of decision space (i.e., the feasibility of performing alternative courses of management action) with each additional objective for management that is considered. This is particularly true of meeting the requirements of the Endangered Species Act and the regulations issued pursuant to the National Forest Management Act to maintain viable populations of vertebrate species well distributed within the planning area (individual National Forests). The new policy of the Forest Service announced in late 1992 to enter into a new era of "ecosystem management" seems, to us, to be absolutely in keeping with meeting the underlying objectives of these Acts. It will, however, not be achieved without further tightening the decision space for achievement of other multiple-use management goals, such as timber harvest, grazing, and fish and wildlife species for consumptive use.

Examination of the history leading up to the listing as threatened or endangered of the northern spotted owl (Thomas et al. 1990, Thomas and Verner 1992, and Meslow and Bruce 1992), marbled murrelet, and several species of anadromous fish lead us to the conclusion that early warnings were inadequately addressed, probably due to associated political, economic, and social costs (Thomas and Verner 1992). With the advantage of hindsight, we see that this led, inevitably, to the listing of various species as threatened or endangered with more to come. At the point that species were officially listed, management prerogatives were severely limited due to the introduction of overriding new objectives to protect and recover listed species, and with the *de facto* sharing of authority for management decisions that bear on the welfare of listed species with the Fish and Wildlife Service or the National Marine Fisheries Service or both.

Potential Restrictions Resulting From Ecosystem Management

Moving to an ecosystem management approach seems most appropriate at this time (Thomas et al. 1990) because a species-by-species approach seems to be becoming increasingly burdensome (USDI 1992a and USDA 1992). However, the assessment made in this report of the status of species of plants and animals that are suspected of being associated with late-successional forests is just one part of the ecosystem management approach. It has produced a tiny preview of considerations that may be included in ecosystem management.

"Ecosystem management" is considered by some as a new buzz word to follow behind "new perspectives" and as merely fluff. We disagree. The concept is sound and the evolving scientific concept and knowledge make it possible to embark on this quantum shift in management paradigm.

Having committed to ecosystem management, it is essential to move forward quickly to develop the supporting conceptual framework for a truly new way of managing land. While, in our opinion, this framework simply does not exist, it is being formulated, developed and implemented in a piecemeal fashion by scientist/manager teams at a significant number of locations around the region. Further, it will take a concentrated effort by the scientific and land management communities to develop that framework. It will not be easy – but the Forest Service is now committed to "ecosystem management". This commitment must be quickly matched with action if credibility is to be maintained.

No Free Lunch

Although there are, in theory, many management options to address the cumulative problems being produced by the listing of the northern spotted owl, the marbled murrelet, and several species of anadromous fish species/stocks (with more species very likely to be listed), they do not address the need to consider ecosystem integrity in land management. All such options are concomitantly subject to scrutiny by the scientific community and the courts and will inevitably impinge on the decision space of land managers and impinge on the traditional production levels of commodities, such as timber harvest, grazing, and big game production, from the lands in question. It is unrealistic to expect otherwise. We find, as other resource analysts before us, that there is simply "no free lunch" (Johnson et al. 1991).

It might be useful for managers to consider as objectives management activities to preserve threatened or endangered species and meet the implied biodiversity retention requirements in the concept of "ecosystem management". When considered as constraints, these actions are automatically and inappropriately interpreted as reducing decision space (i.e., management prerogatives). When viewed as objectives, management of biodiversity through ecosystem management creates a very broad, challenging, uncharted decision space for managers.

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Appendix 1-A

An Historical Perspective on the Evolution of the Spotted Owl Issue and Its Incorporation Into *de facto* Forest Management Policy.

Appendix 1-A
An Historical Perspective on the Evolution of the Spotted Owl Issue and Its Incorporation Into *de facto* Forest Management Policy

This chronology was developed from information presented by Thomas et al. (1990), Thomas and Verner (1992), and Meslow and Bruce (1992).

Introduction

Our objective is to provide an overview of the development of the spotted owl issue and the incorporation of this issue into *de facto* forest management policy for lands managed by the Forest Service to preserve biodiversity through an application of ecosystem management. What began as a northern spotted owl research effort rapidly evolved into an agency and interagency management planning effort. Along the way, the issue has drawn increasing public and political attention. Because of the Endangered Species Act, and the listing of the northern spotted owl (*Strix occidentalis caurina*) by the Fish and Wildlife Service as threatened, the owl now serves as the surrogate for other old-forest associated species and for the old-forest system of the Pacific Northwest. The owl's status under the Endangered Species Act and the processes mandated under the National Environmental Policy Act (U.S. Laws 1970) have moved spotted owl habitat management and the management of public forests in the Pacific Northwest into the courts. A more detailed description of events follows.

Early Concerns With Biodiversity – 1953

In 1953, Aldo Leopold's (1953) now widely quoted admonition concerning the value of biodiversity was printed: "...to keep every cog and wheel is the first precaution of intelligent tinkering." This general concept, so eloquently expressed, was a precursor to the Endangered Species Act of 1973 (U.S. Laws 1973) and the National Forest Management Act of 1979 (U.S. Laws 1976).

Early Investigations – Late 1960's

Little was known about the northern spotted owl until the 1960's. The subspecies was considered a rare or uncommon resident of the conifer forests of southwestern British Columbia, western Washington, western Oregon, and northwestern California. In 1967-1968, Eric Forsman and Richard Reynolds, both undergraduates at Oregon State University, began to search for spotted owls in Oregon. Their efforts revealed that spotted owls could regularly be located in old forests including some sites where Joe Marshall (1942) and Ira Gabrielson and Stanley Jewett (1940) had found spotted owls many years earlier. Forsman and Reynolds brought their findings to the attention of Howard Wight, then a professor at Oregon State University. Forsman spent the next several years in the U.S Army; on his return to Oregon State University in 1972 he began a graduate program under the direction of Wight who was, by then, the Leader of the Oregon Cooperative Wildlife Research Unit and a Fish and Wildlife Service employee.

Recognition of Conflict with Timber Primacy – 1972

Shortly after initiating field work, Forsman and Wight discerned that northern spotted owls were most consistently found in old-forest stands and that these were the forest stands most commonly slated for cutting. Wight, Reynolds, and Forsman brought their emerging suspicions to the attention of various responsible agencies – the Fish and Wildlife Service, Forest Service, Bureau of Land Management, and Oregon Department of Fish and Wildlife (then the Oregon Game Commission). On September 26, 1972, John McGuire, Chief of the Forest Service, wrote Spencer Smith, Director of the Fish and Wildlife Service as follows:

> "Dear Spencer,
>
> Thank you for your memorandum of August 18 with which you sent information on the Oregon Cooperative Wildlife Research Unit's study of the spotted owl. In view of the study findings, we can certainly appreciate your concern regarding the future of this bird.
>
> We are sending this information to our field offices in Portland, San Francisco, and Albuquerque. We are also suggesting to our Portland office that they work with your field people, the local Bureau of Land Management offices, and the state wildlife agencies to improve or develop interim guidelines for location and protection of the spotted owl's habitat until more complete information is available regarding the owl's habitat needs.
>
> Sincerely,
>
> John R. McGuire"

California Investigations – 1973

In 1973, Ed Schneegas, Director for Fish and Wildlife, Regional Office, Pacific Southwest Region of the Forest Service, was responsible for initiating the first survey for the spotted owl in California. Gordon Gould, later with the California Department of Fish and Game, conducted the study in 1973-74. Gould found that the owl was more abundant than previously supposed in California. His study also suggested an association between spotted owls and older forests.

Oregon Endangered Species Task Force – 1973

When, in 1973, the Fish and Wildlife Service revised the "Red Book", which was a precursor to the official list of nationally endangered species, the northern spotted owl was included. Shortly thereafter, John McKean, Director of the Oregon Game Commission, proposed that an interagency task force of qualified specialists be formed to address endangered species management in Oregon. The objective of that task force was to prevent the necessity of listing any more species as threatened or endangered in Oregon. The Oregon Endangered Species Task Force was formed in 1973.

At the suggestion of Howard Wight, the task force agreed to address the needs of species associated with old-growth forests. He further suggested that the northern spotted owl should be the first to receive attention. The task force recommended to state and Federal agencies that 300 acres of old-growth habitat be retained around each spotted owl location as interim protection until statewide guidelines could be adopted within a year. Note that the recommendation was to reserve a specific acreage of forests from timber harvest at identified owl sites. This seemed a logical approach to management of spotted owl habitat given the information available at the time. Unfortunately, this recommendation established a pattern of site-by-site reserves that was the operative management paradigm for 15 years. The recommendation was rejected by the Pacific Northwest Region of the Forest Service and by the Oregon State office of the Bureau of Land Management because they wanted a statewide population management goal established before proceeding further. By this time (1973), spotted owls had been located at about 100 sites in Oregon.

Endangered Species Act – 1973

The Endangered Species Act became law late in 1973. The northern spotted owl was not included on the Federal list of threatened or endangered species. Thus, this Act had no immediate effect on the management of spotted owl habitat. This Act did, however, immediately serve as the yardstick for measuring species protection needs (USDI 1973). One result of the Oregon Endangered Species Task Force's work was the preparation of an Oregon State list of threatened and endangered species which was adopted by the Oregon Wildlife Commission (Marshall 1969 and ODFW 1975)). Prophetically, the northern spotted owl was listed as "threatened" on this administrative list which had no statutory authority at the time. Later, revisions of the Endangered Species Act would include the requirement for recovery plans which would direct attention to the *preservation of the ecosystem* of which the listed species is a part.

National Forest Management Act – 1976

In a compromise made to gain support of the community of scientists for passage of the National Forest Management Act, there were provisions made in the Act for a committee of scientists to prepare materials for inclusion in the regulations issued pursuant to the Act. As a result, there was a provision included that required the Forest Service to conduct management so that *viable* populations of native and desirable non-native vertebrates be maintained within the planning areas (i.e., National Forests). Regulations adopted pursuant to the National Forest Management Act directed the Forest Service to maintain well distributed, viable populations of all native vertebrates on National Forests. This meant that not only was the Forest Service directed to not cause any additional species to be listed as threatened or endangered – the agency was directed to not sever portions of a species range. This is an even stronger mandate than that of the Endangered Species Act to maintain individual species.

First Oregon Owl Plan Takes Shape – 1976

Howard Wight died in 1975 but research efforts in Oregon and California on the biology of the northern spotted owl continued. Forsman and Gould were joined in their research by other scientists in 1980 – most notably R.J. Gutierrez and colleagues operating out of Humboldt State University, Arcata, California. No research studies employed radio-telemetry techniques, however, until Forsman began his Ph.D. work on the H.J. Andrews Experimental Forest in 1975 (Forsman 1976). During 1976, the Oregon Endangered Species Task Force recommended a long-range goal of maintaining ". . .400 pairs of spotted owls on public lands in Oregon consistent with the specific habitat requirement of the species." The task force also indicated that it would, "identify the number of spotted owl habitats and their distribution needed to maintain a viable population throughout their distribution in Oregon." Considering the task force's policy was interim (that is, to be followed while the guidelines were being developed) the task force recommended that the involved agencies, "protect spotted owl sightings and nest sites consistent with the specific habitat requirements as described by Forsman, 1976, and other observers."

Early in 1977, both the Forest Service and the Bureau of Land Management agreed to protect spotted owl habitat in accordance with task force recommendations. In late 1977, the Oregon Spotted Owl Management Plan was submitted to the various agency administrators for review and comment. The plan suggested habitat management areas that included habitat capable of supporting clusters of 3-6 pairs, with a minimum of 1,200 acres of contiguous habitat per pair. Each pair was to have a core area of at least 300 acres of old-growth forest (or oldest available forest). At least 50 percent of the remaining 900 acres were to be in forests older than 30 years. Core areas for two or more pairs of owls were to be no more than 1 mile apart (center to center). Management areas were to be a maximum of 8 to 12 miles apart for multiple pair habitat areas and less for single pairs.

Management areas were allocated to agencies based on the area of land administered. The Forest Service was expected to provide for 290 pairs and the Bureau of Land Management for 90 pairs. State and private lands, as well as those managed by the National Park Service, were expected to accommodate 20 pairs though no formal agreement was performed that involved these entities. A major oversight was made in allocating pairs to the Bureau of Land Management because these lands were spread over twice as much area as those managed by the Forest Service due to checkerboard ownership patterns of one-square-mile blocks. The result was that managed owl sites on lands administered by the Bureau of Land Management were about twice as far from one another as those on lands managed by the Forest Service. The plan also specified ranges in values for several of the criteria. It would soon become apparent as these guides were actually implemented that only the minimum value in a suggested range of values was ever operative when it came to land allocation for the conservation of the spotted owl. This initial "Oregon Spotted Owl Management Plan" was devised without the benefit of information from radio-telemetry studies to establish home range size and habitat use measures.

Both the Forest Service and the Bureau of Land Management agreed to implement the recommendations of the suggested management plan via the agencies' ongoing land management planning processes. Final decisions on the distribution, number and location of sites managed for spotted owls were to be made that included pubic input through the land management planning process. This was 1977, 4 years after the task force began work on the plan.

Oregon-Washington Spotted Owl Subcommittee Established – 1978

A regional interagency organization, called the Oregon-Washington Interagency Wildlife Committee, was established in 1978 to address the variety of wildlife issues common to both states. That committee commissioned a subcommittee of biologists and administrators to deal with spotted owl issues. This Spotted Owl Subcommittee replaced the function of the Oregon Endangered Species Task Force. In December of 1978, the subcommittee refined the Oregon Spotted Owl Management Plan by addressing the need to manage unprotected pairs, encouraging private landowner participation, relocating management areas, and developing a process for periodic plan review.

Efforts to Preserve Habitat for the Spotted Owl Increase – 1979

By 1978, it was evident that effective spotted owl habitat conservation would have a significant impact on the amount of timber cut in the Pacific Northwest Region. The effort expended on owl surveys increased considerably on many forests in Oregon and Washington. In 1979, a Washington Spotted Owl Working Group was initiated. In 1980, the Regional Forester for the Forest Service's Pacific Northwest Region directed National Forest Supervisors in Washington to protect habitat for all confirmed pairs of spotted owls in accordance with the criteria of the Oregon Spotted Owl Management Plan. The 1981, National Forests in Washington were further directed to provide protection to 112 pairs of owls, pending issuance of the Draft Regional Guide for the Pacific Northwest Region later that year.

Oregon Owl Plan Revised – 1981

In 1981, in response to new data derived from radio-telemetry studies by Forsman (1980, 1981), the Spotted Owl Subcommittee revised the 1977 Oregon Spotted Owl Management Plan. The recommendation was that 1,000 acres of old-growth forest be maintained for each pair within a 1.5 mile radius of the nest site. The 1,000 acre figure represented the minimum acreage of old-growth forest found within the home range of six pairs of owls (Forsman and Meslow 1985); the mean acreage of old-growth forest within the home ranges of those six pairs was 2,264 acres, but the subcommittee, again, opted to manage for the minimum. The 1.5-mile radius represented the area within which most of the foraging by nesting pairs took place. These recommendations were forwarded to the Forest Service and Bureau of Land Management in Oregon. The Pacific Northwest Region of the Forest Service agreed to adopt the new recommendations, but only to the extent that they would "maintain the option" to manage for 1,000 acres if further research proved it necessary. The Bureau of Land Management continued to protect 300 acres for each managed pair.

California Standards and Guidelines Formulated – 1981

Regional standards and guidelines for management of the spotted owl (regardless of subspecies) on National Forests in California were formulated in 1981. They were modeled after the Oregon Spotted Owl Management Plan, except that the concept of replacement habitat was added. Habitat areas were to contain 1,000 acres of the oldest available trees provided were owl habitat plus 650 to 1,650 acres of replacement habitat. The acreage of replacement habitat varied according to whether the habitat area was preserved or managed. When possible, areas selected for management were selected to accommodate three closely spaced pairs of owls. Implementation of this plan began in 1982 under the standards and guidelines identified in the land management planning process carried out under the National Environmental Policy Act.

First Status Review – 1981

The Portland Regional Office of the Fish and Wildlife Service undertook a status review of the northern spotted owl in 1981 because of concerns about the decline in acres of old-growth forest (USDI 1982). The Fish and Wildlife Service concluded that the subspecies did not meet listing requirements under the Endangered Species Act. The report stated, ". . .the owls' dependence on large areas of old-growth coniferous forest make them extremely vulnerable. If current trends in old-growth timber harvest continue, the Northern Spotted Owl could become endangered in a relatively short time."

Old-Growth Wildlife Research and Development Program Initiated – 1982

The Forest Service, in cooperation with the Bureau of Land Management, initiated the Old-Growth Wildlife Research and Development Program in 1982 to address the old forest/wildlife issues in western Washington and Oregon. (This program was rechartered in 1986 as the Spotted Owl Research, Development and Application Program and included both the Pacific Northwest and Pacific Southwest Research Stations of the Forest Service.) Under the auspices of this program a variety of studies of spotted owls, other old-forest species, and their habitats have been conducted in Washington, Oregon and California. These studies continue and have generated numerous reports and publications.

Bureau of Land Management/Oregon Department of Fish and Wildlife Agreement – 1982

Also in 1982, the Bureau of Land Management issued a proposed decision on their Coos Bay District Timber Management Plan. The Oregon Fish and Wildlife Commission found that the proposed plan failed to meet State wildlife policies and existing Federal laws, and would not provide adequate habitat for the northern spotted owl. The Oregon Land Conservation and Development Commission sustained this objection. As a result, the Bureau of Land Management and the Oregon Department of Fish and Wildlife were requested by the commission to negotiate a settlement. The negotiation culminated in a 5-year agreement, signed in 1983, in which the two agencies agreed that Bureau of Land Management would, ". . .manage habitat to maintain a population of 90 pairs of spotted owls, with appropriate distribution of pairs, as a contribution to maintaining a minimum viable population in western Oregon."

Research in Washington – 1983

In 1983, the Washington Department of Wildlife began a 3-year cooperative study with the Forest Service to monitor the effectiveness of the proposed Forest Service spotted owl management strategy. This work led to additional studies of home range size and habitat use.

Forest Service Regional Guide – 1984

The Forest Service issued the final Regional Guide (USDA 1984) for their Pacific Northwest Region in 1984. The Regional Guide called for the National Forests to analyze the effects of protecting at least 375 pairs in Oregon and Washington as they developed Land and Resource Management Plans. Managers of National Forests were to follow the 1981 proposed revision of the Oregon Interagency Spotted Owl Management Plan which had been modified to include Washington. Shortly thereafter, the Forest Service's Pacific Northwest Regional Office provided further direction for spacing requirements between reserved areas of forest needed to maintain a well distributed population. This increased to 551 the number of spotted owl habitat areas proposed for management under Land and Resource Management Plans in Oregon and Washington.

Forest Service Supplemental Environmental Impact Statement – 1984

Later in 1984, a consortium of conservation groups appealed the Forest Service's Pacific Northwest Regional (Oregon and Washington) Guide on the grounds that the standards and guidelines it contained were inadequate and that the proposed habitat management approach constituted a major Federal action requiring an Environmental Impact Statement. The Chief of the Forest Service denied the appeal. The Deputy Assistant Secretary of Agriculture reversed that decision and directed the Forest Service to prepare a supplemental Environmental Impact Statement on spotted owl standards and guidelines. Preparation of this document began in 1985.

Forest Service Standards and Guidelines in California – 1984

By 1984, several National Forests had not yet begun to implement the Forest Service's Southwest Region's (California) standards and guidelines that had been issued two years earlier because of delays in preparation of individual Forests' Land and Resource Management Plans. The California Department of Fish and Game and Forest Service Southwest Region agreed that regional standards and guidelines should be implemented promptly before existing spotted owl habitat management opportunities were lost. As a result, a network of spotted owl habitat areas were established on National Forests in the western Sierra Nevada and northwestern California.

The Society of American Foresters Speaks on Management of Old-Growth Forests – 1984

In 1984, the Society of American Foresters released an assessment of the old-growth issue and a position statement (Society of American Foresters 1984). It is significant to note that this group of professional foresters recognized that no information or techniques existed for the silvicultural manipulation or cutting of old-growth forests while concurrently producing or maintaining old-growth characteristics.

National Audubon Advisory Panel – 1985

The National Audubon Society formed a “blue-ribbon advisory panel” in 1985 to review the status of the northern spotted owl in Washington, Oregon and northern California. The panel recommended, in 1986, that a minimum of 1,500 pairs of spotted owls be maintained in the three states, including the Sierra Nevada Range of California, and that additional habitat acreage be protected for pairs of owls in the range of the northern subspecies (Dawson et al. 1986). A variation of this recommendation was included as “Alternative M” in the spotted owl Supplemental Environmental Impact Statement under development at that time by the Forest Service.

Oregon Fish and Wildlife Suggests More Spotted Owls on Lands Administered by the Bureau of Land Management – 1985

After an evaluation of spotted owl management areas, the Oregon Department of Fish and Wildlife recommended, in 1985, that the Bureau of Land Management establish a minimum of 40 additional spotted owl habitat areas. The recommendation was made because many of the 90 sites that the Bureau of Land Management was protecting were characterized by poor habitat and low occupancy; this exacerbated the problem of an already low population density of spotted owl habitat sites. The Bureau of Land Management did not act on this recommendation for 2 years, at which point they agreed to manage for an additional 20 pairs of owls (110 total) on sites that would be jointly selected by the two agencies.

Private Industry Becomes Involved in Research – 1986

Private industry became involved in research efforts on spotted owls in 1986 through the National Council for Air and Stream Improvement. Larry Irwin was selected as lead scientist and was stationed in Corvallis, Oregon. Industry research that focused on habitat use by spotted owls soon involved all three states on both public and private lands.

Bureau of Land Management Environmental Assessment – 1986

In 1986, the Bureau of Land Management initiated a statewide environmental assessment of the spotted owl in Oregon to determine if new information required that a supplemental Environmental Impact Statement be prepared for their existing timber management plans. After public review, the Bureau of Land Management decided, in 1987, that a supplemental Environmental Impact Statement was not warranted.

Fish and Wildlife Service Petitioned to List the Northern Spotted Owl as "Threatened" - The Second Time – 1987

The Fish and Wildlife Service acknowledged, in early 1987, that they had received a petition from Greenworld to list the northern spotted owl as an endangered subspecies under the Endangered Species Act. A new status review was undertaken and, in December 1987, the Fish and Wildlife Service announced that listing was not warranted (USDI 1987). That decision was appealed to the Seattle Federal Court by conservation groups in 1988. The Court determined that the decision not to list was not biologically based and ordered the Fish and Wildlife Service to readdress the listing decision.

California's Planning Process – 1987

In early 1987, the California Department of Fish and Game began filing "nonconcurrences" with regulations of the California Department of Forestry on timber harvest plans that proposed cutting old-growth stands in north coastal California. Later that year, environmental groups brought suit to stop several sales where "nonconcurrences" had been filed by field staff but the California Department of Forestry approved the sale anyway. This litigation caused a review of the Department of Forestry's planning process for cutting of trees and of the Board of Forestry's rules relating to the handling of sensitive wildlife species. In 1989, the California Legislature passed AB 1580, which directed the Department of Forestry to develop a system to better track how planning decisions are made regarding the cutting of timber, and to develop a data base on timberland habitats and wildlife species so that cumulative impacts of timber cutting could be better analyzed. At the same time, the Board of Forestry directed the Department of Forestry to develop a habitat conservation plan so that planning for timber cutting and logging could continue if the northern spotted owl was listed as threatened under the Endangered Species Act at some future date. At this time, the California Department of Forestry had completed a draft habitat conservation plan.

Spotted Owl Listed By States – 1988

In 1988, the Washington Wildlife Commission listed the northern spotted owl as "endangered." As a result of the listing, the Washington Department of Wildlife began to develop a state recovery plan with participation by agency and private organizations. Late in the year, the Oregon Fish and Wildlife Commission, acting under the auspices of the new Oregon State Endangered Species Act, reaffirmed the unofficial listing of the spotted owl as "threatened" in Oregon. Such a listing required habitat protection on all State lands but not on private lands. Protection on private forest lands is being addressed by the Oregon Department of Forestry under recent amendments to the Oregon State Forest Practices Act.

Latest Revision of the Endangered Species Act – 1988

The Endangered Species Act of 1973 was last revised in 1988. It should be noted that though the Act has been revised eight times (twice in 1976, 1977, 1978, 1979, 1982, 1984, and 1988), the overall effect has been to strengthen provisions for protection of species and the ecosystems on which they depend.

Spotted Owl Subcommittee - New Guidelines – 1988

In April 1988, the Spotted Owl Subcommittee proposed new management guidelines for the northern spotted owl that, for the first time, addressed the entire range of the subspecies in Washington, Oregon and northern California. The main features of the new recommendations were to maintain larger population centers, protect all remaining habitat in areas of special concern (such as the Oregon Coast Ranges), regenerate habitat in problem areas, maintain an interconnecting network of habitat areas of one to three pairs per township, retain an amount of habitat per cluster pair that reflected the mean amount of old-growth habitat in home ranges as indicated by data from radio-marked pairs, and provide for replacement habitat. Needs for monitoring and coordination between agencies were also addressed. These recommendations were not acted on by any of the agencies responsible for managing the spotted owl or its habitat. The Spotted Owl Subcommittee has not been active since issuing the above guidelines which were never implemented.

The Wildlife Society Issues an Assessment on Old Growth as Wildlife Habitat – 1988

The Wildlife Society, a organization of wildlife biologists, released an assessment of old growth as a critical and specialized habitat for wildlife (Thomas et al. 1988). On the basis of that assessment, The Wildlife Society issued a position statement that identified old growth as a particularly important and decreasing habitat for wildlife. That statement recognized old-growth forests as significant ecosystems and warned that the issue was National in scope.

Interagency Agreement to Cooperate on Management of the Owl and its Habitat – 1988

A new interagency agreement was signed in August 1988 by the heads of the Bureau of Land Management, Forest Service, Fish and Wildlife Service and the National Park Service. In that agreement, the agencies agreed to work toward a common goal of ensuring population viability for the spotted owl throughout its range. The interagency agreement served as the umbrella under which the Interagency Spotted Owl Scientific Committee was formed in 1989.

Forest Service Final Supplement to the Environmental Impact Statement – 1988

In late 1988, the Chief of the Forest Service issued a Record of Decision on the Supplement to the Environmental Impact Statement for an Amendment to the Pacific Northwest Regional Guide (USDA 1988). The selected alternative directed the 13 National Forests in the Pacific Northwest Region within the range of the northern spotted owl to establish a Spotted Owl Habitat Area Network. Standards and guidelines differed by physiographic province. Amounts of old-forest habitat to be provided per pair in the network varied from 1,000 acres in southern Oregon to 3,000 acres on the Olympic Peninsula. Habitat was to be identified within 1.5 miles of the "core area" for an owl pair in Oregon and within 2.1 miles in Washington. Habitat areas for three or more pairs were to be no more than 12 miles apart; single pair areas were to be no more than six miles apart. Soon after it was issued, the Record of Decision was appealed by the Washington Department of Wildlife, and by both timber and environmental groups, for essentially opposite reasons. The Assistant Secretary of Agriculture denied both appeals.

Fish and Wildlife Service Proposes Listing (for the Third Time) – 1989

The Fish and Wildlife Service initiated another status review (USDI 1989) of the northern spotted owl in January 1989 to supplement the 1987 review. The status review was completed in

April and the spotted owl was deemed to warrant protection as a threatened species under the Endangered Species Act. As a result of this decision, a Fish and Wildlife Service listing review team was established in October 1989 to review this proposal and make a final recommendation, in light of the public comments received, on whether or not to list the spotted owl in June 1990. The proposal to list the owl had triggered the Forest Service and the Bureau of Land Management to confer with the Fish and Wildlife Service under the provisions of Section 7 of the Endangered Species Act. Interim guidelines were prepared by the Fish and Wildlife Service to assist the agencies in evaluating timber sales that would impact spotted owls.

Hatfield-Adams Amendment or Northwest Compromise – 1989

Environmental groups obtained injunctions prohibiting the sale of old-growth timber on lands administered by the Bureau of Land Management near spotted owl sites. Continuous litigation finally resulted in the "Northwest Compromise," also known as the Hatfield-Adams Amendment of 1989. This legislation applied to Oregon and Washington and was attached as a rider (Section 318) to the 1990 Interior and related agencies appropriations bill. It declared the Forest Service's Environmental Impact Statement and Bureau of Land Management's supplemental management plans for spotted owls sufficient for preparing timber sales for fiscal year 1990. The "compromise" expanded the acreage in Forest Service spotted owl habitat areas by 12-25 percent and established 12 new Agreement Areas on lands administered by the Bureau of Land Management, for a period of one year. It also instructed the Forest Service and the Bureau of Land Management to minimize fragmentation of "ecologically significant" stands of old-growth timber in Oregon and Washington. Citizen's advisory boards were established to assist the two agencies in preparing and modifying the 1990 sales. The law also called for the formation of the Interagency Scientific Committee.

Interagency Scientific Committee Established – 1989

As a result of the uncertainty surrounding the status of the northern spotted owl, the Forest Service recommended the formation of an Interagency Scientific Committee to address the issue. The recommendation was agreed to by the heads of the Bureau of Land Management, Forest Service, National Park Service, and Fish and Wildlife Service; in October 1989 the Interagency Spotted Owl Scientific Committee was established. The charge to the committee was "to develop a scientifically credible conservation strategy for the northern spotted owl." The 17 member team contained representatives from the four involved Federal agencies, the three states, timber industry, environmental organizations, and academia. The committee report was called "A Conservation Strategy for the Northern Spotted Owl," (frequently referred to as the "Thomas Report" after the Committee Chairman, Jack Ward Thomas) and was completed and released in April 1990. The Conservation Strategy is one directed specifically at the conservation of the northern spotted owl; it does not purport to address other species or the old-forest ecosystem.

The Conservation Strategy addressed only Federal lands through a system of Habitat Conservation Areas most of adequate size to accommodate 20 pairs or more of owls, and distributed at 12-mile or less spacing throughout the range of the northern spotted owl. No further timber harvest was to occur in the Habitat Conservation Areas and existing cutover areas therein were to be allowed to grow back into superior owl habitat. The forested areas between the Habitat Conservation Areas (called the matrix) were to be managed to facilitate dispersal of owls between Habitat Conservation Areas. Implementation of the 50-11-40 rule establishes the appropriate forest condition: at least 50 percent of each quarter-township (3 miles by 3 miles), was to be maintained in trees averaging at least 11 inches in diameter at breast height and at least 40 percent canopy closure. The 50-11-40 conditions can be routinely met under the usual economic forest rotations of 70 to 100 years in the Pacific Northwest. The committee's report fine tuned this basic approach for problem areas. Importantly, the Conservation Strategy called for a program of adaptive management in the forest matrix directed at developing silvicultural schemes which might facilitate habitat conditions that would allow persistence of the spotted owl in the managed forest landscape. When this could be demonstrated, the Habitat Conservation Areas could be dissolved.

The report of the Interagency Scientific Committee has received wide distribution, close and repeated scrutiny, and wide acclaim in the scientific community. The Conservation Strategy calls for the reservation of 5.8 million acres of Federal land previously not reserved from timber cutting. As a result, cutting of timber on Federal lands within the range of the northern spotted owl would be about half the level of the 1980's. This strategy is a key building block in the development of "ecosystem management" strategies in the Pacific Northwest.

Fish and Wildlife Service Lists Owl as Threatened – 1990

In June 1990, after completion of the fourth status review of the northern spotted owl (Anderson et al. 1990), the Fish and Wildlife Service listed the owl as threatened throughout its range.

The Balance Alternative – 1990

Understandably concerned by the economic impact of the Interagency Scientific Committee's report, the Bush administration appointed a task force headed by Assistant Secretary of Agriculture James Moseley to examine the Committee's report and find lower cost alternatives. After numerous delays, the task force provided no report but, instead, issued a press release on September 21, 1990, to the effect that the Forest Service would operate in a "manner not inconsistent with" the Interagency Scientific Committee's Conservation Strategy. The Bureau of Land Management would proceed with timber sales under the "Jamison" strategy. The "Jamison Strategy" was never peer reviewed nor presented in any form other than a press release. These decisions were not accompanied by Environmental Impact Statements, nor were they formally stated or adopted in a Record of Decision in the Federal Register.

Forest Service Required to Prepare EIS – 1991

In the fall of 1991, the Forest Service was challenged in Federal District Court by the Seattle Audubon Society for failure to formally adopt a credible conservation strategy that would comply, simultaneously, with the requirements of the Endangered Species Act, National Forest Management Act and National Environmental Policy Act. During the ensuing trial, the socio-economic impacts of constraining timber sales in spotted owl habitat on National Forests were presented. The attorneys for the Forest Service were joined by intervenors representing the timber industry in arguing that the Interagency Scientific Committee's Conservation Strategy was both sound and adequate. The attorneys for Seattle Audubon argued the reverse. These same parties, and some of the same attorneys, would reverse roles and positions in hearings a few months later during the proceedings of the Endangered Species Committee (also known as the "God Squad"). On May 23, 1991, Judge Dwyer ruled against the Forest Service, issued an injunction against further timber sales in spotted owl habitat on National Forests, pending Forest Service adoption of a spotted owl habitat management plan following the process described in the National Environmental Policy Act. Judge Dwyer further made it clear that the Forest Service was to comply, simultaneously, with both the National Forest Management Act and the

Endangered Species Act. He gave the agency 10 months to accomplish the task. Timber sales in spotted owl habitat on National Forests within the owl's range were at a standstill pending the successful completion of the Environmental Impact Statement on Management of the Northern Spotted Owl in the National Forests.

Critical Habitat Delineated – 1991

The Endangered Species Act requires the Fish and Wildlife Service, upon listing a species, to designate critical habitat for that species. Critical habitat includes areas within which any proposed action which may adversely affect a listed species requires consultation with the Fish and Wildlife Service. The Fish and Wildlife Service initially declined to designate critical habitat for the northern spotted owl because of the very real difficulty of identifying various components of owl habitat and their importance to the owl. This decision was challenged in Federal District Court in early February 1991 and Judge Zilly ordered the Fish and Wildlife Service to complete mapping of critical habitat by the end of April 1991. The Fish and Wildlife Service initially proposed 11.6 million acres of critical habitat. After a public comment period, this total was reduced to 8.2 million acres (USDI 1991). After further public comment, the Fish and Wildlife Service's final determination of critical habitat designated 6.9 million acres arranged to minimize impacts on private lands (USDI 1992b).

The Report of the Scientific Panel on Late-Successional Forest Ecosystems – 1991

In late May of 1991, the Agriculture Committee and the Merchant Marine and Fisheries Committee of the U.S. House of Representatives commissioned four scientists (K. Norman Johnson of Oregon State University, John Gordon of Yale University, Jerry Franklin of the University of Washington, and Jack Ward Thomas of the Forest Service) to carry out a series of tasks that would result in an array of alternatives for the management of late-successional forests on Federal lands within the range of the northern spotted owl. This group was called the Scientific Panel on Late-Successional Forest Ecosystems (hereafter referred to as the Scientific Panel, also known as "The Gang of Four"). This team was specifically directed to consider the welfare of all species of vertebrates associated with late-successional forests, at-risk fish stocks, and the integrity of the ecosystems on which they depend. This *enlarged* the scope of the question surrounding management of late-successional forests beyond that concerned with spotted owls. On October 8, 1991, the Scientific Panel delivered their report to Congress, outlining 14 basic alternatives and 34 scenarios for management along with risk assessments for the northern spotted owl, marbled murrelet, at-risk fish stocks, ecosystem integrity, and other vertebrate species associated with late-successional forests. The potential timber harvest yield and job numbers associated with each alternative were shown.

The Recovery Plan for the Northern Spotted Owl – 1991

The Endangered Species Act requires that a recovery plan be prepared for any listed species. The preparation of the Recovery Plan for the Northern Spotted Owl was directed by the office of the Secretary of the Interior, Manual Lujan Jr. This included selection of recovery team members in February 1991. The composition of the team was not traditional. Further, this was the first time that the task of selecting a recovery team had not been accomplished by the Fish and Wildlife Service. In this single case, the team was selected by the Secretary's office. The 16 member team included Donald Knowles, Associate Deputy Secretary of Interior (Team Coordinator), an economist and water specialist; John Beuter, Deputy Assistant Secretary of Agriculture, and economist; representatives of the three state governors – two attorneys and an economist; the chief of the Division of Forestry for Bureau of Land Management – a forester; an engineer and political scientist from the Office of Policy Analysis, Department of the Interior; the Supervisory Forester for the Bureau of Indian Affairs; the Forest Service Program Manager for the Spotted Owl Research, Development and Application Program – a forester; a Professor of Forestry at Oregon State University – a silviculturist; and six biologists (the biologists were a distinct minority).

The Northern Spotted Owl Recovery Team met regularly beginning in early 1991 and delivered a Draft Recovery Plan (USDI 1992a) to Secretary Lujan in mid-December 1991. Release of the Draft Recovery Plan was delayed until May 14, 1992, partly in response to President Bush's order for a 90-day moratorium on all proposed government regulations anticipated to have negative economic impact (State of the Union Address, January 28, 1992). The Draft Recovery Plan (USDI 1992a) closely resembles the Interagency Scientific Committee's Conservation Strategy (Thomas et al. 1990).

However there were some differences between the Recovery Plan and the Conservation Strategy: the boundaries of Habitat Conservation Areas were adjusted to better match existing habitat conditions; and new Habitat Conservation Areas were added along the Oregon coast. In addition, the Recovery Plan opened the door for limited commercial and precommercial thinning and salvage in the Habitat Conservation Areas. The Draft Recovery Plan was available for public comment until July 13, 1992. The Recovery Plan itself was not binding on any agency or entity; rather it sets the standard against which actions affecting recovery of the listed species will be judged. Secretary of the Interior Manual Lujan left office on January 20, 1992, without signing the Recovery Plan. As of February 19, 1993, the Recovery Plan was ready for printing and had not been signed.

<u>Convening of the God Squad – 1991</u>

In June 1991, after consultation with the Fish and Wildlife Service, the Bureau of Land Management received "jeopardy opinions" on 44 of their 175 timber sales prepared for 1991. The Fish and Wildlife Service ruled that cutting of these sales would jeopardize the long-term survival of the spotted owl, mostly due to the loss of habitat considered crucial for dispersal.

The Bureau of Land Management requested an exemption from Section 7 of the Endangered Species Act which would, if granted, allow them to cut the 44 sales. On October 1, 1991, Secretary Lujan determined that the Bureau of Land Management's application met threshold criteria and subsequently convened the Endangered Species Committee, the so-called "God Squad." This committee is comprised of six Cabinet level appointees and one nominee from the involved state (Oregon in this case).

A month-long evidentiary hearing was held in Portland in January 1992, at which testimony from 97 witnesses was heard. In this adversarial proceeding, the Bureau of Land Management and intervenors from the timber industry and affected Oregon counties put the science of the Interagency Scientific Committee's Conservation Strategy on trial. The intervenors had now reversed the position that they had taken in the Seattle Audubon Society vs. Evans case and sought, as one attorney was quoted, "...to defrock the high priests of the cult of biology." A public hearing followed in February 1992. A record of the hearings was prepared, summarized, and on May 14, 1992, the Endangered Species Committee met and by a vote of 5 to 2 exempted 13 of the 44 sales from the provisions of the Endangered Species Act. However, as a mitigation measure for exempting the 13, sales the Endangered Species Committee directed the Bureau of

Land Management to implement the Recovery Plan as expeditiously as possible. Further, the Bureau of Land Management was directed to use the Recovery Plan as the basis for its 10-year plan, in preparation as of February 1993, and to use the best available scientific and commercial data in preparing that plan.

A workshop (now referred to as the Fort Collins workshop) of scientists conducting research into the demographics of the northern spotted owl concluded that populations on five study areas, and in total, were declining at a rate of some 7.5 percent per year and that this rate was increasing over time.

Secretary Lujan's Owl Preservation Plan – 1992

Concurrent with the release of the Recovery Plan, the Secretary of the Interior released an Administration sponsored "Owl Preservation Plan" drafted by five assistant and deputy assistant secretaries of agriculture and interior. Their effort, dubbed by some as the "Extinction Plan", mimicked the Draft Recovery Plan but severed about 50 percent of the range of the northern spotted owl. Scientists, assembled to evaluate the risk associated with this plan, indicated there was a 50/50 chance that a sequence of events would lead to the extinction of the northern spotted owl. Secretary Lujan recognized that the institution of this plan would require changes in both the Endangered Species Act and the National Forest Management Act. Congress chose not to act or hold hearings (as of February 19, 1993) on this suggestion.

Bureau of Land Management Timber Sales Enjoined – 1992

On February 19, 1992, Federal District Court Judge Helen Frye temporarily enjoined timber sales on lands administered by the Bureau of Land Management until the agency determined how logging would affect the spotted owl. It is unclear whether the Bureau of Land Management's 10-year management plans, due in mid-1993, will suffice for the required Supplemental Environmental Impact Statement. On June 8, 1992, Judge Frye extended the injunction. The Bureau of Land Management is not selling timber in spotted owl habitat as of February 19, 1993.

Forest Service Spotted Owl Environmental Impact Statement Submitted and Rejected – 1992

The Forest Service completed the Final Environmental Impact Statement on Management for the Northern Spotted Owl in the National Forests required by Judge Dwyer in January 1992, and on March 3, 1992, Assistant Secretary of Agriculture James Mosely issued a Record of Decision adopting the Forest Service's preferred alternative – the equivalent of the Interagency Scientific Committee's Conservation Strategy. On March 25, 1992, the Seattle Audubon Society challenged the legality of the Environmental Impact Statement and Record of Decision alleging that (1) the impact statement failed to consider new information pertinent to assessing the environmental consequences to the owl of continued logging of its habitat (in violation of the National Environmental Policy Act) and (2) did not prescribe measures to protect critical habitat, or address the viability of other old-growth dependent species (all held to be in violation of the National Forest Management Act). Following a hearing on May 22, 1992, Judge Dwyer ruled on May 28, that the Forest Service had not fully complied with the National Environmental Policy Act. On May 29, 1992, Judge Dwyer enjoined Forest Service timber sales in spotted owl habitat.

Scientific Analysis Team Formed – 1992

On July 30, 1992, the Chief of the Forest Service named a team of Forest Service scientists and technical specialists under the leadership of Jack Ward Thomas to provide assessments necessary to answer Judge William Dwyer's questions in the Seattle Audubon case. The team was further assigned to evaluate all the species that may be associated with late-successional forests and to suggest mitigation measures to assure high viability for those species. At-risk fish were included.

Fish and Wildlife Service Required to Prepare Environmental Impact Statement on Designation of Critical Habitat – 1992

In December of 1992, a Federal District Court upheld the claim of the Government of Douglas County, Oregon, that the Fish and Wildlife Service is required to prepare an Environmental Impact Statement on designation of critical habitat under the Endangered Species Act.

Congressional Action Attempted – 1992

In June 1992, with timber sales enjoined on lands managed by both the Forest Service and the Bureau of Land Management, there was effort by Congress to resolve the owl habitat management issue. Both House Agriculture and Interior Committees considered legislation. Both Committees based their possible solutions on options offered to those Committees by the Scientific Panel in 1991. The options that received the most attention offer protection to the spotted owl comparable to the Recovery Plan but fall short of comparable protection for the other resources. No legislation was offered by the Committees to the full House.

Bureau of Land Management Releases Draft Resource Management Plans – 1992

In August 1992, the Bureau of Land Management released their Draft Resource Management Plans for the lands they manage in Western Oregon. The preferred alternative in those plans put forward an "ecosystem management strategy" that was not in keeping with the Draft Recovery Plan (USDI 1992a).

The Forest Conference – 1993

As of the printing of this document, a Forest Conference is scheduled for April 1993.

The Move Toward "Ecosystem Management" – 1993

In 1992, the Forest Service established a policy of "ecosystem management." Secretary of the Interior, Bruce Babbitt, made a public statement in that regard on February 16, 1993. What "ecosystem management" means is unclear in both concept and detail as of February 19, 1993.

As of this Writing – March 1993

After more than 20 years, there is still no resolution to the debate surrounding the conservation of the spotted owl and old-growth ecosystems of the Pacific Northwest.

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Chapter 2

Effects of Exempting Thirteen Bureau of Land Management Timber Sales From Requirements of the Endangered Species Act on the Viability Assessments in the Final Environmental Impact Statement

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Table of Contents

List of Tables

List of Tables (continued)

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INTRODUCTION

In January 1992, the U.S. Department of Agriculture Forest Service issued a Final Environmental Impact Statement on Management for the Northern Spotted Owl in the National Forests (USDA 1992) (hereafter referred to as the Final Environmental Impact Statement). The Final Environmental Impact Statement analyzed five alternatives for management of spotted owl habitat. The Conservation Strategy put forward by the Interagency Scientific Committee (Thomas et al. 1990) was the selected alternative in the Final Environmental Impact Statement.

The Interagency Scientific Committee's Conservation Strategy included lands under management by the Bureau of Land Management in western Oregon and northern California. A major assumption for analysis of all five alternatives of the Final Environmental Impact Statement was that lands administered by the Bureau of Land Management would be managed under a strategy equal or superior to the Interagency Scientific Committee's Strategy with regards to owl viability. In the Forest Service's Final Environmental Impact Statement, it was also assumed that formal consultation between the Bureau of Land Management and the U.S. Fish and Wildlife Service, as required by Section 7 of the Endangered Species Act, would preclude implementation of the Bureau of Land Management timber sales in conflict with the Interagency Scientific Committee's Strategy.

While the viability assessment for the Final Environmental Impact Statement was being prepared, the Bureau of Land Management in Oregon applied to the Endangered Species Committee for an exemption from the requirements of Section 7 of the Endangered Species Act for 44 timber sales, previously judged through consultation with the Fish and Wildlife Service to cause jeopardy to the spotted owl. On May 15, 1992, the committee exempted 13 of these sales. Additionally, the Endangered Species Committee required the Bureau of Land Management to follow the mandates of the Recovery Plan for Northern Spotted Owls (USDI 1992) if they proceeded with the 13 exempted timber sales (Endangered Species Committee 1992).

The granting of exemptions for these sales invalidates the assumption made in the Final Environmental Impact Statement that Section 7 consultation would result in management equal or superior to that provided by the Interagency Scientific Committee's Strategy. It was noted in the Final Environmental Impact Statement that, if an exemption was granted, the viability assessment would need to be reexamined (USDA 1992). On May 28, 1992, an order of the U.S. District Court, Western District of Washington at Seattle, instructed the Forest Service to reexamine the Final Environmental Impact Statement viability analysis reported in the Final Environmental Impact Statement.

Currently, the Bureau of Land Management in Oregon is under a court-imposed injunction which prohibits timber sales in spotted owl habitat until new management plans are implemented in full accordance with the provisions of the National Environmental Policy Act. In the analysis presented, we assumed that the present injunction is temporary and will eventually be rescinded, allowing the Bureau of Land Management to follow a course of management that provides some level of timber harvest.

It seems likely at this point that management of northern spotted owl (*Strix occidentalis caurina*) habitat by the Bureau of Land Management in California will continue to be consistent with the provisions of the Interagency Scientific Committee's Strategy (J. Decker pers. comm.). If so, the assumptions made in preparation of the Final Environmental Impact Statement remain valid for California.

PURPOSE OF THE ANALYSIS

The purpose of the analysis that follows was to evaluate the effect of 13 exempted Bureau of Land Management timber sales on the viability assessments of the Forest Service Final Environmental Impact Statement alternatives. Although this review was triggered by the exemption of these 13 sales, the exemptions are only a part of the larger question regarding the Bureau of Land Management's overall participation in habitat management for the northern spotted owl.

Contributions by the Bureau of Land Management to present and projected amounts of spotted owl habitat are unclear at this time. As a result, Forest Service analysts must make assumptions about current and future trends in spotted owl habitat managed by the Bureau of Land Management. The task of the Scientific Analysis Team was to consider all currently available evidence in the examination of the the Final Environmental Impact Statement assumption that the Bureau of Land Management would manage similar to the Interagency Scientific Committee's Strategy. The exemption of the 13 sales is but part of the evidence. These assumptions of the Final Environmental Impact Statement cannot be examined in isolation of the role of Section 7 consultation and the Bureau of Land Management's current approved management plans.

METHODS

Scenarios Analyzed

Scenario 1 – Exemption/Interagency Scientific Committee - The Scientific Analysis Team based this analysis on the comparison of two habitat management scenarios by the Bureau of Land Management. First, we analyzed the 13 exempted sales as a one-time action followed by the Bureau of Land Management's adherence to a management strategy equal to or superior to the Interagency Scientific Committee's Strategy in terms of providing for northern spotted owls. This analysis was referred to as "Exemption/Interagency Scientific Committee". While current evidence does not support this assumption, the analysis was completed for purpose of comparison and in response to direct instruction given to the Scientific Analysis Team by Forest Service administrators.

Scenario 2 – Current Approved Plans - The second scenario of the analysis is referred to as "Current Approved Plans". It is based on the assumption that following the 13 sale exemption, the Bureau of Land Management in Oregon will follow its current approved plans. These plans are comprised of two components: Management Framework Plans and Agreement Areas. Management Framework Plans were developed in the 1980's (D. Bibles pers. comm.) and specify 60-year rotations for timber harvest on lands available for logging. The Bureau of Land Management's agreement with the Oregon Department of Fish and Wildlife established 110 "Bureau of Land Management/Oregon Department of Fish and Wildlife Agreement Areas" within which suitable spotted owl habitat would be protected (USDI 1988). One such area was transferred to the Bureau of Indian Affairs, leaving 109 Agreement Areas. The Interagency Scientific Committee's Strategy (Thomas et al. 1990:77-80) describes Agreement Areas in detail.

It was apparent from communication with the Bureau of Land Management Oregon State Director (D. Bibles pers. comm.) that the most likely future forest management strategy for Bureau of Land Management administered lands would be based on the Preferred Alternatives of the Bureau of Land Management's Draft Resource Management Plans that were prepared in 1992. The Scientific Analysis Team's charge (Appendix 2-A) was initially limited to an assessment of the exemption of 13 timber sales as related to current approved plans. During that analysis (which is presented in this chapter), we were instructed by Forest Service administrators to conduct a similar analysis of the effects resulting from the Bureau of Land Management following the Preferred Alternatives of their Draft Resource Management Plans. That analysis was also completed by the Scientific Analysis Team and is documented in Chapter 3 of this report.

Results of viability analyses were not directly comparable between the Interagency Scientific Committee's Strategy, the Forest Service Final Environmental Impact Statement, and the Bureau of Land Management Draft Resource Management Plans. For example, the basis for estimates of habitat capability varied: the Interagency Scientific Committee used professional judgment and calculated habitat capability based on number of known owl pairs; the Forest Service developed a model for use in the Final Environmental Impact Statement, and the Bureau of Land Management used the "McKelvey habitat model" which differed significantly from the modeling approach used in the Final Environmental Impact Statement. Similarly, estimates of the potential change in amounts of habitat varied. The Interagency Scientific Committee assumed continued rates of decline in habitat comparable to those observed, based on previous rates of timber harvest, while the Forest Service and the Bureau of Land Management used programming models, (FORPLAN and TRIM-PLUS, respectively). To compare the Interagency Scientific Committee's Strategy with the Bureau of Land Management Preferred Alternative, we found it necessary to use data from the Bureau of Land Management's Draft Resource Management Plans. Only in this manner was a direct comparison possible. We therefore kept the analysis of the Bureau of Land Management's Current Approved Plans (Chapter 2) separate from the analysis of their Preferred Alternative (Chapter 3).

For the analysis of the current approved plans, we assumed that the Bureau of Land Management would continue to plan and offer timber sales which, although in compliance with their current approved management plans, would not be consistent with a management strategy equal, or superior, to the Interagency Scientific Committee's Strategy in providing habitat for the spotted owl. Specifically, sales could be planned in spotted owl Habitat Conservation Areas that were prescribed by the Interagency Scientific Committee. Habitat Conservation Areas are large blocks of Federal land where habitat conditions and prescriptions are expected to provide for multiple pairs of spotted owls now, and in the future. We also assumed that timber sales would be proposed by the Bureau of Land Management that do not comply with provisions of the Interagency Scientific Committee's Strategy for dispersal habitat (the 50-11-40 rule). The 50-11-40 rule provides for at least 50 percent of a quarter-township having trees averaging at least 11 inches in diameter at breast height with a canopy closure of 40 percent or greater.

Consultation with Fish and Wildlife Service

Any action by a Federal agency that "may affect" a species listed under the Endangered Species Act is subject to consultation with the Fish and Wildlife Service under Section 7 of that Act. Therefore, our analysis considered both the additional role that Section 7 consultation might play in modifying the Bureau of Land Management's current approved management plans, and whether this would result in overall management that provides a likelihood of viability for spotted owls similar to that provided by the Interagency Scientific Committee's Strategy.

The Bureau of Land Management routinely consults with the Fish and Wildlife Service on timber sales that may affect spotted owls or their habitat. Our analysis of a Biological Opinion (USDI 1991) issued by the Fish and Wildlife Service for the Bureau of Land Management's 1991 timber sale program revealed that such consultation did *not* cause the Bureau of Land Management to manage spotted owl habitat in a manner similar to the Interagency Scientific Committee's Strategy. The Bureau of Land Management formally consulted with the Fish and Wildlife Service on 174 planned timber sales which conflicted with 50-11-40 standards in 110 quarter-townships. Jeopardy opinions issued by the Fish and Wildlife Service for 52 of the 174 timber sales involved 67 of the 110 quarter-townships in conflict with 50-11-40 standards. Therefore, sales not meeting the 50-11-40 standards in 43 quarter-townships were given non-jeopardy opinions by the Fish and Wildlife Service and allowed to proceed. The exemption granted by the Endangered Species Committee involved another 13 sales in an additional 17 quarter-townships that did not meet 50-11-40 standards. The result was the combined "approval" by the Fish and Wildlife Service and the Endangered Species Committee of sales which would not meet 50-11-40 standards in 60 quarter-townships. The Fish and Wildlife Service's Biological Opinion (USDI 1991) also indicated that three sales were approved in Habitat Conservation Areas, which further conflicts with the Interagency Scientific Committee's Strategy.

The Endangered Species Committee's exemption of 13 sales after the Fish and Wildlife Service's jeopardy determination further demonstrates the uncertainty of assumptions made in the preparation of the Final Environmental Impact Statement about the ability of Section 7 consultations to result in a level of habitat protection that has a high probability of providing for viable populations of threatened or endangered species. As a mitigation measure for granting the exemption for the 13 sales, the Endangered Species Committee required the Bureau of Land Management to submit new 10-year management plans to the Fish and Wildlife Service for consultation which indicated their effects on spotted owls and their habitat (Endangered Species Committee 1992). Superficially, this decision lends credibility to the assumption in the Final Environmental Impact Statement had the committee not added the proviso that, if the Fish and Wildlife Service determines that these 10-year plans will "likely jeopardize the continued existence" of northern spotted owls, the Bureau of Land Management could apply to the Endangered Species Committee for exemption from the requirements of Section 7 of the Endangered Species Act for the *entire management plan*.

Discussions with Fish and Wildlife Service personnel (B. Mulder pers. comm.) and regulations pursuant to the Endangered Species Act in 50 CFR Part 402 (Federal Register 1986) indicate to us that, even without exemptions granted by the Endangered Species Committee, consultation between Federal land management agencies and the Fish and Wildlife Service will not necessarily cause Federal agencies to meet the requirements of a management strategy (such as the Interagency Scientific Committee's Strategy) or the Draft Recovery Plan. Consultation under Section 7(a)(2) of the Endangered Species Act is designed to ensure that Federal agency actions are not likely to jeopardize the continued existence of listed species or result in the destruction or adverse modification of critical habitat. This avoidance of a jeopardy determination is viewed by the Fish and Wildlife Service (B. Mulder pers. comm.) and the Scientific Analysis Team as a significantly lower standard than a recovery or management plan that provides a high likelihood of viable populations. This is accomplished by providing management guidelines for application across the range of the species. Therefore, avoiding jeopardy opinions by the Fish and Wildlife Service on a project-by-project basis, or even cumulatively, seems likely to result, over time, in habitat conditions which would increase the risk to the viability of the northern spotted owl. While "take" of individual owls or pairs of owls may be avoided, consultation may allow, or at least perpetuate, fragmentation of habitat and provide amounts of nesting, roosting, and foraging spotted owl habitat that are minimal or inadequate in both size and arrangement for maintaining reproductive spotted owl pairs in appropriate proximity to other such pairs. The consequences of such situations were clearly analyzed by Thomas et al. (1990). The final effects of consultation between the Bureau of Land Management and the Fish and Wildlife Service regarding designated critical habitat are unclear at this time.

Section 7(a)(1) of the Endangered Species Act requires Federal agencies to "utilize" their authorities to further the purposes of the Act by carrying out programs for the conservation of threatened or endangered species. Implementation of conservation strategies or adoption of a recovery plan for a threatened or endangered species are actions that further those purposes. Discussion reported in the Federal Register (1986:19934) regarding regulations developed to implement the Endangered Species Act clearly state that, "The Fish and Wildlife Service or National Marine Fishery Service will not, nor do they have the authority to, mandate how or when other Federal agencies are to implement their responsibilities under Section 7(a)(1) of the Act. Section 7(a)(1) has limited purpose under the Act: to authorize Federal agencies to factor endangered species conservation into their planning processes, regardless of other statutory directives."

For purposes of analysis, we recognized that Section 7 consultation will modify at least some timber sales proposed by the Bureau of Land Management. Based on Biological Opinions issued by the Fish and Wildlife Service, the actions of the Endangered Species Committee, and the limitations of Section 7 regulations, this assessment was conducted under the assumption that the Section 7 consultation process will not provide a *de facto* "management plan" equal to or superior to the Interagency Scientific Committee's Strategy in terms of providing for viability of northern spotted owls across their range.

Viability Evaluation Criteria

The Final Environmental Impact Statement used seven criteria to assess how well the alternatives provided for northern spotted owls (USDA 1992). None of the criteria can be used independently to assess population viability. The inter-relationships among all criteria must be considered when assessing population viability. It is possible that an alternative could be weak in one criterion but be strong in a compensating criterion which must be considered in developing the overall rating for an alternative.

Criterion 1 - Potential Change. Potential change in amount, and rate of change, of spotted owl nesting, roosting, and foraging habitat over time on National Forests.

Parameter: Population trend, in the short and long term, at the subspecies' range and physiographic province scales.

The intent of this criterion is to assess affects of each alternative on the amount of spotted owl habitat over time. An increase in the amount of habitat provides a higher probability of persistence for the spotted owl than a decrease in habitat. A stable or slow rate of decline in amount of habitat offers lower likelihood of persistence, but allows managers more time to detect, and possibly correct, unacceptable declines in spotted owl populations caused by loss of habitat. A more rapid rate of decline may preclude effective intervention by managers.

Criterion 2 - Distribution. Provision on National Forests for designated spotted owl nesting, roosting, and foraging habitat distributed throughout the range of the northern spotted owl, with emphasis on areas of concern.

Parameter: Population distribution at the subspecies' range and physiographic province scales.

The basic premise for this criterion is that species or subspecies well distributed throughout their ranges are less prone to extinction than those species confined to small portions of their range.

Other elements being equal, a broadly distributed population with few barriers to movement has a higher probability of viability than a subdivided population with more barriers within its range (Thomas et al. 1990:23). A broad, interconnected distribution lessens risk of catastrophic loss due to disease, habitat destruction, and other catastrophic events. Areas of concern are identified in the Interagency Scientific Committee's Report (Thomas et al. 1990:66). Several areas of concern have been identified because, as a result of natural and human-caused activities, they have low amounts of spotted owl habitat or they may be isolated, or both. Thus, problems with distribution may occur in these areas and protection of habitat is therefore especially important.

Criterion 3 - Habitat Capability. Habitat capability, estimated as potential number of pairs of northern spotted owls, within each population over time on National Forests.

Parameter: Population size at the physiographic province scale.

The basic premise of this criterion is that a higher habitat capability is better because of the greater likelihood for sufficient population size to offset potential demographic or genetic problems.

The intent of this criterion is to evaluate habitat capability of large areas supporting interbreeding owls. The values used to assess this criterion are based on estimates from Schonewald-Cox (1983) as adapted by Marcot et al. (1986). Schonewald-Cox described nine levels of protection ranging from low likelihood of long term survival to very high likelihood. The number of reproductive pairs are assumed to approximately equal effective population size (that is, the effective population size is approximately one-half the adult census population size) (Marcot and Holthausen 1987).

Criterion 4 - Dispersal Habitat. Provision for movement or dispersal habitat in National Forests outside of designated areas managed primarily for spotted owl habitat.

Parameter: Distribution among clusters at the local scale.

The basic premise of this criterion is that providing habitat between designated areas facilitates the movement and dispersal of owls among clusters.

A thorough discussion of dispersal habitat was presented in the Interagency Scientific Committee's Report (Thomas et al. 1990:309-310). In summary, the report states,

> "We use 'connectivity' to mean the kinds and amounts of habitat occurring in the zones between [designated areas]. Conditions there must be compatible with the movement of spotted owls, such that they are both capable of moving through these habitats and inclined to do so. Although connecting zones need not assure habitat capable of supporting a pair of breeding owls, they do not need to provide stopover places where owls can find suitable cover and, especially, foraging opportunities. To that extent, then, we believe that the connecting zones between [designated areas] must include some forested landscapes."

Several areas of concern have been identified because they pose barriers to movement and dispersal of spotted owls. Provisions for dispersal habitat in these areas is especially important.

Criterion 5 - Spacing. Spacing between designated areas managed primarily for owl habitat, measured between boundaries of designated areas on National Forests.

Parameter: Population distribution among pairs at the local scale.

The basic premise of this criterion is that designated areas closer together provide greater assurance of successful movement of spotted owls among areas than when such areas are farther apart.

The basis for assessing this criterion is the data set reported in the Interagency Scientific Committee's Report (Thomas et al. 1990:307) which states 67 percent of all juveniles observed dispersed maximum distances of 12 miles or more, and 50 percent dispersed at least 17.5 miles. When designated areas are further than 17 miles apart, there is a greater risk of mortality or lower probability of locating a mate.

To provide for viable populations, habitats need to be both well-distributed and spaced close enough to ensure interchange of spotted owls among designated habitats. Spacing and distribution are related. A habitat conservation strategy has a greater likelihood of success if it provides adequate access among several designated areas. This redundancy in distribution is insurance against severing populations if designated habitat areas are changed to unsuitable conditions due to catastrophic events. Measurements of first, second, and third nearest distances from each designated habitat area provides an estimate of such spacing patterns.

Criterion 6 - Patch Size. Provision for size and distribution of spotted owl nesting, roosting, and foraging habitat patches within designated areas managed primarily for owl habitat on National Forests.

Parameter: Population size and population distribution within clusters at the local scale.

The intent of this criterion is to assess patch size and patch contiguity as two measures of habitat quality. The premise is that larger, more contiguous habitat patches are of higher quality than small non-contiguous habitat. Northern spotted owls are more likely to persist in higher quality habitat than in lower quality habitat. Smaller patches, especially those with abrupt edges, may also result in habitat loss when exposed trees fall in high winds and when stands suffer other impacts associated with forest edges (Thomas et al. 1990). As patches of habitat become smaller and more isolated, habitat quality decreases. Likelihood of future occupancy by spotted owls is higher if currently poor quality habitat is managed to assure recovery of previously harvested areas to regain spotted owl nesting, roosting, and foraging habitat characteristics in large contiguous blocks.

Criterion 7 - Clustering. Provision for designated areas large enough to support multiple pairs of spotted owls on National Forests.

Parameters: Trend in population size at the local scale.

The basic premise of this criterion is that large designated areas containing multiple pairs of owls, referred to as clusters of pairs, provide for greater likelihood of persistence of owls than do small designated areas.

Demographic modeling conducted by the Interagency Scientific Committee (Thomas et al. 1990) suggested that clusters of more than 20 owl pairs were more likely to persist because of, among other factors, increased probability of within-cluster replacement of lost mates by nonterritorial birds. The Interagency Scientific Committee's Report (Thomas et al. 1990:24) noted, "both empirical and modeling results suggest that clusters of 15 to 20 pairs should be stable over the long term, even given low to moderate rates of dispersal among them by juvenile owls." The Interagency Scientific Committee recommended 20-pair clusters because not all pair sites were expected to be occupied at any one point in time.

Because not all areas are capable of supporting large, protected clusters of owls due to existing habitat conditions and ownerships, it is not possible to specify absolute numbers of individual pairs or clusters as a basis for assessing alternatives. Rather, assessments are based on frequency distribution of cluster sizes.

The Scientific Analysis Team examined each criterion in relationship to the two scenarios for habitat management by the Bureau of Land Management described earlier in this Chapter. When possible, and where it provided insight, the seven criteria were used to evaluate effects of each scenario on specific sites, physiographic provinces, and the entire range of the northern spotted owl. Primary sources of information used in this assessment included the Interagency Scientific Committee's Strategy and associated files (Thomas et al. 1990), the Final Environmental Impact Statement (USDA 1992), a Bureau of Land Management District Draft Resource Management Plan (USDI 1992a) and maps, and Environmental Analysis files for each of the Bureau of Land Management sales exempted by the Endangered Species Committee.

RESULTS

Scenario 1 – Exemption/Interagency Scientific Committee

Criterion 1 - Potential Change in Habitat - The Interagency Scientific Committee's Strategy called for protection of nesting, roosting, and foraging habitat in Habitat Conservation Areas and areas reserved from timber harvest under agency resource management plans or congressionally designated Wilderness areas. The Interagency Scientific Committee's Strategy further provided that the lands between the Habitat Conservation Areas and reserved areas could be logged so long as the 50-11-40 rule was applied. The exemption of the 13 Bureau of Land Management timber sales allowed logging of 1,763 acres of nesting, roosting, and foraging habitat *outside* Habitat Conservation Areas or reserved areas. Three of the exempted timber sales, Moore Coon, Windy, and Four Gates, appear to occur within boundaries of three Habitat Conservation Areas (O-31, O-31 and O-28 respectively) as mapped in the Final Environmental Impact Statement (USDA 1992). Based on statements in the Biological Opinion prepared by the Fish and Wildlife Service during formal consultation procedures (USDI 1991) which note that these sales would affect 50-11-40 standards, we assumed that these sales were not actually in Habitat Conservation Areas. We attribute the apparent discrepancy to either mapping error or revision of boundaries of Habitat Conservation Areas by the Bureau of Land Management in a manner consistent with the Interagency Scientific Committee's Strategy. On the other hand, if any of the sales do in fact occur within the boundary of a Habitat Conservation Area as prescribed by the Interagency Scientific Committee, the effect is a small (151 acres) removal of nesting, roosting, and foraging habitat. This very localized minor effect, even if it did occur, did not significantly affect viability ratings of alternatives in the Final Environmental Impact Statement when considered as a one-time action.

We, therefore, assumed that either the Bureau of Land Management made boundary changes consistent with the provisions in the Interagency Scientific Committee's Strategy or, if not, the amount of habitat affected is insignificant. We therefore concluded that there would be no effect on the assumption in the Final Environmental Impact Statement regarding the potential change in the amount of habitat (Table 2-1).

Table 2-1 Range-Wide Acres of Northern Spotted Owl Nesting, Roosting, and Foraging Habitat on Bureau of Land Management Administered Lands by Scenario Analyzed (Percent Change From Future Amounts Anticipated by the Interagency Scientific Committee).[1]

	(Thousands of Acres)		
Scenario	Year 0 (Present)	Year 50	Year 100
Exempt/ ISC[2]	1,153	1,008 (0)	1,229 (0)
Current Approved Plans	1,153	494 (-51%)	483 (-61%)

[1] Acreage estimates for the Bureau of Land Management in Oregon were taken from USDI 1992 while those in California were taken from Thomas et al.

[2]Assumes that the Forest Service follows the Interagency Scientific Committee's Strategy and the Bureau of Land Management follows an equally effective strategy for spotted owl viability after the exemption of 13 timber sales.

The Interagency Scientific Committee anticipated that logging outside Habitat Conservation Areas and reserved areas would occur at rates governed by sustained yield principles of forestry. The expected rates of logging are not necessarily synonymous with expected rates of loss for spotted owl nesting, roosting, and foraging habitat since not all stands that are harvested meet the definitions of such habitat. Expectations for spotted owl habitat in areas outside Habitat Conservation Areas were based primarily on amounts and distribution of dispersal habitat as provided by compliance with the 50-11-40 rule.

Responses by the Interagency Scientific Committee to management questions from agencies following the publication of the Interagency Scientific Committee's Strategy provide further guidance concerning timber harvest in the areas outside Habitat Conservation Areas (Thomas 1991). These responses included provisions allowing logging that would change forest stand conditions from those favorable for nesting, roosting, and foraging by spotted owls to conditions that would limit owl use to only dispersal and foraging. This could result in rapid loss of most of the nesting habitat outside Habitat Conservation Areas and other reserved areas. Therefore, since the Interagency Scientific Committee did not quantify the rate of loss of nesting, roosting, and foraging habitat outside Habitat Conservation Areas and reserved areas, the exemptions of the 13 Bureau of Land Management sales by the Endangered Species Committee have no effect on the assumptions made in the Final Environmental Impact Statement regarding potential change in habitat.

Criterion 2 - Distribution of Nesting, Roosting, and Foraging Habitat - If all 13 exempted sales are outside Habitat Conservation Area boundaries (see Criterion 1), the distribution of areas (Habitat Conservation Areas) designated for the protection of nesting, roosting, and foraging habitat would remain unchanged from that proposed in the Interagency Scientific Committee's Strategy.

Criterion 3 - Capability of the Habitat to Support Pairs of Owls - As in Criterion 1, it was assumed in the Interagency Scientific Committee's Strategy that forested areas outside Habitat Conservation Areas in the forest matrix would be subject to logging, in accordance with 50-11-40 standards, and might therefore be rendered, at least temporarily, unsuitable to support nesting pairs of owls. Because all 13 sales in question are assumed to occur outside Habitat Conservation Areas or be very minor in extent, this criterion would not apply.

Criterion 4 - Provisions for Dispersal Habitat - The Interagency Scientific Committee's Strategy provided for well-distributed dispersal habitat (i.e., stands with trees at least 11 inches in dbh and at least 40 percent crown closure) through the application of the 50-11-40 rule. The exemption of the 13 Bureau of Land Management timber sales by the Endangered Species Committee will cause or worsen conflicts with the 50-11-40 standards in 17 quarter-townships. Of these 17, 14 quarter-townships were already below the 50-11-40 standard and three other quarter-townships will be reduced below that standard as a result of cutting the exempted sales. It should be noted that these conflicts with 50-11-40 standards are occurring in areas where lands administered by the Bureau of Land Management occur interspersed with private lands in a checkerboard pattern. Strict compliance with the 50-11-40 rule, which applies only to Federal lands, may result in an overall condition where only 25 percent of a quarter-township meets the 11-40 standards.

In the short term, the quality of dispersal habitat will be most affected in the areas where the exempted sales are concentrated between Habitat Conservation Areas. These sales will further reduce dispersal habitat in areas where lack of dispersal habitat may already adversely affect successful dispersal.

Dispersal of spotted owls between Habitat Conservation Areas O-27 and O-26 is likely to be severely and adversely affected by large areas of private land that are not subject to, and do not currently meet, 50-11-40 standards. Further worsening the situation, the distance between these adjacent Habitat Conservation Areas is 12 miles–the maximum distance recommended by the Interagency Scientific Committee. The 13 exempted Bureau of Land Management sales impact 404 acres of dispersal habitat adjacent to a large block of private land situated between these Habitat Conservation Areas that likely does not meet the 50-11-40 criteria. Five quarter-townships that lie between these two Habitat Conservation Areas will be adversely affected by the exempted sales. Two of these quarter-townships currently meet the 50 percent standard; one will be reduced from 58 to 37 percent, the other from 55 to 34 percent. One quarter-township will remain above minimum standards at 51 percent, and two others, which are already below 11-40 standards, will be reduced even further.

The exempted sales will result in the logging of 307 acres between Habitat Conservation Areas O-25 and O-27. Three quarter-townships will be affected between these two Habitat Conservation Areas, all three of which are already below the 50-11-40 standard for dispersal habitat. The area in each quarter-township meeting the 50-11-40 standard will be reduced to 29, 31, and 35 percent. Here, the expanse of private land and a distance of 24 miles (twice the 12-mile distance considered appropriate by the Interagency Scientific Committee) between these Habitat Conservation Areas makes the maintenance of adequate dispersal habitat to provide for movement of spotted owls even more critical.

The exempted sales will result in logging 277 acres of dispersal habitat between Habitat Conservation Areas O-29 and O-31. A total of five quarter-townships will be affected between these two Habitat Conservation Areas, all of which are already below the 50-11-40 standard for dispersal habitat. Three will be reduced to 19 percent, one to 16 percent, and one to 31 percent of the quarter-township meeting the 11-40 standard. The Bureau of Land Management administered lands here are more contiguous than in the more typical checkerboard areas. The distance between these Habitat Conservation Areas is four miles, well within spacing guidelines of the Interagency Scientific Committee's Strategy. Hence, while the effects of cutting such stands conflict with the Interagency Scientific Committee's Strategy, they are probably less significant here than in other areas.

All of the 13 exempted Bureau of Land Management sales are located in the Oregon Coast Range Physiographic Province. This province has been identified as an area of concern by both the Interagency Scientific Committee (Thomas et al. 1990) and the Fish and Wildlife Service (USDI 1991) due to scarcity of nesting, roosting, and foraging habitat, low numbers of owls, fragmented habitat, and the distances between patches of habitat. Prior to the exemption of the 13 sales by the Endangered Species Committee, 40 percent (127 of 317) of quarter-townships on lands administered by the Bureau of Land Management in the province did not meet 50-11-40 standards (USDI 1991). After the exemption and assuming the sales will be harvested, 41 percent (130/317) will not meet the standards. Seven other sales in the province that conflict with the 50-11-40 standards in seven quarter-townships were given nonjeopardy Biological Opinions by the Fish and Wildlife Service.

Three of the exempted sales (Devore Mt., Camas Valley West, and Prego) have particular potential to adversely affect movement of spotted owls between physiographic provinces. None of these three sales disrupts direct connections with adjacent provinces, but each represent a short-term loss of dispersal habitat in areas of potential use by owls for east/west and north/south movement between provinces.

Whereas it was possible, by assuming that meeting 50-11-40 standards equated to meeting dispersal requirements, to quantify changes to habitat that will occur as a consequence of cutting the exempted sales. It was not possible to quantify the effects on actual dispersal by spotted owls. Qualitatively, we expected that an increase in the number of quarter-townships not meeting dispersal standards and further degradation of habitat conditions in quarter-townships already below standards would result in increased exposure of owls to predation and increased competition for prey in areas between Habitat Conservation Areas. Subsequently, these owls might well be less likely to successfully disperse between Habitat Conservation Areas. The number of owls that will not successfully disperse, and the increase in mortality rate of dispersing owls resulting from the exemption of the 13 sales, cannot be predicted. We conclude that the cumulative effect of this harvest and prior timber cutting based on management plans that do not provide for well-distributed dispersal habitat would continue the trend of declining quantity and quality of dispersal habitat in an area already deficient in dispersal habitat.

Recent analysis by the Bureau of Land Management (USDI 1992a) indicated that if the Bureau of Land Management implemented the 50-11-40 standards which would protect dispersal habitat to the level expected by the Interagency Scientific Committee, most if not all of their quarter-townships would meet the standards within 40 years, that is, by around year 2030 (USDI 1992a). In other words, there is a pronounced problem with dispersal habitat on lands administered by the Bureau of Land Management for at least the next 40 years. This problem is acute in the short term (10-40 years). However, if the Bureau of Land Management were to adopt standards for dispersal habitat equal or superior to those prescribed by the Interagency Scientific Committee, the problem would diminish with time until alleviated in 40 years. The exemption of the 13 Bureau of Land Management sales further worsens the situation.

Criterion 5 - Spacing Between Areas Designated for Spotted Owl Management - The spacing analysis described in the Final Environmental Impact Statement was conducted for Habitat Conservation Areas under Alternatives B, C, and D, and for Spotted Owl Habitat Areas under Alternative A. Since the exempted timber sales are outside of Habitat Conservation Areas and SOHAs, this criterion is not affected.

Criterion 6 - Patch Size of Habitat - Assuming exempted timber sales occur outside Habitat Conservation Areas, neither the size of Habitat Conservation Areas or number of owl pairs within Habitat Conservation Areas would be affected.

Criterion 7 - Clustering of Owl Pairs - Since the sales are not in designated reserve areas, there would be no effect on clustering.

Scenario 2 – Current Approved Plans

Our analysis of the effects of the 13 exempted sales as a one-time action concluded that only Criterion 4 was affected. However, the following analysis of the exempted 13 sales, when viewed as part of the Bureau of Land Management's current approved management plans, illustrated that all of the evaluation criteria would be affected as follows.

Criterion 1 - Potential Change in Habitat - Current approved management plans for the Bureau of Land Management in Oregon do not provide Habitat Conservation Areas or other large blocks where suitable habitat and forest stands capable of growing into habitat for spotted owls will be protected. The Bureau of Land Management/Oregon Department of Fish and Wildlife Agreement Areas will protect 109 areas totaling approximately 228,000 acres compared to an estimated 734,000 acres in Habitat Conservation Areas administered by the Bureau of Land Management in Oregon as described under the Interagency Scientific Committee's Strategy (Thomas et al. 1990). Only the habitat currently suitable in the Bureau of Land Management/Oregon Department of Fish and Wildlife Agreement Areas is protected. All current suitable habitat and stands with potential to develop into suitable habitat are protected in Habitat Conservation Areas as prescribed by the Interagency Scientific Committee. Significant reductions in nesting, roosting, and foraging habitat below that described in the Interagency Scientific Committee's Strategy will occur as a result. Expected changes in the amounts of suitable spotted owl habitat that the Bureau of Land Management expects to provide through time are displayed in Table 2-1 for the two analyzed scenarios.

There would be a 51 percent reduction (under the current approved plans scenario) in the amount of nesting, roosting, and foraging habitat that the Bureau of Land Management would contribute in 50 years, as compared to the amount expected by Interagency Scientific Committee. In 100 years, the reduction would be 61 percent (Table 2-2).

Table 2-2 Potential Change in Acres[1] of Northern Spotted Owl Nesting, Roosting, and Foraging Habitat (Percent Change From Expectations of the Interagency Scientific Committee) on Lands Administered by the Forest Service and the Bureau of Land Management.

	Thousands of Acres					
	Year 0 (Present)		Year 50		Year 100	
Scenario	FS/BLM	Total	FS/BLM	Total	FS/BLM	Total
Exempt/ ISC [2]	6,073/1,153	7,226	5,605/1008 (0%)	6,613 (0%)	6,025/1,229 (0%)	7,324 (0%)
FEIS-Alt B BLM-Current Approved Plans	6,073/1,153	7,226	5,605/494 (-51%)	6,009 (-9%)	6,025/483 (-61%)	6,508 (-11%)
FEIS-Alt C BLM-Current Approved Plans	6,073/1,153	7,226	6,171/494 (-51%)	6,665 (+1%)	6,673/483 (-61%)	7,156 (-2%)
FEIS-Alt D BLM-Current Approved Plans	6,073/1,153	7,226	6,951/494 (-51%)	7,445 (+13%)	7,640/483 (-61%)	8,123 (+11%)

[1]Forest Service acreages are from USDA (1992). Acreages for the Bureau of Land Management in Oregon are taken from USDI (1992) while those in California are taken from Thomas et al. (1990).
[2]Assumes that the Forest Service follows the Interagency Scientific Committee's Strategy and the Bureau of Land Management follows an equivalent strategy following the exemption of 13 timber sales by the Endangered Species Committee.

Criterion 2 - Distribution of Nesting, Roosting, and Foraging Habitat - Current approved management plans of the Bureau of Land Management protect nesting, roosting, and foraging habitat in Bureau of Land Management/Oregon Department of Fish and Wildlife Agreement Areas. The Bureau of Land Management/Oregon Department of Fish and Wildlife Agreement Areas are distributed over the Oregon Coast Range (n=51), Klamath Mountains (n=30), and Oregon Cascades West (n=28) Physiographic Provinces. The Agreement Areas currently contain an average of 2,100 acres (range from 734 to 4,188 acres) of spotted owl nesting, roosting, and foraging habitat (Thomas et al. 1990). The Bureau of Land Management/Oregon Department of Fish and Wildlife Agreement Areas are well-distributed within and among the physiographic provinces and are essentially equal to the distribution of habitat provided by Habitat Conservation Areas under the Interagency Scientific Committee's Strategy. However, in the long term (100 years) it can be expected that, because of the limited size of Agreement Areas and increasing fragmentation of habitat within the areas, they will likely support far fewer or no pairs of spotted owls (USDI 1992a:4-71).

The distribution of designated areas (i.e., Habitat Conservation Areas) in the Interagency Scientific Committee's Strategy is affected in the long term if the Bureau of Land Management does not designate Habitat Conservation Areas. Failure of the Bureau of Land Management to designate Habitat Conservation Areas would eliminate 11 complete Habitat Conservation Areas and portions of 13 others on lands administered by the Bureau of Land Management (Table 2-3).

As discussed earlier, the Oregon Coast Range Physiographic Province has been identified as an area of concern, where the density of northern spotted owls is one-eighth of that recorded in other coastal areas (Thomas et al. 1990:67). Habitat conditions on lands administered by the Bureau of Land Management within the Oregon Coast Range Province are critical for maintaining a well-distributed, connected network of nesting, roosting, and foraging habitat (USDA 1992). Forecasted future conditions of the Bureau of Land Management/Oregon Department of Fish and Wildlife Agreement Areas indicate that under the Bureau of Land Management's current approved management plans, the Agreement Areas will not effectively contribute to maintaining such a network (USDI 1992a).

Reduced long-term distribution of spotted owl habitat linking the Oregon Coast Range, Klamath Mountains, and Oregon Cascades West Physiographic Provinces is highly likely to reduce chances of spotted owls moving among these provinces. The distribution of Habitat Conservation Areas proposed by the Interagency Scientific Committee (Thomas et al. 1990) on National Forests alone will not meet the Interagency Scientific Committee's Strategy's requirements for well-distributed blocks of habitat connected by dispersal habitat.

Table 2-3 Habitat Conservation Areas in the Interagency Scientific Committee's Strategy Affected by the Bureau of Land Management in Oregon Following Current Approved Plans and Number of Adjusted Future Expected Pairs In the Interagency Scientific Committee's Strategy Compared to the Bureau of Land Management's Current Plans.

	Pairs of Owls			Pairs of Owls	
Shared FS/BLM HCAs BLM portion Lost	ISC Expectations	Current BLM Plans	Entire BLM HCAs Lost	ISC Expectations	Current BLM Plans
0-6	23	14	0-12	24	0
0-7	25	23	0-16	22	0
0-11	22	18	0-24	20	0
0-17	25	3	0-26	23	0
0-19	29	25	0-27	28	0
0-20	17	17	0-28	24	0
0-21	23	3	0-30	25	0
0-29	20	7	0-37	17	0
0-31	23	16	0-38	5	0
0-32	21	16	0-39	2	0
0-33	20	4	0-40	14	0
0-35	20	19			
0-36	26	4			
Total: 13			11		

Criterion 3 - Capability of the Habitat to Support Pairs of Owls - Both the Bureau of Land Management (USDI 1992a) and Forest Service (USDA 1992) estimated the capability of habitat to support owl pairs. Unfortunately, each agency used different processes and time scales. In the Final Environmental Impact Statement, the Forest Service used a process differing from procedures previously used, such as those used for Interagency Scientific Committee estimates. As a result, direct comparisons between these efforts are not possible. However, it was possible to crudely assess the effects of the Bureau of Land Management's current approved plans on the capability of areas designated for spotted owl habitat to support pairs of spotted owls. These data were then compared with estimates made for the Interagency Scientific Committee's Strategy (Table 2-4).

Table 2-4 Future Capability of Category 1 and 2 Habitat Conservation Areas or Oregon Department of Fish and Wildlife Agreement Areas on Lands Administered by the Bureau of Land Management in Oregon to Support Pairs of Spotted Owls, Based upon Estimates in the Interagency Scientific Committee's Strategy by Analysis Scenario and by Physiographic Province.

Scenario	Physiographic Province	Adjusted Future Pairs[1]	Percent Reduction From ISC Expectations
Exempt/ ISC [2]	Oregon Coast R.	164	0
	Klamath Mtns.	89	0
	Oregon Cascades	83	0
	Total:	336	0
Current Approved Plans	Oregon Coast R.	0-23	100-86
	Klamath Mtns.	0-43	100-52
	Oregon Cascades	0-24	100-71
	Total:	0-90[3]	100-73[3]

[1] Adjusted future pairs based on estimates for Habitat Conservation Areas on lands administered by the Bureau of Land Management in Oregon and proportions of ownerships jointly shared by the Bureau of Land Management and the Forest Service Habitat Conservation Areas, and based on Interagency Scientific Committee estimates and proportions of Bureau of Land Management acreages lost.
[2] Assumes that the Forest Service will follow the Interagency Scientific Committee's Strategy and that Bureau of Land Management will follow an equal strategy after the exemption of the 13 timber sales.
[3] Bureau of Land Management/Oregon Department of Fish and Wildlife Agreement Areas are theoretically capable of supporting 90 pairs of spotted owls (Thomas et al. 1990). Estimates in draft resource management plans (USDI 1992a) indicate that for Alternative B, an alternative very similar to the current approved management plans (J. Lint pers. comm.), the outlook for sustaining owl pairs on lands administered by the Bureau of Land Management in Oregon is near zero (USDI 1992a:4-71). The actual capability probably is somewhere between the two estimates and likely toward the low value.

Although the Bureau of Land Management/Oregon Department of Fish and Wildlife Agreement Areas were established to maintain 90 pairs of spotted owls over the long term (50-100 years), the likelihood of that occurring is near zero because they are small, fragmented, single pair areas in which habitat conditions are expected to deteriorate (Thomas et al. 1990, USDI 1992). Even if the Agreement Areas are assumed to be capable of supporting 90 pairs, when compared to the 336 future pairs expected on lands administered by the Bureau of Land Management in Oregon under the Interagency Scientific Committee's Strategy, it represents a 73 percent reduction. The actual reduction, based on the analysis Bureau of Land Management has completed, for an alternative of draft resource management plans which approximate the current plans, show the reduction is likely to be significantly greater than 73 percent (USDI 1992a:4-71).

The effect of continuing the Bureau of Land Management's current approved plans in Oregon on the capability of all Federal lands to support pairs of spotted owls varies by physiographic province. The Oregon Coast Range Province is the most adversely affected. Here, the number of pairs is reduced by 141 (56 percent of 250 future expected pairs on Federal lands), relative to that expected by the Interagency Scientific Committee. This assumes the Bureau of Land Management/Oregon Department of Fish and Wildlife Agreement Areas support pairs at anticipated levels–which is highly unlikely for reasons documented earlier. Assuming the Agreement Areas will not support any pairs of owls in the future, the number of pairs lost is 164, a 66 percent reduction. Reductions in pairs in the Klamath Mountains Province based on similar assumptions range from 12 percent to 16 percent of 600 pairs expected in the future on Federal lands, and from 14 percent to 19 percent of 435 pairs expected in the future on Federal lands in the Oregon Cascades West Province.

On a range-wide basis, reductions in the number of northern spotted owl pairs on Oregon Bureau of Land Management administered lands results in a total future expected population level less than that envisioned by the Interagency Scientific Committee. The Interagency Scientific Committee estimated the conservation strategy would provide at least 1,469 future expected owl pairs. The Bureau of Land Management's current approved plans may reduce this total by an estimated 17 percent (assuming Agreement Areas maintain 90 pairs) to 23 percent (assuming Agreement Areas maintain no owl pairs).

Criterion 4 - Provisions for Dispersal Habitat - The 13 exempted Bureau of Land Management sales will reduce existing dispersal habitat by 1,763 acres. If Bureau of Land Management follows current approved plans, approximately 50 percent of all Bureau of Land Management quarter-townships in western Oregon will likely fail to meet 50-11-40 standards within about 10 years. This assumes that the increase in number of quarter-townships not meeting the 50-11-40 standard would increase at a rate of 1 percent per year if the Bureau of Land Management's 1991 timber sale program, after consultation, is any indication of future actions (USDI 1991). It also assumes that because of 60-year harvest cycles, insignificant amounts of habitat will grow into a condition that meets 11-40 standards in the next 10 years.

Some dispersal habitat would be retained by means of other land allocations such as riparian zones, but in unknown amounts and distribution. Patches designated for protection as nesting, roosting, and foraging habitat would also aid dispersal. However, the Interagency Scientific Committee's Strategy determined that additional measures were required to increase the probability of movement of owls between Habitat Conservation Areas (Thomas et al. 1990:26). Recent analyses by the Bureau of Land Management for their Draft Resource Management Plans indicated that implementation of any management alternatives lacking such provisions would likely eventually result in most or all of the quarter-townships within the planning areas not meeting 50-11-40 standards as prescribed in the Interagency Scientific Committee's Strategy (USDI 1992a).

Adherence by the Bureau of Land Management to standards that would provide for levels of well distributed dispersal habitat equal to or superior to those of the Interagency Scientific Committee's Strategy becomes particularly critical and difficult to achieve where private and Federal lands are intermingled in a checkerboard pattern as previously discussed. Here, if there is no contribution to the 50-11-40 standards from private lands, strict compliance with the Interagency Scientific Committee's Strategy by the Bureau of Land Management would result in about 25 percent of the landscape providing dispersal habitat if it were all capable.

Private lands will likely contribute some dispersal habitat when stands on those lands exceed about 40 years of age. The amount of time such stands contribute significantly to dispersal habitat will depend on the stand age and condition and when harvested. This in turn will depend largely on conditions of the forest products markets. Because of concerns about risks to dispersing spotted owls in this type of landscape, the Interagency Scientific Committee called for a review of the effectiveness of the 50-11-40 rule in such areas after three years (i.e., by 1993).

Present forest conditions (i.e., pronounced and increasing fragmentation, lack of habitat, and intermingled, clearcut private lands) make it likely that there will be a rapid reduction of dispersal habitat under current approved plans for the Bureau of Land Management in Oregon. This seems likely to continue in the short term (1-50 years) even if consultation between Bureau of Land Management and Fish and Wildlife Service determines that logging of such habitat is likely to result in jeopardizing the continued existence of northern spotted owls. Significant additional losses of dispersal habitat due to catastrophic events will almost certainly occur, further contributing to poor conditions of dispersal habitat in the province. Short rotation ages (60 years) will restrict the future amounts of forests reaching conditions needed for successful dispersal.

Dispersal habitat for owls on lands administered by the Bureau of Land Management is crucial to enhancing movement of owls within and among habitats on National Forests in the Oregon Cascades West, Klamath Mountains, and Oregon Coast Range Provinces. Difficulty with dispersal of owls is likely to be pronounced between Habitat Conservation Areas O-19 and O-20 if there are no requirements to provide adequate quantity, quality, and arrangement of dispersal habitat. Under the Bureau of Land Management's current approved plans, dispersal habitat will not be adequately and appropriately distributed. Further, habitat within the Agreement Areas will continue to deteriorate (USDI 1992a). As this occurs, spotted owls on National Forests in the Oregon Coast Range may well become increasingly demographically isolated. This will likely significantly increase the probability, but to an unknown extent, that spotted owls will be eventually extirpated within that province. Successful dispersal of juvenile owls between the Oregon Cascades West Province and the Klamath Mountains Province will also become increasingly unlikely.

Range-wide, all of these collective factors seem likely to significantly increase the risk of lowering the long-term viability of the metapopulation of northern spotted owls. How much of an increase is not precisely quantifiable.

Criterion 5 - Spacing Between Areas Designated for Spotted Owl Management - We do not expect most of the 109 Bureau of Land Management/Oregon Department of Fish and Wildlife Agreement Areas to support pairs of owls over the long term (50-100 years). Therefore, the responsibility of the Forest Service is increased under regulations pursuant to the National Forest Management Act to provide for viable populations of spotted owls well distributed in the planning areas (interpreted by the Scientific Analysis Team as National Forests within the range of the northern spotted owl). The Forest Service portions of the 13 Habitat Conservation Areas (Table 2-3) identified in the Interagency Scientific Committee's Strategy as being shared with Bureau of Land Management will support fewer pairs of spotted owls than listed in Table Q5 of the Interagency Scientific Committee's Strategy (Thomas et al. 1990:335). The loss of the Bureau of Land Management's contributions affects both the size and spacing of some Habitat Conservation Areas. In some cases Habitat Conservation Areas change from Category 1 Habitat Conservation Areas (capable of supporting 20 or more pairs of spotted owls) to Category 2 Habitat Conservation Areas (capable of supporting 2-19 pairs). Loss of all or portions of a Habitat Conservation Area affects criteria established by the Interagency Scientific Committee's Strategy for spacing between Habitat Conservation Areas. Category 1 Habitat Conservation Areas are to be no more than 12 miles apart. Distance between Category 2 Habitat Conservation Areas is to be a maximum of 7 miles.

A total of 10 shared (Forest Service and Bureau of Land Management) Habitat Conservation Areas will drop in habitat capability from Category 1 to Category 2. The average first, second, and third nearest neighbor distances between boundaries of Habitat Conservation Areas will also increase (Table 2-5). The most significant increase is in the Oregon Coast Range Province where only the first nearest neighbor Habitat Conservation Area is within the prescriptions of the Interagency Scientific Committee's Strategy for spacing. Here, six Habitat Conservation Areas changed in habitat capability from Category 1 to Category 2. These are in a north to south line. Because they are now Category 2 Habitat Conservation Areas, a separate nearest neighbor analysis was conducted. The average distance from these Category 2 Habitat Conservation Areas (previously Category 1 Habitat Conservation Areas) to the first, second, and third nearest neighbor Habitat Conservation Areas is 7.9, 19.7, and 26.8 miles respectively. These distances are above the maximum prescribed for Category 2 Habitat Conservation Areas in the Interagency Scientific Committee's Strategy. One of the goals of the Interagency Scientific Committee's Strategy was to have any one Habitat Conservation Area in close proximity (within spacing standards) to at least three other Habitat Conservation Areas. Because of ownership patterns and habitat conditions, it was not possible to fully meet that goal in the Interagency Scientific Committee's Strategy. Under the Bureau of Land Management's current approved plans the connections will be further weakened.

Table 2-5 Average First, Second, and Third Nearest Neighbor Distances (In Miles) Between Boundaries of Category 1 and 2 Habitat Conservation Areas on National Forests and Lands Administered by the Bureau of Land Management by Physiographic Province (NN = Nearest Neighboring Habitat Conservation Area Within the Province).

		Physiographic Province		
		Oregon Cascade W.	OR Coast Range	Klamath Mtns.
Scenario	NN	Distance	Distance	Distance
Exemption/	1st	5.2	5.1	4.5
ISC	2nd	8.5	9.3	7.2
	3rd	12.6	15.7	12.1
Current	1st	5.1	8.2	4.2
Approved	2nd	9.1	19.6	7.8
Plans	3rd	16.1	25.4	12.8

In addition to increased distances between Habitat Conservation Areas, Bureau of Land Management's current approved plans will affect areas identified as "critical links" (Thomas et al. 1990). These are areas where movements of spotted owls between physiographic provinces are most likely. The Interagency Scientific Committee's Strategy prescribed Habitat Conservation Areas to bridge these "gaps". The average distance between Habitat Conservation Areas across physiographic provinces in critical link areas increase 3 to 4 times under the Bureau of Land Management's current approved plans (see Table 2-6). The increased distances represent levels where successful movement of owls between physiographic provinces is increasingly unlikely.

Table 2-6 Average Distances (Miles) Between Boundaries of Habitat Conservation Areas Across Physiographic Province Boundaries in Areas Identified as "Critical Links". Percent Column Indicates Percent of Radio-Tagged Juveniles Known to Disperse at Least as Far as the Average Distance Between Habitat Conservation Areas.

Scenario	Critical Link	Distance	%
Exemption/ ISC	Oregon Coast to Western Oregon Cascade	17.4	50
	Oregon Coast to Klamath	16.5	54
	Klamath to Western Oregon Cascade	6.9	74
Current Approved Plans	Oregon Coast to Western Oregon Cascade	56.4	2
	Oregon Coast to Klamath	68.4	0
	Klamath to Western Oregon Cascade	29.6	21

Criterion 6 - Patch Size of Habitat - Areas of contiguous habitat probably support a larger number of northern spotted owls than an equal amount of habitat distributed as small patches (USDA 1988, Anderson et al. 1990). Fragmentation of habitat blocks increases the ratio of edge habitat to interior habitat, resulting in a smaller amount of interior habitat overall (Thomas et al. 1990:293). A primary objective of identifying Habitat Conservation Areas was to provide large blocks of nesting, roosting, and foraging habitat, and to provide for areas which are expected to develop into superior owl habitat through time (Thomas et al. 1990:167). In this context, patch size is equated to Habitat Conservation Area size for a quantitative analysis. A management strategy which reduces Habitat Conservation Area size, however, must also be viewed in the light of acres of habitat removed from Habitat Conservation Areas.

Throughout the range of the northern spotted owl, Habitat Conservation Areas as described in the Interagency Scientific Committee's Strategy are comprised of mixed ownerships, including Federal, state, private, and tribal lands. The Scientific Analysis Team analysis focused on management of Federal lands as prescribed by the Interagency Scientific Committee's Strategy. Assuming that the Bureau of Land Management follows their current approved plans, the average size of Habitat Conservation Areas generally decreases within affected provinces due to the loss of the Bureau of Land Management's portion of shared Habitat Conservation Areas (Table 2-7). An exception is the Oregon West Cascade Province where average Habitat Conservation Area size increases by 8,042 acres per Habitat Conservation Area because the eliminated Habitat Conservation Areas are smaller. However, it should be remembered that total Bureau of Land Management acreage designated as Habitat Conservation Areas decreased by 734,000 acres. The size of Habitat Conservation Areas in the Oregon Coast Range Province decreases by an average of 15,203 acres per Habitat Conservation Area (32 percent). Habitat Conservation Areas in the Klamath Mountains Province average a reduction of 4,554 acres per Habitat Conservation Area (5 percent). Smaller Habitat Conservation Areas reduce the probability of reaching the desired numbers of pairs (cluster size) within each Habitat Conservation Area, and hence, the population goal within each province.

Table 2-7 Number and Average Size of Habitat Conservation Areas Under the Two Scenarios Analyzed By Physiographic Province.

	Exemption/ISC		Current Approved Plans	
Province	No. of HCAs	Mean HCA Size (Ac.)	No. of HCAs	Mean HCA Size (Ac.)
Oregon Coast Range	12	47,917	7	32,714
Oregon Cascades West	18	74,333	16	82,375
Oregon Cascades East	6	22,167	6	22,167
Klamath Mtns.	43	44,279	40	42,100
CA Cascades/Modoc	12	21,283	12	21,283
No. CA Coast Range	31	7,435	31	7,435
WA Olympic Peninsula	1	676,000	1	676,000
WA Cascades West	22	67,727	22	67,727
WA Cascades East	13	39,000	13	39,000
Range wide:	127	55,975	117	39,905

Based on the loss or reduction of Habitat Conservation Areas within the affected provinces, average Habitat Conservation Area size would decrease from 55,975 to 39,905 acres range wide (Table 2-7). This reduction (29 percent) in average size of Habitat Conservation Areas would negatively affect the total number of owls on a range wide basis (clustering analysis criterion 7).

Criterion 7 - Clustering of Owl Pairs - Currently the Bureau of Land Management/Oregon Department of Fish and Wildlife Agreement Areas provide sufficient habitat to maintain pairs of owls individually or in small clusters. The majority (range = 91-100 percent) of Agreement Areas currently provide clusters of one to four pairs of owls (Table 2-8). The sum of column totals in Table 2-8 do not total 109 Agreement Areas because groups of two or more contiguous Agreement Areas were treated as one. In the long term, we assume the Bureau of Land Management/Oregon Department of Fish and Wildlife Agreement Areas will support considerably fewer or no pairs of owls (USDI 1992). Loss of territorial owl pairs from these areas is expected due to anticipated loss of quality, quantity, and distribution of suitable owl habitat within these designated areas. Lack of provisions for well distributed dispersal habitat on Bureau of Land Management administered lands would preclude or reduce effective dispersal and recolonization of Bureau of Land Management/Oregon Department of Fish and Wildlife Agreement Areas.

Table 2-8 Number of Bureau of Land Management/Oregon Department of Fish and Wildlife Agreement Areas by Cluster Size (Multiple Pairs of Owls).

	Physiographic Province					
	Klamath Mtns		OR Coast Range		OR Cascades W.	
Cluster size	Presently	AFEP[1]	Presently	AFEP	Presently	AFEP
0	0	20	0	22	0	17
1-4	20	0	20	0	16	0
5-9	0	0	2	0	1	0
Total:	20	20	22	22	17	17

[1]AFEP = Adjusted future expected pairs of owls, based on Thomas et al. 1990.

Table 2-8 illustrates that currently only 5 percent of the Agreement Areas are capable of supporting more than four pairs of spotted owls and that none are capable of supporting more than nine pairs. Table 2-8 further displays that, in the future, the Agreement Areas will likely provide few or no clusters of owls.

In addition to the assessment of Agreement Areas, our analysis for this criterion focused on the number of Habitat Conservation Areas and number of owl pairs within Habitat Conservation Areas. Of the three physiographic provinces affected by the Bureau of Land Management's current approved plans, the Oregon Coast Range shows the greatest expected reduction (42 percent) in the number of Habitat Conservation Areas (Table 2-9). Expected reductions in the number of Habitat Conservation Areas of 22 percent and 5 percent occur within the Oregon Cascades West and Klamath Mountains Physiographic Provinces, respectively. As a result, there will likely be a resulting downward trend in the number of owl pairs within Habitat Conservation Areas and in each affected province.

Table 2-9 Comparison of the Number of Category 1 and 2 Habitat Conservation Areas Based on the Two Scenarios Analyzed by Physiographic Province.

Physiographic Province	Number of HCAs		
	Exemption/ISC	Cur.Approv.Plns.	% Reduction
Oregon Coast Range	12	7	42
Oregon Cascades West	18	14	22
Oregon Cascades East	6	6	0
Klamath Mtns.	43	41	5
CA Cascades/Modoc	11	11	0
No. Calif. Coast Range	31	31	0
WA Olympic Peninsula	1	1	0
WA Cascades West	22	22	0
WA Cascades East	13	13	0
Range wide:	157	146	5

The number of adjusted future expected pairs of owls in Habitat Conservation Areas will be below the desired level of at least 20 pairs for the majority of Habitat Conservation Areas within two of the three affected provinces (Table 2-10). Of the affected provinces, the Oregon Coast Range would lose 9 of 10 Category 1 Habitat Conservation Areas prescribed by the Interagency Scientific Committee's Strategy and would have the lowest (8 percent) ratio of Habitat Conservation Areas containing at least 20 pairs of owls. This represents a 90 percent reduction in Category 1 Habitat Conservation Areas for the Oregon Coast Range Province, which is an area of special concern (Thomas et al. 1990). Four Habitat Conservation Areas (27 percent) with clusters of pairs greater than 20 will be lost in the Klamath Mountains Province and six (35 percent) will be lost in the Oregon Cascades West Province.

Table 2-10 Comparison of Frequency Distribution of Habitat Conservation Areas and Bureau of Land Management/Oregon Department of Fish and Wildlife Agreement Areas Based on the Two Scenarios Analyzed by Cluster Size and Physiographic Province. (Cluster Size Represents the Number of Adjusted Future Expected Owl Pairs.)

	Physiographic Province[1]					
	OR Coast Range		OR Casc West		OR Casc East	
Cluster size	Exempt/ ISC	Current Approv Plns	Exempt/ ISC	Current Approv Plns	Exempt/ ISC	Current Approv Plns
0	0	5	0	3	0	0
1-4	0	2	0	1	5	5
5-9	1	1	0	0	0	0
10-14	0	0	1	1	0	0
15-19	1	3	0	2	0	0
20-24	7	1	12	9	1	1
25-29	3	0	4	1	0	0
30+	0	0	1	1	0	0
Total:	12	12	18	18	6	6

	Klamath Mtns		CA Casc/Modoc		CA Coast Range	
Cluster size	Exempt/ ISC	Current Approv Plns	Exempt/ ISC	Current Approv Plns	Exempt/ ISC	Current Approv Plns
0	8	11	4	4	7	7
1-4	11	12	6	6	7	7
5-9	1	1	0	0	2	2
10-14	2	2	1	1	0	0
15-19	6	6	0	0	0	0
20-24	12	8	0	0	1	1
25-29	1	1	0	0	0	0
30+	2	2	0	0	0	0
Unknown					14	14
Total:	43	43	11	11	31	31

	WA Oly Pen		WA Casc West		WA Casc East	
Cluster size	Exempt/ ISC	Current Approv Plns	Exempt/ ISC	Current Approv Plns	Exempt/ ISC	Current Approv Plns
0	0	0	0	0	0	0
1-4	0	0	10	10	9	9
5-9	0	0	3	3	1	1
10-14	0	0	2	2	1	1
15-19	0	0	1	1	0	0
20-24	0	0	3	3	2	2
25-29	0	0	2	2	0	0
30+	1	1	1	1	0	0
Total:	1	1	22	22	13	13

Table 2-10 (continued) Comparison of Frequency Distribution of Habitat Conservation Areas and Bureau of Land Management/Oregon Department of Fish and Wildlife Agreement Areas Based on the Two Scenarios Analyzed by Cluster Size and Physiographic Province. (Cluster Size Represents the Number of Adjusted Future Expected Owl Pairs.)

	Range-wide	
Cluster size	Exempt/ ISC	Current Approv Plns
0	23	34
1-4	73	77
5-9	12	12
10-14	11	11
15-19	9	13
20-24	43	30
25-29	12	6
30+	6	6
Unknown	14	14
Total:	203	203

[1]Provinces: WA Oly Penn. = Washington Olympic Peninsula; WA Casc West = Washington Cascades West; WA Casc East = Washington Cascades East; OR Coast Range = Oregon Coast Range; OR Casc West = Oregon Cascades West; OR Casc East = Oregon Cascades East; CA Casc/Modoc = California Cascades/Modoc; and CA Coast Range = Northern California Coast Range.

Range wide, Bureau of Land Management's current approved plans will decrease the number of Habitat Conservation Areas on Federal lands by 7 percent (11 of 157 Habitat Conservation Areas)(Table 2-9). Approximately 21 percent (42 of 203) of Habitat Conservation Areas would retain 20 or more adjusted future expected pairs of owls under the Bureau of Land Management's currently approved plans, compared to 30 percent (61 of 203) under the Interagency Scientific Committee's Strategy (Table 2-10). In addition, 11 Habitat Conservation Areas will decrease to a size where zero future adjusted pairs of owls are expected. This is a 41 percent increase in the number of such Habitat Conservation Areas. An expectation of zero future adjusted pairs occurs when the amounts and arrangement of habitat are not expected to maintain a pair of owls consistently each year.

The effects of Bureau of Land Management's current approved plans on the numbers and size of clusters prescribed by the Interagency Scientific Committee's Strategy significantly reduce the strategy's overall expected future populations. Range wide reductions in future pairs ranging from 14 percent to 19 percent (246-336) from the numbers of pairs described by the Interagency Scientific Committee's Strategy will result from Bureau of Land Management following their current approved plans.

Smaller clusters also create conditions that make occupancy by spotted owls of the remaining clusters (i.e., Habitat Conservation Areas) less certain. Empirical data and modeling indicate that local extinction rates increase as the size of population clusters decreases (Thomas et al. 1990). Therefore, the prorated shares of spotted owl pairs expected in Habitat Conservation Areas formerly shared between the Bureau of Land Management and Forest Service may not be attainable. This situation would then be further exacerbated by reduced probabilities for successful dispersal.

SUMMARY AND CONCLUSIONS

The Scientific Analysis Team analyzed implications of exempting 13 Bureau of Land Management timber sales from requirements of the Endangered Species Act. Specifically, we analyzed changes to viability assessments for alternatives in the Forest Service's Final Environmental Impact Statement from two perspectives. First, an exemption of the 13 sales represented as a one-time action followed by the Bureau of Land Management implementing the Interagency Scientific Committee's Strategy (i.e., the Exemption/Interagency Scientific Committee scenario). Second, following exemption of the 13 sales, the Bureau of Land Management continuing to follow their currently approved plan (i.e., the Current Approved Plan scenario).

The effects on viability ratings of the Forest Service Final Environmental Impact Statement differed by management scenario considered for the Bureau of Land Management. Of the seven vibility criteria assessed, the 13 timber sales when viewed as a one-time action only affected one criterion (criterion 4 - provisions for dispersal habitat). While exemption of the timber sales worsens the problem of providing for dispersal habitat in landscape of checkerboard ownership, the sales removed a small total area (1,763 acres) of dispersal habitat and affected few (17 of 317 quarter-townships). Although impacts to dispersal habitat were relatively localized and occurred within an area of concern, the Scientific Analysis Team concluded that exemption of 13 Bureau of Land Management timber sales by the Endangered Species Act would not change the ratings of viability presented for alternatives in the Final Environmental Impact Statement. No mitigation measures were proposed.

In contrast, the Scientific Analysis Team concluded that such an exemption followed by implementation of the Bureau of Land Management's currently approved plans significantly affected all seven viability criteria. An increase in the risk to the viability of northern spotted owls was attributed to the following, compared to Interagency Scientific Committee: 1) a potential change in the amount (51 percent reduction) and distribution (loss of effective habitat areas over the long term) of habitat; 2) loss of owl pairs (17-23 percent reduction); 3) loss of dispersal habitat (failure to meet 50-11-40 standards within 10 years); 4) increased distances between Habitat Conservation Areas (exceeding 7 and 12 mile maximum distances between category 2 and category 1 Habitat Conservation Areas, respectively); 5) changes in size of Habitat Conservation Areas (29 percent reduction in average size); and 6) number of Habitat Conservation Areas (7 percent reduction). Independently and collectively, these factors fail to achieve desired population levels set by the Interagency Scientific Committee. Consequently the Scientific Analysis Team believes a reassessment of viability ratings for alternatives in the Final Environmental Impact Statement and mitigation options are warranted.

REASSESSMENT OF VIABILITY RATINGS FOR EACH OF THE FINAL ENVIRONMENTAL IMPACT STATEMENT ALTERNATIVES

Contributions of lands administered by the Bureau of Land Management to northern spotted owl habitat, based on the two scenarios analyzed, affect each of the five alternatives in the Final Environmental Impact Statement. The effects on each scenario vary. Discussions of each alternative and the effects to the viability assessments associated with each scenario are affected are described below. For this reassessment the Scientific Analysis Team used a five-scale rating system, instead of the three used in the Final Environmental Impact Statement, because of differences between alternatives that warranted distinction. The ratings for this analysis follow.

HIGH – There is a high likelihood that the population(s) of the species would stabilize on National Forests within the range of the northern spotted owl. This provides *broad* latitude for natural catastrophes and uncertainties in knowledge. The likelihood of widespread or complete extirpation is low.

MEDIUM HIGH – There is a moderately high likelihood, somewhat better than 50/50, that the populations of the species would stabilize on National Forests within the range of the northern spotted owl. This provides *limited* latitude for natural catastrophes and uncertainties in knowledge. There is less than a 50/50 likelihood of widespread or complete extirpation.

MEDIUM - There is a roughly 50/50 likelihood that the population would stabilize, and a similar likelihood of widespread or complete extirpation. This provides *extremely limited* latitude for natural catastrophes and uncertainties in knowledge.

MEDIUM LOW - There is less than a 50/50 likelihood that the population would stabilize, and a greater than 50/50 likelihood of widespread or complete extirpation. There is *no* latitude for natural catastrophes and uncertainties in knowledge.

LOW - It is highly unlikely that the species' populations would stabilize, and there is high likelihood of widespread or complete extirpation. There is *no* latitude for natural catastrophes and uncertainties in knowledge.

Assessments of viability ratings are presented for each alternative rather than each evaluation criterion in a manner identical to analyses completed for the Final Environmental Impact Statement. Inter-relationships among all criteria were considered collectively when assessing population viability.

Alternative A of the Final Environmental Impact Statement

Alternative A of the Final Environmental Impact Statement provides spotted owl habitat by using a network of habitat areas where nesting, roosting, and foraging habitat capable of supporting single pairs of spotted owls would be protected. No provisions are made for dispersal habitat. This strategy was evaluated by the Interagency Scientific Committee and described as having a high risk of spotted owls being extirpated from significant portions of their range. The viability assessment reported in the Final Environmental Impact Statement likewise rated Alternative A of the Final Environmental Impact Statement as having a low likelihood of population viability. Neither analysis scenario (Exemption/Interagency Scientific Committee or Current Approved Plans), has an effect upon this rating. The rating remains low.

Alternative B of the Final Environmental Impact Statement

Alternative B of the Final Environmental Impact Statement is the Interagency Scientific Committee's Conservation Strategy which uses multiple pair Habitat Conservation Areas to provide nesting, roosting, and foraging habitat, and the 50-11-40 rule to provide well distributed dispersal habitat of adequate quality. Since this strategy was developed to include National Parks, National Forests, and lands administered by the Bureau of Land Management, deviations from its standards and guidelines affect the probability of success. Such a deviation would be the exemption of the 13 Bureau of Land Management sales, which conflicts with dispersal habitat guidelines. The magnitude of the effects on overall viability depends on the analysis scenario.

Scenario 1 - Exemption/Interagency Scientific Committee. Under Alternative B of the Final Environmental Impact Statement, this scenario affects only expectations of the Interagency Scientific Committee concerning well distributed dispersal habitat. It results in the removal of 1,763 acres of habitat used for dispersal by spotted owls. This represents about 0.17 percent of the nesting, roosting, and foraging habitat, on lands administered by the Bureau of Land Management in Oregon, which are also important to owls for dispersal. Additional, but unknown, acreages of forest stands used by owls only for dispersal and limited foraging exist. Considering only suitable spotted owl habitat on all involved Federal ownerships within the range of the northern spotted owl, the 13 exempted sales total less than 0.02 percent of such habitat. If, as we assumed for this scenario, the Bureau of Land Management provides for well distributed dispersal habitat similar to the standards of the Interagency Scientific Committee's Strategy, the loss of suitable habitat, which also provides dispersal habitat, can be considered minor and relatively insignificant. Therefore, the overall effect of the exemption of these 13 sales, standing alone, would have negligible effects on the "high" viability rating assigned to Alternative B in the Final Environmental Impact Statement.

Scenario 2 - Current Approved Plans. Under Alternative B of the Final Environmental Impact Statement effects are significant and likely consequences result in serious weakening of the Interagency Scientific Committee's Strategy. Increased isolation of the owl population in the Oregon Coast Range Province would occur. Instead of a future subpopulation level of about 250 pairs in 50 years as anticipated under the Interagency Scientific Committee's Strategy, about 86 pairs could be anticipated in 50 years. These pairs will occur in two separate geographical areas. This small number of pairs in isolated subpopulations would be susceptible to diminution by catastrophic and demographic events that could greatly increase the likelihood of low viability or even eventual extirpation in this province.

There likely will be a decrease in the rate of successful dispersal of spotted owls between the Klamath Mountains and Oregon Cascades West Provinces, with a high and increasing probability of producing relatively isolated subpopulations of spotted owls in these provinces. The Bureau of Land Management's current approved plans are anticipated to result in a subpopulation of about 460 owl pairs in the Klamath Mountains and other physiographic provinces of California that provide habitat for northern spotted owls, instead of approximately 550 pairs anticipated under the Interagency Scientific Committee's Strategy. Slightly more than 350 pairs are expected in the Oregon Cascades East and West Provinces compared to 436 pairs expected under the Interagency Scientific Committee's Strategy.

There will be an increased likelihood that Category 1 Habitat Conservation Areas, which are reduced from 20 plus pair areas, to smaller Category 2 Habitat Conservation Areas will fail to actually support the number of pairs anticipated.

The combined effects would lower the overall viability rating for Alternative B in the Final Environmental Impact Statement from "high" to "medium low" (Table 2-11) with a "high" probability of extirpation of the Oregon Coast Range population over the long term.

Alternative C of the Final Environmental Impact Statement

Alternative C in the Final Environmental Impact Statement is comprised of the components of the Interagency Scientific Committee's Strategy and further applies Habitat Conservation Area standards and guidelines to Critical Habitat Units which are areas of habitat on Federal land, designated by the Fish and Wildlife Service under provisions of the Endangered Species Act. In Alternative C of the Final Environmental Impact Statement, the Critical Habitat Units are to be managed according to the standards and guidelines for Habitat Conservation Areas. Alternative C of the Final Environmental Impact Statement was rated as having a "high" likelihood of providing for viable populations.

Scenario 1 - Exemption/Interagency Scientific Committee - As in Alternative B of the Final Environmental Impact Statement, this scenario will not change the viability rating of "high" described for Alternative C of the Final Environmental Impact Statement but local reductions in successful dispersal by spotted owls would likely occur.

Scenario 2 - Current Approved Plans - The addition of large blocks of habitat in designated Critical Habitat Units to the Habitat Conservation Area network has several beneficial effects that tend to alleviate the negative effects of this scenario. They include:

1. Reduction of the loss of habitat by designating more acreage to the Habitat Conservation Areas. Approximately 800,000 acres on National Forests in Oregon in the three affected physiographic provinces would be added, thereby increasing the Habitat Conservation Area network.

2. Increased numbers of pairs of spotted owls expected, in the long term, on National Forests by 18 percent over Alternative B of the Final Environmental Impact Statement.

3. Increased patch sizes designated for protection and, thereby, increasing the number of clusters of 20 or more owl pairs from 34 such clusters in Alternative B of the Final Environmental Impact Statement to 40 such clusters under Alternative C of the Final Environmental Impact Statement.

4. Reduction of distances between Habitat Conservation Areas to facilitate movement of owls between Habitat Conservation Areas. This is particularly called for in the Oregon Coast Range Province where first nearest neighbor distances decrease by 82 percent and second neighbor distances decrease by 65 percent. Values in the Oregon Cascades West Province are -49 percent and -37 percent respectively. Spacing in the Klamath Mountains Province remains essentially unchanged.

5. Increased distribution of spotted owl habitat to be protected in designated areas. The Critical Habitat Units will create greater redundancy in the network, that is more habitat over more of the landscape, which is an important hedge against catastrophic loss of habitat.

In spite of the benefits discussed above, the spotted owl population in the Oregon Coast Range would still become increasingly isolated. This isolated population would be expected to be larger than under Alternative B of the Final Environmental Impact Statement, up to 122 pairs (a 42 percent increase), but it would still be in two separate geographic areas. Additionally, some of the Habitat Conservation Areas that would be reduced from Category 1 to Category 2 size status would not be adjacent to Critical Habitat Units and would remain small. This scenario makes it increasingly likely that the Forest Service could not, over the long term, meet National Forest Management Act regulations for maintaining a viable population of owls well distributed within the planning area.

Based on the above assessment, the Scientific Analysis Team believes the viability rating of Alternative C of the Final Environmental Impact Statement will be "medium" for overall viability of the northern spotted owl (Table 2-11).

Alternative D of the Final Environmental Impact Statement

Alternative D of the Final Environmental Impact Statement entails applying standards and guidelines of the Interagency Scientific Committee's Strategy plus all remaining nesting, roosting, and foraging habitat. It provides the benefits ascribed to Alternative C of the Final Environmental Impact Statement above, but to a greater area. A larger population of owls (136 pairs compared to 122 in Alternative C of the Final Environmental Impact Statement) would be expected for the Oregon Coast Range Province Habitat Conservation Areas on National Forests. Here again, isolation of the province would be of concern, although the larger population would be somewhat less susceptible to extirpation from stochastic events over a given timeframe than compared to Alternative C of the Final Environmental Impact Statement.

Scenario 1 - Exemption/Interagency Scientific Committee - As explained in the assessment of Alternative B of the Final Environmental Impact Statement, this scenario would not change the viability rating of "high" described in Alternative D of the Final Environmental Impact Statement (Table 2-11).

Scenario 2 - Current Approved Plans - The "high" viability rating assigned to Alternative D of the Final Environmental Impact Statement will drop to a "medium-high" rating (Table 2-11) because of the likely isolation of the population of spotted owls in the Oregon Coast Range. Simply protecting all existing nesting, roosting, and foraging habitat between the Habitat Conservation Areas and perhaps gaining 12 pairs, as in this alternative compared to Alternative C, would not result in future habitat conditions conducive to reducing risks to such a subpopulation. This alternative, by not providing for reductions of fragmentation in the areas between Habitat Conservation Areas, will cause the nesting, roosting, and foraging habitat patches to be less effective in supporting reproduction pairs of spotted owls through time. A strategy that provides for the maximum number of pairs possible by allowing forested lands, with the potential to do so, to grow back into nesting, roosting, and foraging habitat would increase the rating.

Alternative E of the Final Environmental Impact Statement

Alternative E of the Final Environmental Impact Statement, titled the "Multi-resource Strategy", incorporates certain elements of Alternative B of the Final Environmental Impact Statement (the Interagency Scientific Committee's Strategy). However, it decreases the size and number of Habitat Conservation Areas, thereby increasing distances between them. It further reduces provisions for dispersal by reducing the area where dispersal habitat is provided, and also reduces the standards compared to the 50-11-40 rule. The Final Environmental Impact Statement reported that this alternative had a "low" likelihood of providing for population viability. The likelihood of maintaining viability is further reduced under Alternative E of the Final Environmental Impact Statement by the increasing isolation of the Coast Range population and reduction of the number of future expected owl pairs. However, "low" is the lowest rating assigned under the rating scheme used. The rating assigned by the Scientific Analysis Team to Alternative E of the Final Environmental Impact Statement, therefore, remains at "low" for both scenarios analyzed in this chapter (Exemption/Interagency Scientific Committee and Current Approved Plans).

Table 2-11 summarizes the effects of the analysis scenarios on viability ratings of northern spotted owls on National Forests for the five alternatives of the Final Environmental Impact Statement.

Table 2-11 Viability Ratings of the Alternatives of the Final Environmental Impact Statement Based on Assumptions of the Final Environmental Impact Statement Compared to Ratings for the Analysis Scenarios.

FEIS Alternative	FEIS Viability Rating	Revised Viability Rating for Exemption/ ISC	Revised Viability Rating for Current Approved BLM Plans
A	LOW	LOW	LOW
B	HIGH	HIGH	MEDIUM LOW
C	HIGH	HIGH	MEDIUM
D	HIGH	HIGH	MEDIUM HIGH
E	LOW	LOW	LOW

RECOMMENDED MITIGATION OPTIONS

Recommended mitigation options are offered as a means of at least partially offsetting the effects of each analysis scenario.

Scenario 1 – Exemption/Interagency Scientific Committee

The Scientific Analysis Team offers no mitigation options for this management scenario because we determined that there would be very minor effects on dispersal habitat. Subsequently there is no change to the viability ratings of alternatives in the Final Environmental Impact Statement resulting from an exemption of 13 Bureau of Land Management timber sales when considered as a one-time action followed by the Bureau of Land Management managing habitat at least equal to the levels provided under the Interagency Scientific Committee's Strategy.

Scenario 2 – Current Approved Plans

The exemption of the 13 Bureau of Land Management timber sales, when considered part of the Bureau of Land Management's current approved plans, require considerable mitigation. The three alternatives of the Forest Service Final Environmental Impact Statement that received "high" ratings in the analysis drop below a rating of "high" (Table 2-11). The other two alternatives which were rated low remain "low" (Table 2-11). Alternative B, the selected alternative in the Final Environmental Impact Statement, is rated under this scenario as having a "medium-low" probability (Table 2-11) of providing for viable populations of northern spotted owls.

The Scientific Analysis Team Report

A letter from the Deputy Chief of the Forest Service, James Overbay (See Appendix 2-A), provided instructions for this analysis. These instructions said that, if the exempted Bureau of Land Management sales were determined by the Scientific Analysis Team to reduce the viability rating of the Final Environmental Impact Statement selected alternative, appropriate mitigation options were to be developed and recommended to the Final Environmental Impact Statement team. The Final Environmental Impact Statement team would revise the Final Environmental Impact Statement as necessary. Recommendations designed to mitigate the effects of the Bureau of Land Management's current approved plans over the long term on Alternative B of the Final Environmental Impact Statement and thus return it to conditions warranting a "high" viability rating, are discussed below. Since both Alternatives C and D of the Final Environmental Impact Statement incorporated all the management elements of Alternative B of the Final Environmental Impact Statement, the recommended mitigation measures below, if adopted, will also result in "high" ratings for these alternatives.

Table 2-12 lists brief summaries of the effects of Bureau of Land Management's current approved plans and mitigation options on National Forests. The options are discussed in greater detail following the table. Site specific mitigation recommendations are delineated on the map in Appendix 2-B.

Table 2-12 Effects of the Bureau of Land Management's Current Approved Plans in Oregon on Alternative B of the Final Environmental Impact Statement (the Selected Alternative) and Recommended Mitigation Options.

Effects	Recommended Mitigation
Reduced nesting, roosting, and foraging habitat in designated areas (i.e., HCAs).	Increase numbers or sizes of HCAs on National Forests in Oregon.
Reduced distribution of nesting, roosting, and foraging habitat.	Partially mitigated by increasing numbers or sizes of HCAs on National Forests in Oregon.
Reduced capability to support pairs of spotted owls in the long term.	Increase numbers or sizes of HCAs on National Forests in Oregon.
Reductions in well distributed dispersal habitat.	Reduce distances between HCAs by increasing numbers or sizes of HCAs on National Forests in Oregon or strengthen standards for providing well distributed dispersal habitat.
Increased spacing between HCAs.	Increase numbers or sizes of HCAs on National Forests in Oregon.
Decreased size of habitat patches protected in the long term.	Increase sizes of HCAs on National Forests in Oregon.
Decreased numbers and size of areas for multiple pairs of spotted owls (clusters).	Increase numbers and sizes of HCAs on National Forests in Oregon.
Increased isolation of the Oregon Coast Range Physiographic Province subpopulation of spotted owls.	Partially mitigated by increasing protection of habitat on National Forests in Oregon to allow for maximum numbers of spotted owls in the future to reduce risks of local extirpation.

Options to mitigate for the lower viability ratings resulting from the effects of Bureau of Land Management following their current management plans are limited. Increasing the levels of reserves (i.e., Habitat Conservation Areas) for spotted owl management on National Forest System lands seems to be the only means of compensation or mitigations within Forest Service control. Compensation for the loss of Habitat Conservation Areas on lands administered by the Bureau of Land Management or loss of portions of shared Bureau of Land Management/Forest Service Habitat Conservation Areas can only be *partially* achieved by increasing the size and numbers of Habitat Conservation Areas on National Forests. This means the population will be distributed much differently than envisioned by the Interagency Scientific Committee with concentrations on National Forests. Additions or expansion of Habitat Conservation Areas on National Forests also partially compensate for increased spacing, loss of habitat patch size, decreases in cluster size, and reduced future expected populations, which result when comparing the Bureau of Land Management's current approved plans to that envisioned by the Interagency Scientific Committee.

It is also clear that loss of well distributed dispersal habitat on lands administered by the Bureau of Land Management between the Oregon Coast Range and the other physiographic provinces in Oregon can be only partially compensated for by altered management on National Forests. Increasing numbers and sizes of the Habitat Conservation Areas will improve probabilities of successful dispersal between and among Habitat Conservation Areas. However, probabilities of successful movements of owls among the Oregon Coast Range, the Klamath Mountains, and Oregon Cascades West Physiographic Provinces will be lower than if the Bureau of Land Management complied with the Interagency Scientific Committee's Strategy. High probabilities of successful movement of owls are possible only if lands administered by the Bureau of Land Management provide habitat to support for movement among these provinces.

Another option for improving the likelihood of successful dispersal among and between Habitat Conservation Areas included strengthening standards of the Interagency Scientific Committee's strategy for well distributed habitat by increasing the requirements of the 50-11-40 rule on National Forests. The percentage of the quarter-township required to meet dispersal habitat criteria could be increased upward from 50 percent. The standards for average diameter and canopy closure could likewise be increased. This would tend to move the characteristics of dispersal habitat toward the attributes of nesting, roosting, and foraging habitat and afford dispersing spotted owls greater security from predation as well as increased opportunities for catching prey, thereby increasing odds of successful dispersal. The Scientific Analysis Team has not recommended this option as mitigation to increase amounts of habitat, patch size, and clusters which generally reduce spacing to distances that would enhance the probabilities of successful dispersal.

Loss of Habitat Conservation Areas on Oregon Bureau of Land Management administered lands, which bridge the gaps outside National Forests in the physiographic provinces of Oregon, are impossible to replace. Isolation of the Oregon Coast Range was judged to become increasingly likely if the Bureau of Land Management follows their current approved plans and the suggested mitigation measures are not implemented on the National Forests. We therefore recommended, as a hedge against extirpation, that the Siuslaw National Forest be managed to increase the future population of spotted owls to the maximum extent possible. Such an increased population but increasingly isolated would then have a higher probability of surviving over a long period of time (100 years) and eventually interacting with other populations. See the discussion in Thomas et al. (1990) for a discussion of a similar solution for retaining a demographically isolated population of spotted owls by the Olympic Peninsula.

The subpopulation of owls in the Oregon Coast Range Physiographic Province is disjunct. Here, a mixture of landownerships are intermingled with Federal lands within boundaries of National Forests. This factor combined with low densities of spotted owls precludes assigning a "high" viability rating for spotted owls in this subpopulation of spotted owls in this province alone if the Bureau of Land Management follows their current approved plans. In contrast, a subpopulation of owls on the Olympic Peninsula is similarly geographically isolated, but there the Interagency Scientific Committee concluded a "moderate" rating of viability was possible for the owl population there. This rating was attributed to provisions for a very large, contiguous Habitat Conservation Area which provided for a large number of multiple pairs of owls that had a high probability of interacting.

To further compensate for isolation risks, additional Habitat Conservation Areas should be designated on the northern and southern ends of the Umpqua National Forest and the northern end and western edge of the Siskiyou National Forest. Existing Habitat Conservation Areas on the Rogue River National Forest in the vicinity of the I-5 Corridor (an area of concern) (Thomas et al. 1990) should be increased in size. These increases should improve the likelihood of successful movement of owls among the Oregon Coast Range, Klamath Mountains, and Oregon Cascades West Physiographic Provinces.

Table 2-13 provides a summary of the viability ratings for Alternatives of the Final Environmental Impact Statement assuming Bureau of Land Management follows their current approved plans, and the rating if the National Forest mitigation measures discussed above and included on the map in Appendix 2-B are implemented. A discussion and rationale for each recommended addition to the network is presented in Appendix 2-C.

Table 2-13 Viability Ratings of the Alternatives of the Final Environmental Impact Statement Based on Currently Approved Plans of the Bureau of Land Management Compared to Viability Ratings if Mitigation Recommendations are Implemented.

FEIS Alternative	Viability Rating-BLM Current Approved Plans	Viability Rating-If Mitigation Implemented
A	LOW	No mitigation was offered as this alternative would not retain its identity if mitigated to attain a high rating.
B	MEDIUM LOW	HIGH
C	MEDIUM	HIGH
D	MEDIUM HIGH	HIGH
E	LOW	No mitigation was offered as this alternative would not retain its identity if mitigated to attain a high rating.

Summary - Once the Scientific Analysis Team's assessment of the 13 exempted timber sales under the two scenarios (Exemption/Interagency Scientific Committee and Current Approved Plans) identified an increased risk to the viability of spotted owls, our instructions directed us to provide recommendations that would mitigate for that risk. We have explored the options of management actions that could be accomplished by the Forest Service and found them to be limited. We believe, however, that our recommendations for mitigation if implemented will result in an overall viability rating of "high" for the northern spotted owl.

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Appendix 2-A

Instructions for the Scientific Analysis Team

United States Department of Agriculture	**Forest Service**	**Washington Office**	**14th & Independence SW P.O. Box 96090 Washington, DC 20090-6090**

Reply to: 2630/1950 **Date:** July 30, 1992

Subject: Scientific Team for Northern Spotted Owl

To: Deputy Chiefs, National Forest System and Research
Regional Foresters, Regions 5 and 6
Station Directors, Pacific Northwest and Pacific Southwest

On July 21 Judge Dwyer ordered the Forest Service to submit to the court a schedule for completion of a new or supplemental EIS to remedy the NEPA deficiencies he found in his May 28 order. Deputy Chief Jim Overbay has signed a declaration stating that the Forest Service will need at least 24 months to comply with his order. It is not known whether the Judge will accept this timeline or not. The Department of Justice has filed a notice of appeal of Judge Dwyer's decision with the Ninth Circuit Court of Appeals.

Before any work on an EIS can begin, a scientific review of the points ordered by Judge Dywer must be conducted. I am assigning Dr. Jack Ward Thomas to lead a team of scientists to accomplish this task. Dr. Thomas will be assisted by Staff Assistant Jerry Hutchins. The purpose of this team will be to address the points of noncompliance with NEPA found by Judge Dwyer in the final environmental impact statement for Management of the Northern Spotted Owls on National Forest Lands. The team will also provide an assessment of management actions needed to resolve the noncompliance problems.

Specifically, the team is to:

1. Determine if the decision by the Endangered Species Committee to allow 13 timber sales proposed by the BLM causes a change in the viability rating assigned to each alternative in the final EIS. If there would be a change in the rating, the team will determine what the change should be. A precise set of assumptions will be provided to the team from the Washington Office.

2. Determine if the assessment of owl populations prepared by Andersen/Burnham, or any other information on spotted owls that was not examined in the final EIS, require adjustments to maintain a high viability rating. If such adjustments are deemed necessary, they should be identified for the selected conservation strategy.

3. Determine if the northern spotted owl conservation strategy will result in the extirpation of any of the 32 species identified in the Judge's order and develop an analysis of the effect of the conservation strategy on these species.

Dr. Thomas has suggested the following people be assigned to the team:

Grant Gunderson, R6
Bruce Marcot, PNW
Martin Raphael, PNW
Eric Forsman, PNW
David Solis, R5
Dick Holthausen, WO

I ask that you make these personnel available for this task. If there are significant difficulties with this assignment, please work with Dr. Thomas to identify alternates. The team leader may request additional personnel to assist with the work of the team. This will be coordinated by Jerry Hutchins with the appropriate line officers. Also, the team leader is authorized to approve work schedules, overtime, and travel within the United States. The team leader may utilize technical experts from outside the Forest Service and pay for such services and associated costs. The Washington Office spotted owl team will provide coordination in the WO.

This is a high priority project and I request the support of the Regional Foresters and Station Directors. Because of on-going litigation, it is very important that confidentiality of this effort be maintained. This is not the start of a NEPA process, but rather an in-house review of the Judge's order in regards to the adopted conservation strategy.

/s/ George M. Leonard

F. DALE ROBERTSON
Chief

United States Department of Agriculture
Forest Service
Washington Office
14th & Independence SW
P.O. Box 96090
Washington, DC 20090-6090

Reply to: 1950/2630

Date: AUG 2 8 1992

Subject: Instructions for the Scientific Analysis Team

To: Dr. Jack Ward Thomas, Team Leader

On July 30 the Chief established a scientific analysis team to review the deficiencies noted by Judge Dwyer in the enivornmental impact statement and record of decision for management of the northern spotted owl. In that letter three specific tasks were identified for the team to accomplish. After the meeting on August 14, and after receipt of the Judge's August 17 order, we agreed to provide a more specific set of guidelines for use by the team.

Enclosed is a copy of those guidelines. If further clarification is needed, please work with Jerry Hutchins to coordinate that with the WO owl team. Also, attorneys from OGC will be available for consultation during the process.

Thank you for taking on this task. It is an important one and your cooperation and support is appreciated.

James C. Overbay

JAMES C. OVERBAY
Deputy Chief

cc: Jerry Hutchins
Mary Coulombe
OGC-WO

Caring for the Land and Serving People

FS-6200-28b(4/88)

GUIDELINES FOR THE SCIENTIFIC ANALYSIS TEAM FOR THE NORTHERN SPOTTED OWL

BACKGROUND

A scientific analysis team has been formed to conduct selected technical analyses associated with the environmental impact statement (EIS) for the northern spotted owl (NSO) (Leonard, 2630/1950, 7/30/92). The analyses are needed to meet Judge Dwyer's rulings of May 28, July 2, July 21 and August 17. The specific analyses include:

1. Determine if the decisions by the Endangered Species Committee to allow 13 Bureau of Land Management (BLM) timber sales changes the viability ratings assigned to alternatives in the EIS.

2. Determine if the information developed by Anderson and Burnham on owl populations (or any other "new information" considered by the scientific team to be authoriatative and scientifically credible) would change the spotted owl population viability ratings in the EIS.

3. Determine how implementation of the selected NSO management strategy is likely to affect the viability of 32 old growth-related species identified in the EIS as associated with NSO habitats.

GUIDELINES

The scientific team is to conduct selected technical analyses and provide scientific interpretations. They should not be burdened with making legal, administrative, or political interpretations. The scientific team shall examine the effects of the three analyses on the viability ratings for all alternatives. For the purposes of their analyses and interpretations, the scientific team shall be guided by the following:

1. <u>BLM timber sales</u>

   A. Revised viability assessments should incorporate the same assumptions as used in the EIS with two exceptions:

      1. incorporate the fact that 13 timber sales (1700 acres) are exempted from Section 7 of the Endangered Species Act (ESA). The Endangered Species Committee required the BLM to comply with the REcovery Plan if the 13 sales are cut. Because the Recovery Plan is only in draft, the team should not consider this at this time.

      2. assume that all other activities of Federal agencies will comply with Section 7 requirements regarding protection of critical habitat.

   B. For analyses and/or constraints consider only <u>approved</u> agency plans and existing regulations.

C. The impacts of the BLM sales should be analyzed and interpreted in the context of influence on viability within physiographic provinces and range-wide viability.

D. Clearly display assumptions used in analyses and discuss sources and implications of uncertainty.

E. If the BLM sales are determined to reduce the viability rating for the selected alternative (Forest Service conservation strategy), recommend appropriate mitigating options to the EIS team.

2. Anderson-Burnham report

A. Accept Anderson-Burnham draft report(s) as new information that must be technically considered.

B. Determine and discuss how Anderson-Burnham data should and should not be used to modify the viability ratings in the EIS.

C. If considerations of Anderson-Burnham indicate need for modifying viability ratings for the alternatives, conduct appropriate viability analyses and propose mitigating options to the EIS team.

D. Items A, B, and C should represent a "reasoned discussion and response..." (Dwyer, 5/28/92, p. 17).

3. Viability of other old growth species associated with NSO habitat

A. Determine if implementation of any of the alternatives would cause the extirpation/extinction of other native vertebrate species indentified in the EIS as associated with old growth NSO habitat.

B. In estimating influences on other old growth species, the team is not expected to conduct a formal viability assessment for every species (Dwyer, 7/2/92, p. 9).

C. "Common sense and expert judgement..." can be used (Dwyer), but the process used for establishing viability ratings needs to be explicitly displayed and discussed.

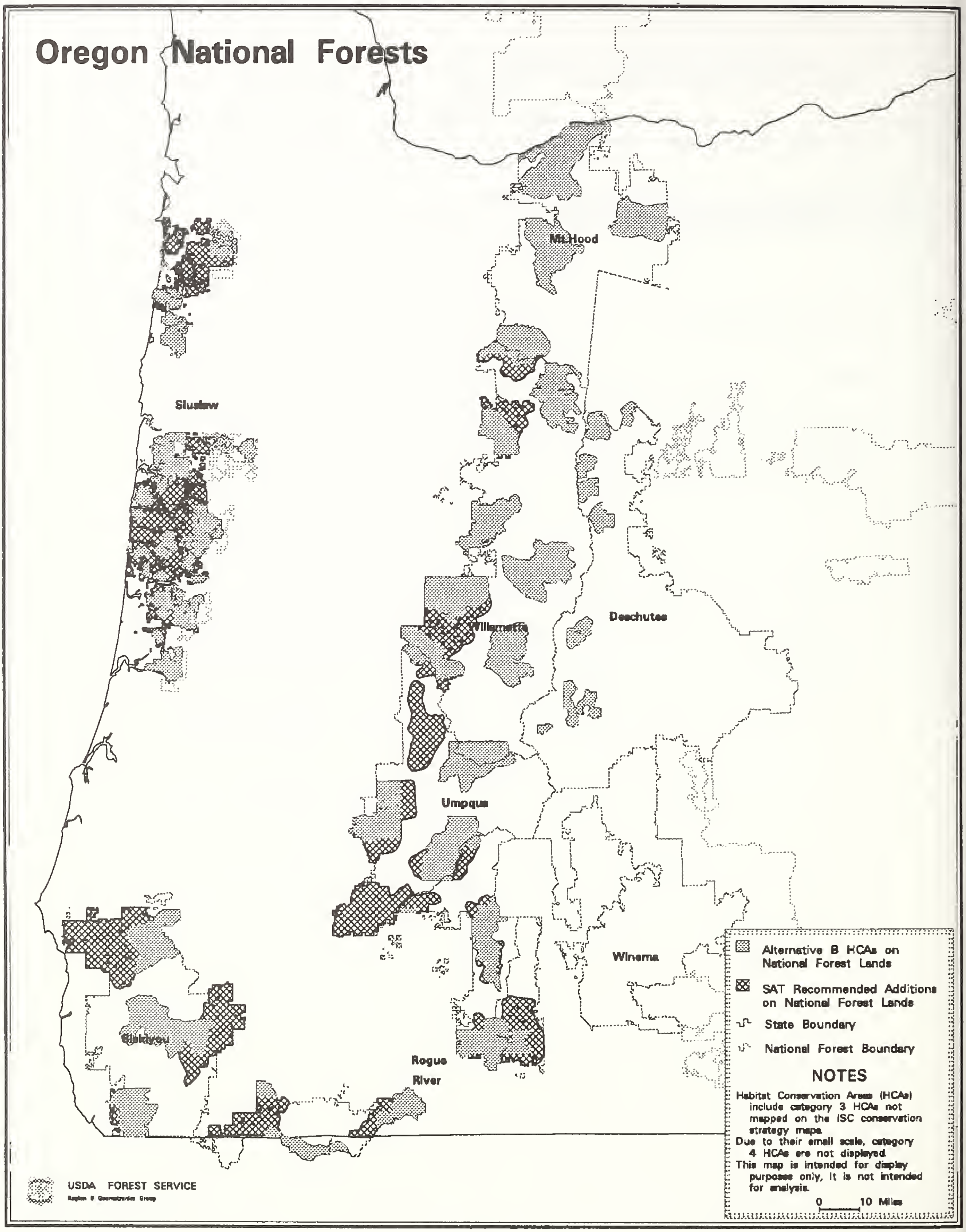
D. If analyses indicate low viability ratings, as a result of proposed Forest Service actions, for other old growth species, the scientific team should propose appropriate mitigating options to the EIS team.

Appendix 2-B

Map of Mitigation Recommendations

Appendix 2-B

Map of Mitigation Recommendations if BLM Continues With Current Approved Plans



Appendix 2-C

Rationale for Recommended Mitigation Options

Appendix 2-C
Rationale for Recommended Mitigation Options

Methods

The following is a description of the mitigation measures recommended for National Forests to maintain a "High" viability rating for the northern spotted owl under the current approved plans scenario. These mitigation measures address provisions for dispersal and number and size of Habitat Conservation Areas if the Bureau of Land Management continued to follow current approved management plans. Isolation and reduction of the Oregon Coast Range Province spotted owl population is a primary concern, as well as movement between the Klamath and Oregon Cascades West Provinces. We attempted to solve the problems of isolation as well as replace lost Bureau of Land Management Habitat Conservation Areas. This approach led to designation, as Habitat Conservation Areas, of a greater amount of lands in the National Forests than the amount lost on lands administered by the Bureau of Land Management.

Results

Table 2-C-1 summarizes the recommended additions to Habitat Conservation Areas and the resulting known owl pairs gained within those additions, along with known owl pairs which would be lost in the future within Habitat Conservation Areas on Bureau of Land Management administered lands. A total of about 1,134,000 acres are recommended for addition to Habitat Conservation Areas. This acreage provides additional long-term protection for 197 known owl pairs, and an undetermined number of adjusted future expected owl pairs on lands managed by the Forest Service. Calculation of adjusted future expected owl pairs for Habitat Conservation Area additions was not completed for this analysis. However, it is believed, based on trends observed as a result of thorough surveys of existing Habitat Conservation Areas on National Forests, that the future number of pairs added through our recommendations will be commensurate with the future numbers of pairs lost from Habitat Conservation Areas within lands administered by the Bureau of Land Management. On these lands, a total of 228 currently known owl pairs and 194 future adjusted expected owl pairs in Category 1 and 2 Habitat Conservation Areas would be lost if the Bureau of Land Management continues to follow current approved management plans.

Where possible, additions to Habitat Conservation Areas were made on National Forests, closest to where Bureau of Land Management Habitat Conservation Areas or portions thereof were lost. This represents an attempt to maintain the Interagency Scientific Committee's Strategy distribution of habitat. Where lack of suitable habitat or ownership patterns prevented additions in the close vicinity, the Scientific Analysis Team selected areas which are expected to improve chances for successful dispersal of owls between Habitat Conservation Areas and reduce risks of isolation of spotted owl pairs or populations.

Appendix 2-C
Rationale for Recommended Mitigation Options (continued)

Table 2-C-1 Known Owl Pairs Lost Within Bureau of Land Management Category 1 and 2 Habitat Conservation Areas and Known Owl Pairs and Acres Added Within Recommended Additions to Forest Service Habitat Conservation Areas by Physiographic Province.

Physiographic Province	HCA Acres Added	Known Owl Pairs	
		Added (FS)[1]	Lost (BLM)[2]
Oregon Coast Range	295,500	33*	93
Klamath Mountains	337,800	56	44
Oregon Cascade West	500,700	108	91
Total:	1,134,000	197	228

* These additional owl pairs are protected in the long term even though presently all known and future owls on National Forests within the Oregon Coast Range are presently protected by Category 3 Habitat Conservation Areas. Presently, under Alternative B of the Final Environmental Impact Statement, Category 3 Habitat Conservation Areas are temporary and remain a part of the network until the Category 1 or 2 Habitat Conservation Areas reach target numbers of pairs. The recommended additions are permanent, thereby protecting the pairs permanently.

[1]All known pair numbers on National Forests are reported from 1987 through 1991.
[2]All known pair numbers on Bureau of Land Management administered land are reported from 1986 through 1990.

Oregon Coast Range Physiographic Province - The Siuslaw National Forest contains the only Forest Service managed lands within the Oregon Coast Range Province. As a hedge against demographic isolation discussed in this report, and to attain the maximum possible numbers of spotted owls to increase the probability that such a population would function as a self sustaining metapopulation, it is recommended that the entire Siuslaw National Forest be designated for Habitat Conservation Area status.

These additions will also partially compensate for the loss of portions of Habitat Conservation Areas O-28, O-29, O-30, O-31, O-32, O-33 O-35, and O-36 within lands administered by the Bureau of Land Management.

Appendix 2-C
Rationale for Recommended Mitigation Options (continued)

Klamath Mountains Physiographic Province - Within the Klamath Mountains Province, all or portions of five Habitat Conservation Areas on lands administered by the Bureau of Land Management critical to spotted owl dispersal between provinces will be lost. To compensate for the loss of habitat and pairs of spotted owls, and to maintain proximity of habitat between the Klamath Mountains and Oregon Cascades West Provinces, Forest Service Habitat Conservation Areas should be increased in size and positioned to provide for reduced spacing among Habitat Conservation Areas in the Oregon Coast Range and Oregon Cascades West Provinces. To achieve this, the following additions to the Habitat Conservation Area network are recommended (see map Appendix 2-B):

Habitat Conservation Area O-20 should be increased in size to partially compensate for loss of habitat and pairs of spotted owls in O-40.

Habitat Conservation Area O-21 should be increased in size to compensate for loss of Bureau of Land Management habitat and pairs of spotted owls in O-21 and to maintain spacing standards to O-23.

Habitat Conservation Area O-22 should be increased in size to partially compensate for loss of habitat and pairs of spotted owls in O-24.

Habitat Conservation Area O-23 should be increased in size to compensate for the loss of habitat and pairs of spotted owls in O-24, to maintain adequate spacing to O-21, and to increase pair clusters within an Habitat Conservation Area which will increase probabilities of successful dispersal between the Klamath Mountains Province and the Oregon Cascades West Province.

Habitat Conservation Area O-25 should be increased in size to compensate for loss of habitat and pairs of spotted owls in O-26 and part of O-27, and to increase pair clusters within an Habitat Conservation Area which will in turn increase probabilities of successful dispersal between the Klamath Mountains Province and the Oregon Cascades West Province within a critical link area.

A new Category 1 Habitat Conservation Area should be designated for the northwest corner of the Siskiyou National Forest to partially replace the loss of Habitat Conservation Area O-27 and increase the chances of successful movement of spotted owls to the Oregon Coast Range Province.

Appendix 2-C
Rationale for Recommended Mitigation Options (continued)

Oregon Cascades West Physiographic Province - All or portions of nine Bureau of Land Management Habitat Conservation Areas will be lost within the Oregon Cascades West Province. Five of these Habitat Conservation Areas are considered parts of critical links for spotted owl dispersal between the Oregon Cascades West and the Klamath and Oregon Coast Range Provinces. To compensate for the loss of habitat and to reduce the spacing of habitat between the Oregon Cascades West Province and both the Oregon Coast Range and Klamath Provinces, we recommend increasing the size of Habitat Conservation Areas O-11, O-14, and O-19. To achieve this, the following additions to the Habitat Conservation Area network are recommended (see map Appendix 2-B):

Habitat Conservation Area O-11 should be increased in size to compensate for habitat and pairs of spotted owls lost in the Bureau of Land Management's portion of O-11 and O-39, and to increase pair clusters within an Habitat Conservation Area 0-11 which will in turn facilitate dispersal of spotted owls to the Oregon Coast Range Province.

A new Category 1 Habitat Conservation Area should be placed east of Bureau of Land Management Habitat Conservation Area O-12 on lands managed by the Forest Service land to compensate for the loss of habitat and pairs of spotted owls in O-12, and to increase pairs within this newly created Habitat Conservation Area which will in turn facilitate dispersal of spotted owls to the Oregon Coast Range Province.

Habitat Conservation Area O-14 should be increased in size to increase pair clusters within Habitat Conservation Area 0-14 which will aid dispersal between provinces.

A new Category 1 Habitat Conservation Area should be placed east of Bureau of Land Management Habitat Conservation Area O-16 on lands managed by the Forest Service to partially compensate for loss of habitat in O-16 and O-17, and to increase pair clusters within Habitat Conservation Area 0-17 to aid dispersal between provinces.

Habitat Conservation Area O-19 should be increased in size to partially compensate for loss of habitat and pairs of spotted owls in O-40 and to maximize pair clusters within Habitat Conservation Area 0-19 which will in turn increase probabilities of successful dispersal of spotted owls between the Klamath Mountains and Oregon Cascades West Physiographic Provinces.

In addition to loss of Bureau of Land Management "critical link" Habitat Conservation Areas, portions or all of Habitat Conservation Areas O-6, O-7, and O-17 will be lost. To compensate for the loss of habitat and pairs of spotted owls, the following Habitat Conservation Areas on National Forests should be increased in size: Habitat Conservation Areas 0-6, 0-4, 0-15, and 0-18.

Chapter 3

Effects of Bureau of Land Management Implementing Preferred Alternatives in Draft Resource Management Plans on the Viability Assessments in the Final Environmental Impact Statement

CHAPTER 3

Effects of Bureau of Land Management Implementing Preferred Alternatives in Draft Resource Management Plans on the Viability Assessments in the Final Environmental Impact Statement

Table of Contents

Table of Contents (continued)

List of Tables

List of Tables (continued)

List of Figures

CHAPTER 3

Effects of Bureau of Land Management Implementing Preferred Alternatives in Draft Resource Management Plans on the Viability Assessments in the Final Environmental Impact Statement

INTRODUCTION

In January 1992, the Forest Service issued a Final Environmental Impact Statement on Management for the Northern Spotted Owl in the National Forests (USDA 1992) (hereafter referred to as the Final Environmental Impact Statement). The Final Environmental Impact Statement analyzed five alternatives for management of spotted owl habitat. The Conservation Strategy put forward by the Interagency Scientific Committee (Thomas et al. 1990) was the selected alternative.

The Interagency Scientific Committee's Strategy applied to all Federal lands, including those under management by the USDI Bureau of Land Management in western Oregon and northern California. A major assumption made in the analysis of owl viability, under all five alternatives in the Final Environmental Impact Statement, was that Bureau of Land Management administered lands would be managed under a strategy equal or superior to the Interagency Scientific Committee's Strategy in providing for viability for the owl. It was also assumed in the Final Environmental Impact Statement that formal consultation between the Bureau of Land Management and Fish and Wildlife Service on any activity that might adversely affect spotted owls or their habitat would preclude implementation of Bureau of Land Management timber sales which were in conflict with the Interagency Scientific Committee's Strategy or an equivalent plan.

Subsequent to the preparation of the viability assessments that were included in the Final Environmental Impact Statement, the Bureau of Land Management applied to the Endangered Species Committee for an exemption from the requirements of Section 7 of the Endangered Species Act for 44 timber sales in western Oregon, judged by the Fish and Wildlife Service to cause jeopardy to the spotted owl. On May 15, 1992, the Endangered Species Committee exempted 13 of these timber sales. Additionally, the Endangered Species Committee required that if the Bureau of Land Management proceeded with the 13 exempted timber sales, the agency would, thereafter, adhere to mandates in the Draft Recovery Plan for the Northern Spotted Owl (USDI 1992) (hereafter referred to as the Draft Recovery Plan).

Results of the Scientific Analysis Team analysis of the effects of the 13 exempted Bureau of Land Management timber sales on viability assessments reported in the Final Environmental Impact Statement are reported in Chapter 2. The Scientific Analysis Team concluded that the exemption of these 13 timber sales, when viewed as a one-time action, would have negligible effects on the "high" viability rating of the Forest Service selected alternative, Alternative B (i.e., the Interagency Scientific Committee's Strategy). The Scientific Analysis Team however, believed that cutting these sales would locally compromise the conservation of dispersal habitat for the northern spotted owl (*Strix occidentalis caurina*) in a "critical link" area that was already below standards of the Interagency Scientific Committee's Strategy in terms of dispersal habitat.

We also concluded that exemption of the 13 Bureau of Land Management sales was only a part of a larger question regarding Bureau of Land Management's contributions to present and future spotted owl habitat. In Chapter 2, of this report, we analyzed the effects of the Bureau of Land Management following their current plans. However, based personal communication with the Bureau of Land Management Oregon State Director (D. Bibles Pers. comm.), we considered the Preferred Alternatives presented in Draft Resource Management Plans (USDI 1992a, USDI 1992b, USDI 1992c, USDI 1992d, USDI 1992e, USDI 1992f, USDI 1992g) for six western Oregon Bureau of Land Management Districts represent the closest approximations of how the Bureau of Land Management will provide habitat for northern spotted owls in the future. Thus, we used the Preferred Alternatives in the Bureau of Land Management Draft Resource Management Plans as the benchmark for our analysis.

PURPOSES OF THE ANALYSIS

This analysis had two objectives. First, we evaluated the effects on northern spotted owl habitat from the exemption of the 13 timber sales and resulting from implementation of Preferred Alternatives in Draft Resource Management Plans on six western Oregon Bureau of Land Management Districts (Salem, Eugene, Roseburg, Coos Bay, Medford, and Klamath Districts). Second, we determined if the Bureau of Land Management Preferred Alternative would provide spotted owl habitat at levels equal or superior to the Interagency Scientific Committee Conservation Strategy. The assessment of viability in the Final Environmental Impact Statement was based on such an assumption.

DESCRIPTION OF THE ANALYSIS

The Bureau of Land Management in Oregon is in the process of developing 10-year Resource Management Plans for each Bureau of Land Management District within the range of the northern spotted owl. These plans will establish direction for management of natural resources on Bureau of Land Management administered lands and will disclose consequences for the northern spotted owl and its habitat. Preferred Alternatives in the Draft Resource Management Plans have been identified and are hereafter referred to collectively as the "Bureau of Land Management Preferred Alternative". Each of the six Bureau of Land Management Draft Resource Management Plans also includes an Alternative D that represents the Interagency Scientific Committee's Strategy (hereafter referred to collectively as "Bureau of Land Management Alternative D").

Two basic premises that governed our analysis are described below. In the analysis documented in Chapter 2 of this report, we concluded that consultation under Section 7 of the Endangered Species Act has not and will not provide *de facto* management strategies that would ensure high probabilities of viability for northern spotted owls. Also, when implemented, agency management plans rather than Section 7 consultation procedures would ultimately produce the level of risks associated with the continued existence of viable populations.

Another basic premise undergirding this analysis is that implementation of Bureau of Land Management Alternative D along with implementation of the selected alternative of the Final Environmental Impact Statement (Interagency Scientific Committee's Strategy and hereafter referred to as Final Environmental Impact Statement Alternative B) on National Forests, results in a "high" viability rating for Final Environmental Impact Statement Alternative B. The high rating was deemed warranted due to full implementation of the Interagency Scientific Committee's Strategy on Federal lands throughout the range of the northern spotted owl as anticipated by the Interagency Scientific Committee.

The premise behind this high viability rating is consistent with assumptions used in making the viability assessments in the Final Environmental Impact Statement. Further, these assessments remain valid in the opinion of the Scientific Analysis Team. This assessment followed a review of new information regarding demographics of the spotted owl (Chapter 4) and the analysis of the effects of exemption by the Endangered Species Committee of 13 Bureau of Land Management timber sales considered as a one-time action (Chapter 2).

This analysis, then, focused on comparing Bureau of Land Management Alternative D (i.e., Interagency Scientific Committee's Strategy) to the Bureau of Land Management Preferred Alternative and assessing the significance of any differences. The Bureau of Land Management and Forest Service planning alternatives which address the Interagency Scientific Committee Conservation Strategy are compared as follows.

> Bureau of Land Management Alternative D = Interagency Scientific Committee Conservation Strategy applied to Bureau of Land Management administered lands in Oregon within the range of the northern spotted owl.
>
> Final Environmental Impact Statement Alternative B = Interagency Scientific Committee Conservation Strategy applied to lands managed by the Forest Service within the range of the northern spotted owl.

Bureau of Land Management Alternative D - Interagency Scientific Committee's Strategy

The Interagency Scientific Committee's Strategy as represented by Bureau of Land Management Alternative D and Final Environmental Impact Statement Alternative B was described in detail by Thomas et al. (1990). The strategy calls for establishment of large blocks of habitat spaced close enough (7-12 miles) to other large blocks of habitat to facilitate movement of spotted owls among such blocks. These blocks, known as Habitat Conservation Areas, have primary objectives of providing superior spotted owl habitat and supporting stable concentrations (multiple pairs) of northern spotted owls now and in the future. The Interagency Scientific Committee's Strategy prohibits timber harvest within Habitat Conservation Areas except under special situations involving the loss of extensive areas of forest through catastrophic events. These standards were established to allow previously logged forests inside Habitat Conservation Areas to develop naturally into superior spotted owl habitat (Thomas et al. 1990:167). The Interagency Scientific Committee assumed that natural growth of young-age forests results in better habitat conditions, sooner, than if such young forests were to be silviculturally treated. This assumption was made because there were no data to demonstrate that silvicultural practices could improve upon natural succession. Silvicultural practices applied to forests outside Habitat Conservation Areas were to serve as a means to scientifically test whether, with proper prescriptions designed to create or accelerate attainment of owl habitat, timber harvest might provide spotted owl habitat in the long-term future.

The Interagency Scientific Committee's Strategy also provided management prescriptions for Federal lands between Habitat Conservation Areas within the range of the northern spotted owl. These prescriptions direct the of retention of forest stands around spotted owl nests (Category 4 Habitat Conservation Areas) and provide for well-distributed dispersal habitat for spotted owls based on the 50-11-40 rule. The 50-11-40 rule provided for at least 50 percent of a quarter-township having trees averaging at least 11 inches in diameter at breast height with a canopy closure of 40 percent or more.

Bureau of Land Management Preferred Alternative

The Bureau of Land Management Preferred Alternative incorporates many aspects of the Interagency Scientific Committee's Strategy and the Draft Recovery Plan (USDI 1992h). Basic elements of the Bureau of Land Management Preferred Alternative pertaining to spotted owl habitat are described as follows.

Old-Growth Emphasis Areas are established and often overlap areas designated in the Interagency Scientific Committee's Strategy as Habitat Conservation Areas. Two types of Old-Growth Emphasis Areas are identified: (1) Deferred Old-Growth Emphasis Areas where regeneration logging in spotted owl habitat is deferred for 80 years; and (2) Non-deferred Old-Growth Emphasis Areas where limited regeneration cutting begins immediately following implementation, for purposes of testing the feasibility of a number of timber harvest techniques for maintenance of both old-growth conditions and sustained timber production (USDI 1992a:13). After 80 years, regeneration cutting in deferred Old-Growth Emphasis Areas will consist of small patch cuts (1 to 5 acres) with overall cutting cycles (i.e., rotations) of 300 years. One-fourth to one-third of 100- to 300-acre forest stands would receive regeneration harvest every 50-100 years. Overall, regeneration harvest would occur at a rate of about 3 percent of the total acreage of suitable habitat per decade. The Bureau of Land Management Preferred Alternative does not provide a stated objective for Old-Growth Emphasis Areas with respect to spotted owls.

Both types of Old-Growth Emphasis Areas would be silviculturally treated through density management to promote stand diversification and development of structural characteristics needed by species that prefer old-growth habitat (USDI 1992a:13). Density management consists of logging commercial trees in younger forest stands (not considered spotted owl habitat) to control densities of trees (D. Dippon pers. comm.). Objectives of density management are to accelerate creation of old-growth forest conditions and to produce timber (USDI 1992a:13). Based on discussions with Bureau of Land Management personnel (D.Dippon, pers. comm.), production of timber in Old-Growth Emphasis Areas is considered secondary to the primary objective of the development or maintenance of spotted owl habitat. Even though the Bureau of Land Management expects such treatments to hasten the development of suitable spotted owl habitat, analyses in Draft Resource Management Plans do not model the rate of habitat development at a rate faster than expected to occur naturally (D. Dippon pers. comm.).

Deferred Old-Growth Emphasis Areas are located in and include essentially the same geographic locations as proposed Designated Conservation Areas in the Draft Recovery Plan (USDI 1992h). The locations also roughly correspond to Habitat Conservation Areas of the Interagency Scientific Committee Conservation Strategy. One non-deferred Old Growth Emphasis Area in the western portion of the Salem District corresponds in location to both a Habitat Conservation

Area and a Designated Conservation Area. The other non-deferred Old-Growth Emphasis Areas are located in areas outside the Habitat Conservation Areas or Designated Conservation Areas.

The Bureau of Land Management Preferred Alternative establishes two major prescriptions for forested lands administered by the Bureau of Land Management between Old-Growth Emphasis Areas (i.e., the matrix). One prescription is applied to "connectivity areas" which are linear tracts of Bureau of Land Management administered lands between and among Old-Growth Emphasis Areas. Here, the majority of the forest stands would be managed on harvest cycles of 120-200 years with 12-18 trees (size not specified) per acre remaining after logging. The other prescription is applied to forest stands called General Forest Management Areas. In southern Oregon, some of the General Forest Management Areas would be logged on 120 year rotations (USDI 1992a:13); 18-25 trees (size not specified) per acre would remain after logging (J. Lint pers. comm.). The Bureau of Land Management expects a 40 percent canopy closure to remain when such numbers of trees are left (D. Dippon pers. comm.). In other areas, the General Forest Management Areas would be logged on 80-110 year rotations; 6-8 trees (size not specified) per acre would remain after logging (USDI 1992b:2-41). Canopy closure of 40 percent is not expected in these areas.

All currently known and newly found spotted owl pair sites in the forest matrix outside Old-Growth Emphasis Areas will be protected temporarily and to some degree. A total of 80-100 acres will be protected from logging at each location for at least 80 years in the two types of General Forest Management Areas and in connectivity areas (USDI 1992b:2-43.). These small reserves may correspond to Category 4 Habitat Conservation Areas of Bureau of Land Management Alternative D (Interagency Scientific Committee's Strategy). However, the Bureau of Land Management Preferred Alternative does not specify that pair sites be comprised of suitable habitat, in contrast to the Interagency Scientific Committee's Strategy.

Prescriptions for snags and down logs are provided in the Bureau of Land Management Preferred Alternatives and generally call for leaving snags "where feasible" and four logs per acre 24 inches in diameter and 50 feet in length "where available", regardless of location relative to Old-Growth Emphasis Areas (USDI 1992b:2-41).

The key elements of Bureau of Land Management Alternative D and the Bureau of Land Management Preferred Alternative listed above are summarized in Table 3-1.

Table 3-1 Summary of Key Elements of Bureau of Land Management Alternative D and the Bureau of Land Management Preferred Alternative.

BLM Alternative D	BLM Preferred Alternative
Number of owl pairs in multiple pair reserves:	
Establishes HCAs to support at least 20 pairs of spotted owls unless habitat or ownership prevented.	Not stated.
Single pair reserves:	
Protects an area equal to a home range (Category 3 HCAs) for all known and future pairs of spotted owls in the Oregon Coast Range Area of Special Concern (Thomas et al. 1990).	Incorporates some of the spotted owl pairs that would be included in Category 3 HCAs into OGEAs. No provisions are made for protection of home range size areas of other known pairs.
Timber harvest in reserves:	
Prohibits harvest of any age-class of forest within HCAs with few exceptions.	Timber harvest allowed in OGEAs to accelerate and develop old-growth characteristics and to provide timber.
Experimental forestry:	
Research outside the HCAs encouraged to validate hypotheses regarding silvicultural treatments.	Provides for treatments, most of which are largely experimental, to be conducted in OGEAs.
Protection of residual stands at pair sites:	
Establishes protection areas of up to 80 acres of suitable habitat around known spotted owl pair sites outside HCAs up to a maximum of seven per township.	Protection of 80-100 acres around all known and spotted owl pair sites found in the future outside OGEAs. Habitat quality is not specified.
Dispersal habitat:	
Provisions for well distributed dispersal habitat per the 50-11-40 rule--to be attained as soon as possible.	Provisions that will likely meet 50-11-40 standards in parts of the range e.g., connectivity areas and General Forest Management Areas in portions of southern Oregon. Standards of 50-11-40 will be met in most other areas in 40-50 years.

Table 3-1 (continued) Summary of Key Elements of Bureau of Land Management Alternative D and the Bureau of Land Management Preferred Alternative.

Dispersal standards apply to all areas within the range of the owl outside HCAs.	Dispersal standards apply to most areas within and surrounding OGEAs (USDI 1992e:4-70).
<u>Spacing of reserve areas:</u>	
Spacing of 20+ pair areas to be no more than 12 miles apart, 2 to 19 pair areas no more than 7 miles apart.	Not stated.
<u>Distribution of reserve areas:</u>	
Distribution of HCAs to provide a hedge against catastrophic loss of habitat and represent varying elevations and vegetative communities within the range of the spotted owl.	Not stated.
<u>Slash disposal:</u>	
No provisions for disposal of logging slash in preparation for regeneration of forest stands since logging, for the most part, is prohibited in HCAs.	Prescribes fire as preferred method of slash disposal and method of preparing harvest units for planting in OGEAs.
<u>Habitat components:</u>	
No prescriptions for numbers of snags or down logs following logging since cutting is, for the most part, prohibited in HCAs.	Prescribes retention of snags "where feasible" and four logs, 20 inches in diameter and 50 feet long per acre "where feasible" following regeneration harvest in OGEAs.
<u>Oversight of implementation:</u>	
Calls for interagency oversight to ensure consistent interpretation and implementation if adopted as per ISC Strategy recommendations.	No provisions for interagency oversight.

METHODS

The Bureau of Land Management's Draft Resource Management Plans provide information on seven alternatives for natural resource management on Bureau of Land Management administered lands. The plans present anticipated effects of each alternative on several attributes of spotted owl habitat. We used these attributes to make direct comparisons between alternatives. Some of these attributes correspond to criteria 1 through 7 used in the viability analysis in the Final Environmental Impact Statement. Where data were insufficient to assess alternatives relative to spotted owl viability, we contacted appropriate Bureau of Land Management staff to seek additional information. If data were not available, our viability assessments were made based on professional judgement of risk.

SCENARIOS ANALYZED

Comparison of Bureau of Land Management Alternative D (Interagency Scientific Committee's Strategy) to Bureau of Land Management Preferred Alternative

We assumed that Bureau of Land Management Alternative D of the Draft Resource Management Plans and Final Environmental Impact Statement Alternative B (USDA 1992:96) exactly meet provisions of the Interagency Scientific Committee Strategy. Therefore, the Bureau of Land Management Preferred Alternative was assessed to determine how it varied from Bureau of Land Management Alternative D relative to each criterion. Differences between Bureau of Land Management Alternative D and the Bureau of Land Management Preferred Alternative serve to demonstrate differences between the Interagency Scientific Committee's Strategy and the Bureau of Land Management's expected management strategy in providing for the viability of the spotted owl. Increased ability to meet each criterion and all criteria collectively would result in a higher viability rating. Conversely, a decreased ability to satisfy the criteria would reflect greater risk to viability.

VIABILITY EVALUATION CRITERIA

Seven criteria were used to assess how well the five alternatives of the Final Environmental Impact Statement provided for viability of the northern spotted owl (USDA 1992). More detailed discussions of the criteria can be found in Chapter 2. The criteria are as follows:

1. Potential change in the amount and rate of change of spotted owl nesting, roosting, and foraging habitat.

2. Distribution of designated spotted owl nesting, roosting, and foraging habitat throughout the range of the northern spotted owl with emphasis on areas of concern.

3. Capability of the habitat to support pairs of spotted owls through time.

4. Provisions for dispersal habitat to facilitate successful dispersal of spotted owls between and among areas designated for spotted owl habitat.

5. Spacing between areas designated for spotted owl habitat.

6. Provisions for size of spotted owl nesting, roosting, and foraging habitat patches.

7. Provisions for designating multiple pairs of spotted owls thereby increasing probabilities that such areas will be occupied consistently through time (i.e., "clustering").

RESULTS

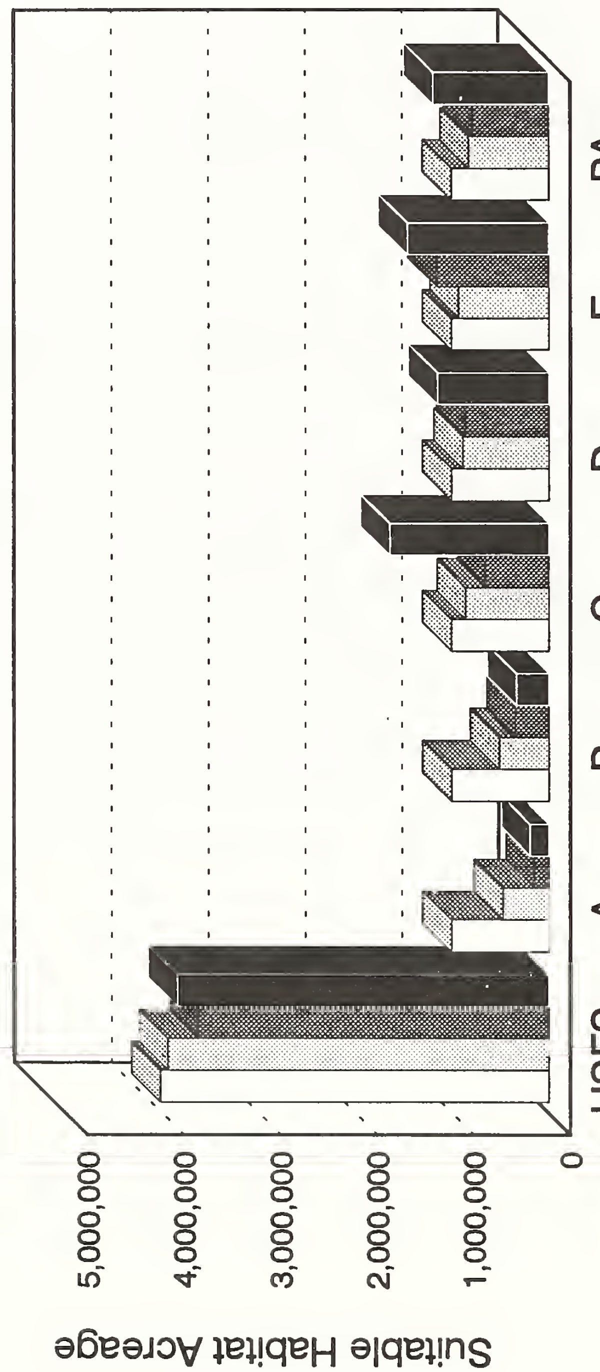
Comparison of Bureau of Land Management Alternative D (Interagency Scientific Committee's Strategy) to Bureau of Land Management Preferred Alternative

Criterion 1 - Potential Change in Habitat

Factors contributing to quantity of spotted owl habitat include, but are not limited to, total acreage, age, juxtaposition, and size of habitat blocks across the landscape (Thomas et al.).

Total Acreage of Habitat - Figure 4-21 in the Roseburg District Draft Resource Management Plan, and included here as Figure 3-1, compares potential changes in spotted owl habitat on all Bureau of Land Management administered lands in western Oregon among alternatives analyzed in Draft Resource Management Plans. The total amount of suitable habitat decreases for about 50 years then increases thereafter in both Bureau of Land Management Alternative D and the Bureau of Land Management Preferred Alternative. Implementation of the Bureau of Land Management Preferred Alternative would result in less available suitable spotted owl habitat in both the first 10 years (62,000 fewer acres) and 50 years (71,000 fewer acres) compared to Bureau of Land Management Alternative D. In 100 years, the Bureau of Land Management Preferred Alternative would result in an increase of 46,000 acres of suitable spotted owl habitat, compared to Bureau of Land Management Alternative D. These projections are based on Bureau of Land Management assumptions that silvicultural practices proposed in the Old-Growth Emphasis Areas will succeed in providing spotted owl habitat.

Figure 3-1 Total Suitable Spotted Owl Habitat Western Oregon - Lands Administered by the Forest Service and BLM by Alternative



	USFS	A	B	C	D	E	PA
Current	4,022,000	1,009,000	1,009,000	1,009,000	1,009,000	1,009,000	1,009,000
After 10 years	3,942,000	479,000	516,000	862,000	892,000	934,000	830,000
After 50 years	3,625,000	152,000	350,000	651,000	864,000	1,160,000	793,000
After 100 years	3,848,000	198,000	339,000	1,647,000	1,155,000	1,463,000	1,201,000

USFS 10-year data prorated between current and 50-year projection

This is a reproduction of Figure 4-21 from page 4-66 of the Draft Roseburg District Resource Management Plan and EIS (USDI 1992b).

Each Draft Resource Management Plan provided estimates of expected amounts of suitable owl habitat at time periods of 10, 50 and 100 years after implementation. Differences in suitable spotted owl habitat between Bureau of Land Management Alternative D and the Bureau of Land Management Preferred Alternative are most pronounced at 50 years (Table 3-2).

Table 3-2 Acres of Suitable Spotted Owl Habitat by Bureau of Land Management District After 10 Years/50 Years For Bureau of Land Management Alternative D and Bureau of Land Management Preferred Alternative.

	Acres in Thousands	
District	BLM Alternative D	BLM Preferred Alternative
Salem	157/159	149/146
Eugene	107/114	102/116
Roseburg	190/156	174/144
Coos Bay	112/106	100/95
Medford	312/322	291/271
Klamath Falls	14/8	14/21
Totals	892/865	830/793

Draft Resource Management Plans indicate that the total amount of suitable spotted owl habitat decreases more in the short term (10-50 years) under the Bureau of Land Management Preferred Alternative than under Bureau of Land Management Alternative D. Overall, Bureau of Land Management Alternative D results in a decrease of 14 percent from the current amount (1,009,000 acres) of suitable spotted owl habitat on Bureau of Land Management administered lands in Oregon after 50 years. The Bureau of Land Management Preferred Alternative results in a decrease of 21 percent in that same time period. This decrease occurs in all but the Oregon Cascades East Physiographic Province and affects four of six districts (Table 3-3).

Table 3-3 Acres of Suitable Spotted Owl Habitat on Bureau of Land Management Administered Lands by Physiographic Province After 10 Years/50 Years for Bureau of Land Management Alternative D and Bureau of Land Management Preferred Alternative[1].

Physiographic Province	Acres in Thousands	
	BLM Alternative D	BLM Preferred Alternative
Oregon Coast Range	290/304	270/288
Oregon Cascades West	260/236	242/213
Oregon Cascades East	14/9	14/22
Klamath Mountains	328/315	304/270
Totals	892/864	830/793

[1] Data are from Draft Resource Management Plans for each district.

Decreases in the amounts of suitable spotted owl habitat within both the Bureau of Land Management Preferred Alternative and Alternative D may be related to miles of roads constructed. The Executive Summary of the Bureau of Land Management's Draft Resource Management Plans (USDI 1992a:10) indicates an annual road construction rate of 14 more miles per year under Bureau of Land Management Alternative D compared to the Bureau of Land Management Preferred Alternative for the first 10 years. This results in 140 more miles of roads per decade under Bureau of Land Management Alternative D than under the Bureau of Land Management Preferred Alternative. This seems inconsistent with projections for decreases in amounts of suitable habitat discussed above and expected timber sale volumes. The Executive Summary indicated that the Bureau of Land Management Preferred Alternative is expected to produce an additional 131 million board feet (MMBF) of timber per year compared to Bureau of Land Management Alternative D. Data compiled from each Draft Resource Management Plan indicated that, for the first 10 years, 98 more miles of roads will be constructed in the Bureau of Land Management Preferred Alternative than in Bureau of Land Management Alternative D. Estimates of total annual timber production in the Draft Resource Management Plans for the Bureau of Land Management Preferred Alternative also indicate an expected increase of 131 MMBF compared to Bureau of Land Management Alternative D. This seems more consistent with other projections. For our analysis, we assumed each Draft Resource Management Plan was more accurate than the Executive Summary.

Age of Habitat - The amount of old-growth forest remaining across the landscape is another factor related to amounts of spotted owl habitat over time. Patches of old-growth forests are frequently the key to spotted owl occupancy of an area comprised of younger forests that are approaching maturity. Logging of isolated patches of old growth, even if relatively small (i.e., 10 - 20 acres) can reduce the probability of spotted owl use of the younger stands.

Old growth is defined in the Bureau of Land Management planning documents (USDI 1992b:4-19) as either unmanaged stands older than 195 years, or managed stands which meet the definition in Forest Service Pacific Northwest Research Station Note PNW-447 (USDA 1986). While spotted owls do not typically use only old-growth forests, studies of habitat use by spotted owls have shown they strongly select older forest types. Use of habitat by owls, in general, is positively correlated with advanced stand development. Northern spotted owls use old, multilayered forests much more frequently than other structural and age classes (Thomas et al., 1990). This pattern shows that for most forest types in Oregon, Washington, and California, old forest [old-growth forest] is clearly preferred habitat (USDA 1991:2). The Interagency Scientific Committee (Thomas et al. 1990:144) adopted the following operational approach dealing with the ecological dependency of spotted owls on preferred habitat:

> "When patterns of a species' abundance and distribution show a consistent, close association with a particular type or types of habitat we assume that the habitat is essential for the species' persistence. We contend that habitat selection is a behavior that reflects the long-term needs of a given species, and that it has so evolved over thousands of years of varying environmental conditions as a result of natural selection. Consequently, preference for a given habitat or habitat attribute likely indicates a need."

Given this relationship between the needs of spotted owls and old-growth forests, it seems likely that decreases in the amounts of existing old-growth forests will have adverse effects on spotted owl pairs. Such effects could be disproportionately greater than the acreage lost. This is especially true where the amount of superior habitat is slightly less than spotted owls typically require, but where availability of additional marginal habitat may tip the balance in favor of successful occupancy or even occasional breeding (Thomas et al. 1990:143).

Implementation of the Bureau of Land Management Preferred Alternative reduces both average patch size and quantity of old-growth habitat, compared to the Bureau of Land Management Alternative D. With the exception of the Salem District, Draft Resource Management Plans indicate the Bureau of Land Management Preferred Alternatives would result in 274,600 acres of old growth which is in patches greater than 20 acres during the first decade, compared to 286,700 acres in such patch sizes for Bureau of Land Management Alternative D. This represents a 4 percent decline. The Executive Summary for the Draft Resource Management Plans (USDI 1992a:10) indicates that 475,000 acres of old growth would occur on Bureau of Land Management administered lands in 100 years under the Bureau of Land Management Preferred Alternative. This compares to 506,000 acres expected under Bureau of Land Management Alternative D. This is a 31,000 acre (6 percent) difference.

The distribution of old growth among various land allocations varies between Bureau of Land Management's Preferred Alternative and Alternative D. Less than 1 percent of the acres of old growth on the Roseburg District are expected to occur on lands available for timber production under Bureau of Land Management Alternative D while 65 percent of the old-growth acres are expected to occur on lands available for timber production under the Bureau of Land Management Preferred Alternative (Table 3-4). The implication is that Bureau of Land Management expects timber management to be compatible with maintaining or replacing old-growth forests.

Juxtaposition and Size of Habitat Blocks - Five Bureau of Land Management districts (all but Klamath Falls) provided comparisons of the numbers and sizes of blocks of old-growth forests by various block sizes expected over the next 10 years for each of the Draft Resource

Management Plans' alternatives. Implementation of the Bureau of Land Management Preferred Alternative results in reductions in the number of blocks of old growth in all size classes except for blocks greater than 600 acres. Numbers of large (300 to 599 acres) blocks of old growth decreased 14 percent under the Bureau of Land Management Preferred Alternative as compared to Bureau of Land Management Alternative D, within 10 years on the Eugene, Roseburg, and Medford Districts (Table 3-5). Reductions in total numbers of blocks and the overall reduction in acreage of old growth may be because the Bureau of Land Management Preferred Alternative does not provide reservation of habitat for for all the single pair areas (Category 3 Habitat Conservation Areas) called for under Bureau of Land Management Alternative D (D. Dippon pers. comm.).

Another factor to consider relative to amounts of suitable spotted owl habitat is the arrangement of old-growth stands across the landscape. More contiguous stands of older forests are believed to provide better habitat conditions than an equal amount of habitat in loose aggregations of fragmented blocks (Thomas et al. 1990:285). Recent work by Meyer et al. (1992) indicates that known owl sites selected at random contain more old growth, larger average size of old-growth patches, and larger maximum size of old-growth patches than occur in landscape locations selected at random (USDI 1992d:3-44). Lehmkuhl and Raphael (In press) report the same result for the Olympic Peninsula.

Table 3-4 Acres of Stands in the Commercial Forest Landscape Expected to Attain Old-Growth Structural Characteristics within 100 Years*

Alternatives	Acres of Stands Meeting Old-Growth Definitions: Lands Available for Timber Production	Lands Not Available for Timber Production	Total
NA	0	39900	53300
A	0	22500	22500
B	200	45800	46000
C	74600	72400	147000
D	200	115800	116000
E	500	174900	175400
PA	64600	34900	99500

*Old-Growth defined as either unmanaged stands older than 195 years, or managed stands which meet the definition in USFS PNW 447.

This is a reproduction of Table 4-7 from page 4-19 of the Draft Roseburg District Resource Management Plan and EIS (USDI 1992b).

Alternatives from BLM Draft Resource Management Plan

PA=Preferred Alternative

Table 3-5 Comparison of the Expected Number of Old-Growth Blocks in 10 Years by Size Category and District Between Bureau of Land Management Alternative D and the Bureau of Land Management Preferred Alternative (PA) of Bureau of Land Management's Draft Resource Management Plans.

Block Size	BLM District	Numbers of Blocks: BLM Alternative D	Numbers of Blocks: BLM PA	% Change
20-79 acres	Salem	229	185	-19
	Eugene	280*	245*	-12
	Roseburg	543	516	-5
	Coos Bay	175	171	-2
	Medford	492	476	-3
Totals		1,719	1,593	-7
80-299 acres	Salem	73	67	-8
	Eugene	120*	120*	0
	Roseburg	219	219	0
	Coos Bay	79	78	-1
	Medford	243	232	-5
Totals		734	716	-2
300-599 acres	Salem	7	7	0
	Eugene	20*	18*	-10
	Roseburg	55	45	-18
	Coos Bay	17	17	0
	Medford	47	38	-19
Totals		146	125	-14
600+ Acres	Salem	2	3	+50
	Eugene	5*	5*	0
	Roseburg	19	18	-5
	Coos Bay	14	14	0
	Medford	12	12	0
Totals		52	52	0
Totals-all Blocks	Salem	311	262	-16
	Eugene	425	388	-9
	Roseburg	836	798	-5
	Coos Bay	285	280	-2
	Medford	794	758	-5
Totals		2,651	2,486	-6

* = Values estimated from Bar Chart in Eugene Draft Resource Management Plan

In summary, implementation of the Bureau of Land Management Preferred Alternative, compared to Bureau of Land Management Alternative D, results in the following:

1) An additional 8 percent (71,000 acres) reduction in the amount of suitable spotted owl habitat in 50 years;
2) A 4 percent (46,000 acres) increase in the amount of suitable spotted owl habitat in 100 years;
3) A 4 percent (12,100 acres) reduction in old growth over 10 years for five of six districts;
4) A 6 percent (31,000 acres) reduction of old growth after 100 years; and
5) A 6 percent (165 blocks) reduction in total old-growth blocks (20 acres or larger) over 10 years for five of six districts.

Criterion 2 - Distribution of Nesting, Roosting, and Foraging Habitat

The distribution of spotted owl habitat in the Bureau of Land Management Preferred Alternative is similar to that of Bureau of Land Management Alternative D, with the following exceptions:

1. The Bureau of Land Management Preferred Alternative includes relatively minor inclusions and exclusions of acreages from 16 Habitat Conservation Areas (0-6, 0-7, 0-11, 0-12, 0-16, 0-17, 0-19, 0-21, 0-26, 0-27, 0-28, 0-31, 0-32, 0-33, 0-36, 0-38) identified in Bureau of Land Management Alternative D. The result of these changes is a net decrease of about 4,000 acres.

2. An additional 44,000 acres which can be considered a part of Habitat Conservation Area 0-30 is included in the Bureau of Land Management Preferred Alternative.

3. An additional 16,000 acres within six new Old-Growth Emphasis Areas are included in the Bureau of Land Management Preferred Alternative.

These changes result in a total addition of approximately 56,000 acres of Bureau of Land Management administered lands being managed in Old-Growth Emphasis Areas under the Bureau of Land Management Preferred Alternative compared to Bureau of Land Management Alternative D. It should be remembered that the Bureau of Land Management Draft Resource Management Plans make no statement as purpose of the Old-Growth Emphasis Areas as they pertain to spotted owls. A majority (90 percent) of the added acres are within the Oregon Coast Range Province and within the portion of the province identified by the Interagency Scientific Committee as an area of special concern.

The overall distribution of spotted owl habitat in reserved areas is slightly better in the Bureau of Land Management Preferred Alternative because new areas were added between habitat blocks (Habitat Conservation Areas) identified under Alternative D. In addition, a new Old Growth Emphasis Area extends locations of habitat blocks on Federal lands 7 miles farther north from Habitat Conservation Area O-36 in the Oregon Coast Range.

Criterion 3 - Capability of the Habitat to Support Pairs

Bureau of Land Management evaluated alternatives in the Draft Resource Management Plans using a population model developed by the Pacific Southwest Forest and Range Experiment Station, Redwood Sciences Laboratory in Arcata, California (McKelvey in USDI 1992b). This model is commonly referred to as the McKelvey model. Although this is a different method than used by the Forest Service in the Final Environmental Impact Statement to estimate capability of habitat to support pairs of spotted owls, it provides a means to compare Bureau of Land Management Alternative D with the Bureau of Land Management Preferred Alternative.

The McKelvey model provides estimates of mean annual occupancy of a given habitat based on a number of factors including amounts and arrangements of habitat. Based on predicted habitat changes in the future, the model provides estimates of how likely it is that an area will be occupied by spotted owl pairs. These estimates are not actual projections of expected populations. The model is dependent on spatially explicit vegetative data to generate accurate estimates. The Bureau of Land Management has interpreted the mean annual occupancy estimates to be the spotted owl carrying capacity of the habitat at points in time. This represents an inappropriate use of the model. McKelvey (pers. comm.) indicated the only appropriate use of the model, as applied to the Bureau of Land Management's planning alternatives, was as a tool for the comparison of such alternatives.

Draft Resource Management Plans provided model-generated estimates of spotted owl carrying capacities at 10 and 100 year intervals following implementation of these plans. Two estimates were provided: one based on the premise that 60 percent of a 2,500 acre area had to be in suitable habitat for spotted owls to constantly occupy an area, the other based on 40 percent.

Table 3-6 summarizes Bureau of Land Management data taken from each of the Draft Resource Management Plans as corrected by the Bureau of Land Management (D. Dippon pers. comm.) since the plans were published. Bureau of Land Management data indicate that, for all assumptions and time periods given, carrying capacity of habitats for the spotted owl is greater under the Bureau of Land Management Preferred Alternative compared to Bureau of Land Management Alternative D, at both 10 and 100 years (Table 3-6).

We would expect a direct correlation of carrying capacity to expected amounts of suitable spotted owl habitat (see discussion for Criterion 1). Data presented in Draft Resource Management Plans, however, do not show this relationship. Estimated carrying capacity for all Bureau of Land Management Districts in western Oregon increases 1 percent and 4 percent for the 60 percent and 40 percent assumptions of habitat suitability, respectively, over 10 years. During the same 10 years, 62,000 fewer acres of suitable spotted owl habitat and 6 percent (n = 165 blocks) fewer old-growth blocks are expected for the Bureau of Land Management Preferred Alternative than for Bureau of Land Management Alternative D. This absence of positive correlation between trends in habitat and expected carrying capacity of spotted owls was difficult for the Scientific Analysis Team to to understand and warrants further examination.

The McKelvey model directly links habitat variation to demographic variation to assess effects of forest management on populations of the northern spotted owl (McKelvey 1992 in USDI 1992b:Appendix 4-107). Habitat projections developed by the Bureau of Land Management for the Bureau of Land Management Preferred Alternatives are based on assumptions discussed later in this Chapter (see Discussion Regarding Risk). Should these assumptions prove optimistic, it is likely the estimated carrying capacities for spotted owls will likewise be optimistic.

No estimates of carrying capacities were presented in the Bureau of Land Management Draft Resource Management Plan for spotted owls at 50 years, the period of the greatest difference between amounts of suitable spotted owl habitat for the Bureau of Land Management Preferred Alternative and Alternative D of the Draft Resource Management Plans.

Table 3-6 Estimated Carrying Capacity (Mean Annual Occupancy) of All Bureau of Land Management Administered Lands in Western Oregon by District at Years 10 and 100 for Bureau of Land Management Alternative D and Bureau of Land Management Preferred Alternative (PA). Based on Bureau of Land Management Analysis Data.

		Carrying Capacity by BLM Alternative	
Assumption	District	D	PA
60% assumption at 10 years	Salem	16	17
	Eugene	7	8
	Roseburg	13	14
	Coos Bay	8	8
	Medford	39	38
	Klamath Falls	1	0
Totals:		84	85
40% assumption at 10 years	Salem	53	50
	Eugene	28	29
	Roseburg	42	42
	Coos Bay	26	45
	Medford	88	84
	Klamath Falls	5	2
Totals:		242	252
60% assumption at 100 years	Salem	48	48
	Eugene	21	32
	Roseburg	25	38
	Coos Bay	45	50
	Medford	105	134
	Klamath Falls	3	1
Totals:		247	303
40% assumption at 100 years	Salem	80	80
	Eugene	56	87
	Roseburg	69	83
	Coos Bay	65	69
	Medford	183	254
	Klamath Falls	7	6
Totals:		460	579

Criterion 4 - Dispersal Habitat

The Bureau of Land Management assessments of dispersal habitat in Draft Resource Management Plans were based on whether 1,389 quarter-townships individually meet 50-11-40 standards. This included approximately 103 quarter-townships located wholly within Old-Growth Emphasis Areas. To compare the Bureau of Land Management Preferred Alternative with the intent of the Interagency Scientific Committee's Strategy, the Scientific Analysis Team used quarter-townships or parts of quarter-townships outside of Old-Growth Emphasis Areas with the potential to meet 50-11-40 standards (n = 1,263). Bureau of Land Management quarter-townships within the Willamette Valley were analyzed as being either in the Oregon Coast Range Province or Western Oregon Cascades Province. Primary sources of information included a set of Bureau of Land Management maps (WODDB 50-11-40, July 31, 1992) showing the expected 50-11-40 status of quarter-townships at various time intervals (i.e., current, year 2030, and year 2040) for the Bureau of Land Management Preferred Alternative.

Bureau of Land Management Alternative D - Compliance with 50-11-40 standards in Bureau of Land Management Alternative D provides for dispersal habitat in accordance with expectations of the Interagency Scientific Committee's Strategy. The intent under Bureau of Land Management Alternative D is for all quarter-townships between Habitat Conservation Areas to reach 50-11-40 conditions as soon as possible, as described in detail in Thomas et al. (1990). Under this alternative, dispersal habitat improves steadily. The percentage of quarter-townships with potential to meet 50-11-40 standards increases from 71 percent (n = 894 of 1,263) at present to 100 percent by year 2030 (Table 3-7; Figure 3-2). All quarter-townships, then, continue to meet 50-11-40 standards through year 2040.

Data were not available to ascertain trends of quarter-townships meeting 50-11-40 standards over 50 years by physiographic province for Bureau of Land Management Alternative D. However, it seemed reasonable to assume that there will be a continual increase in the number of quarter-townships meeting 50-11-40 standards because assessments of all Bureau of Land Management administered lands in western Oregon indicate such a trend (J. Lint pers. comm.).

The percentage of quarter-townships outside of Old-Growth Emphasis Areas with the capability to meet 50-11-40 standards is summarized by physiographic province (Figure 3-3). With the exception of the Oregon Cascades East Physiographic Province, the frequency distribution of quarter-townships capable of meeting 50-11-40 standards is similar between physiographic provinces.

Figure 3-2 Comparison of 50-11-40 Conditions on BLM Administered Lands Outside OGEAs Alternative D and Preferred Alternative - Western Washington

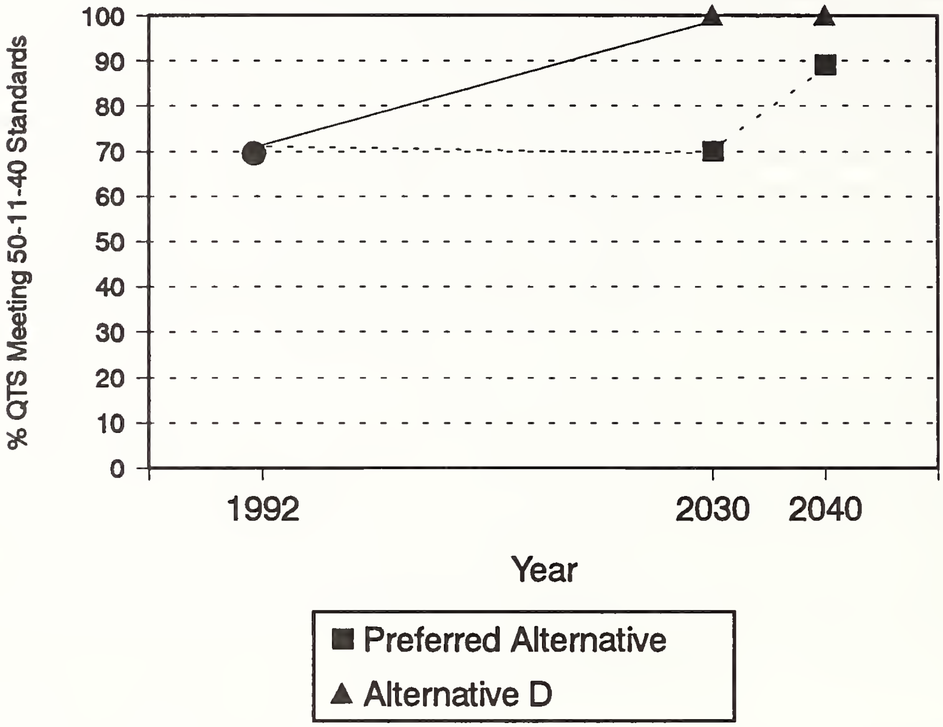
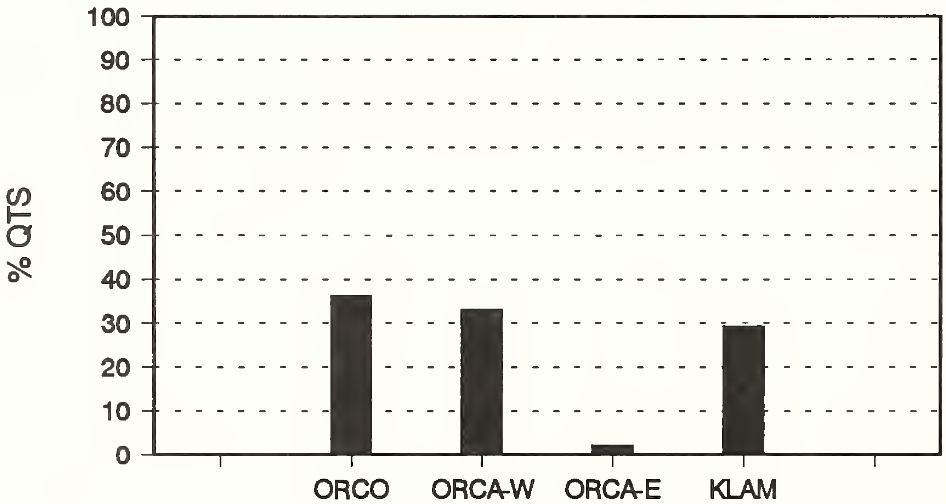


Figure 3-3 Percent of BLM Quarter-Townships by Physiographic Province



ORCO=Oregon Coast Range Province
ORCA-W=Oregon Cascades West Province
ORCA-E=Oregon Cascades East Province
KLAM=Klamath Mountain Province

Bureau of Land Management Preferred Alternative - Under the Bureau of Land Management Preferred Alternative, quarter-townships are managed to improve overall from current conditions, with an emphasis on quickly meeting 50-11-40 standards in quarter-townships in linear bands between Old-Growth Emphasis Areas (designated as connectivity areas) and in non-deferred Old-Growth Emphasis Areas (J. Lint pers. comm.).

Under the Bureau of Land Management Preferred Alternative, the percentage of quarter-townships meeting 50-11-40 standards initially declines slightly from 71 percent (n = 894) at the present time to 70 percent (n = 878) by year 2030. A decline from 71 to 70 percent in the number of quarter-townships meeting 50-11-40 standards (dispersal habitat) is likely not a significant reduction. What is significant is that it occurs during a period when owl populations, and amounts of nesting, roosting, and foraging habitat are declining. Further, it occurs where conditions for dispersal are already most tenuous (i.e., the checkerboard ownership of Bureau of Land Management administered lands). The Bureau of Land Management Preferred Alternative will worsen conditions for spotted owls by slightly reducing current amounts of dispersal habitat and by delaying development of other stands which would meet 50-11-40 standards more quickly under Bureau of Land Management Alternative D. Between years 2030 and 2040, quarter-townships meeting 50-11-40 standards increase to 89 percent (n = 1,120) (Table 3-7, Figure 3-2). Beyond year 2040, the Bureau of Land Management Preferred Alternative is expected to nearly (90 percent or better) meet 50-11-40 standards in most areas (Bureau of Land Management maps). This initial decline and following delay in meeting 50-11-40 standards represents a significant divergence from the intent of the Interagency Scientific Committee's Strategy.

Table 3-7 Number of Quarter-Townships Meeting 50-11-40 Standards on Bureau of Land Management Administered Lands Within the Range of the Northern Spotted Owl under Bureau of Land Management's Preferred Alternative.

Year	Physiographic province[1]	No. of quarter-townships
Current	All	894
	ORCO	307
	ORCA-W	287
	ORCA-E	17
	KLAM	283
2030	All	878
	ORCO	341
	ORCA-W	279
	ORCA-E	23
	KLAM	235
2040	All	1120
	ORCO	399
	ORCA-W	390
	ORCA-E	27
	KLAM	304

[1] Physiographic provinces: ORCO = Oregon Coast Range; ORCA-W = Oregon Cascades West; ORCA-E = Oregon Cascades East; KLAM = Klamath Mountains.

The following provides both a quantitative and qualitative description of the status of quarter-townships under the Bureau of Land Management Preferred Alternative.

a. Oregon Coast Range Province: Numbers of quarter-townships meeting 50-11-40 standards gradually increase (from 67 to 87 percent) over the next 50 years (Figure 3-4). Spatial distribution of quarter-townships meeting 50-11-40 generally improves as well. There is an increase in number of quarter-townships meeting 50-11-40 standards between Old-Growth Emphasis Areas overlapping with Habitat Conservation Areas O-28, O-29, O-30, O-31, O-32, O-33, O-35, O-36, O-37, and O-38 at years 2030 and 2040.

The number of quarter-townships meeting 50-11-40 standards in some areas near the outer boundaries of the Oregon Coast Range Province (e.g., the northeast corner of the province on the Bureau of Land Management Salem District and the southeast corner of the province on the Bureau of Land Management Coos Bay District) decreases or does not change. The overall effect at both years 2030 and 2040 represents an improvement in amount and distribution of quarter-townships meeting 50-11-40 standards but at a rate well below the numbers meeting such standards under Alternative D. This trend is significant because of the large (36 percent n = 460 of 1,263) (Figure 3-3) percentage of Bureau of Land Management quarter-townships in the Oregon Coast Range Province and its identification as an area of special concern (Thomas et al. 1990).

Figure 3-4 Percent of 1263 BLM Quarter-Townships Meeting 50-11-40 Standards Under BLM's Preferred Alternative - Oregon Coast Range Physiographic Province

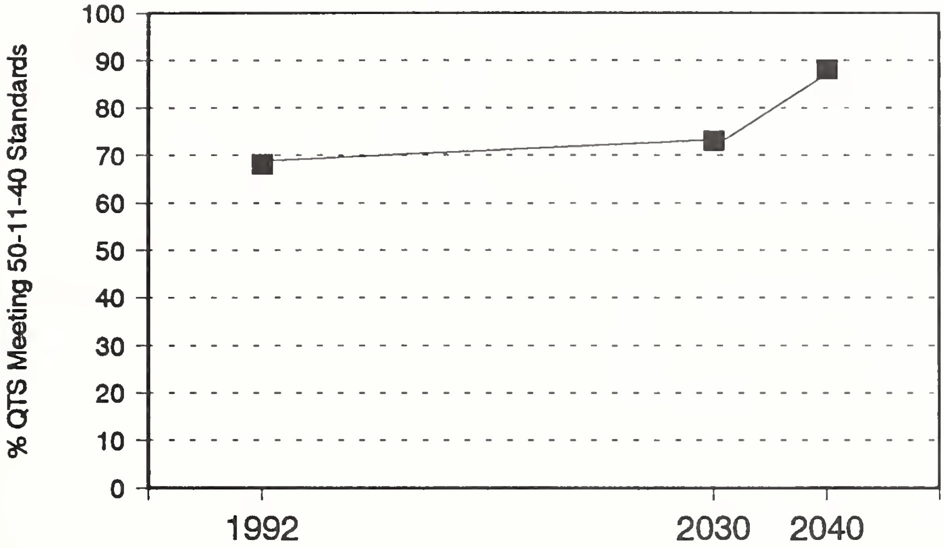
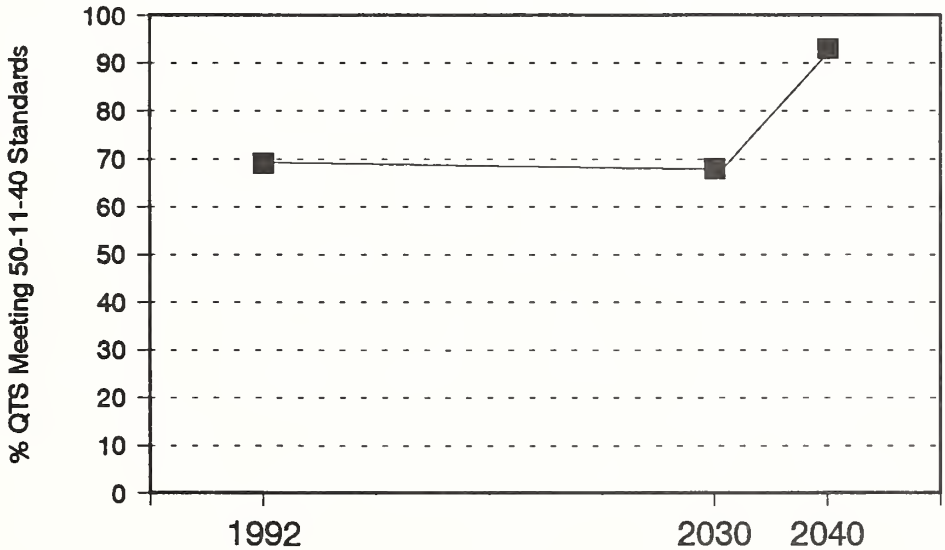


Figure 3-5 Percent of 1263 BLM Quarter-Townships Meeting 50-11-40 Standards Under BLM's Preferred Alternative - Oregon Cascade West Physiographic Province



b. Oregon Cascades West Province: Initially, the percentage of quarter-townships meeting 50-11-40 standards drops slightly from 69 percent to 67 percent at year 2030, then reaches 94 percent in year 2040 in the Bureau of Land Management Preferred Alternatives (Figure 3-5). Quarter-townships not meeting 50-11-40 standards at year 2030 are concentrated and increase in two locations; one near Eugene, Oregon; the other, an area east of Roseburg, Oregon. While both areas improve by the year 2040, neither fully complies with 50-11-40 standards by year 2040.

The Fish and Wildlife Service identified the Southern Willamette/North Umpqua area between the Oregon Coast Range and Oregon Cascades West Physiographic Provinces as an area of concern (USDI, 1992h). Virtually all quarter-townships in this area of concern meet 50-11-40 standards by year 2030, a result similar to Bureau of Land Management Alternative D.

Quarter-townships anticipated to not meet 50-11-40 standards are highly concentrated in the southern portion of the province, an area east and north of Medford, Oregon. This condition remains virtually unchanged through year 2030. Between years 2030 and 2040, most of these quarter-townships are anticipated to meet 50-11-40 standards in this area.

The Oregon Cascades West Province contains approximately 33 percent (n = 414 of 1263) of all the Bureau of Land Management quarter-townships outside Old-Growth Emphasis Areas in Oregon within the range of the northern spotted owl (Figure 3-3). A decision to defer full compliance with 50-11-40 standards for 40 years after initiation of the plan in concentrated areas within this province represents a divergence from the results anticipated under the Interagency Scientific Committee's Strategy, and may pose localized dispersal obstacles to movement by spotted owls.

c. Oregon Cascades East Province: The Bureau of Land Management Preferred Alternative indicates a steady increase in quarter-townships meeting 50-11-40 standards from 63 to 100 percent over the next 50 years in this province (Figure 3-6). This is the only province in which the Bureau of Land Management expects to fully (100 percent, n = 27 quarter-townships) meet 50-11-40 standards (Table 3-7) in all quarter-townships in a 50-year time period. Approximately 2 percent (n = 27 of 1263) of Bureau of Land Management quarter-townships outside of Old-Growth Emphasis Areas in Oregon within the range of the northern spotted owl are located in this province. The 50-11-40 standards will be fully met under the Bureau of Land Management Preferred Alternative by year 2040. However, the province represents a relatively minor percentage of the landscape under consideration (Figure 3-3).

d. Klamath Mountains Province: The number of quarter-townships meeting 50-11-40 standards initially drops from 78 to 65 percent before increasing to 84 percent at year 2040 (Figure 3-7). The spatial distribution of quarter-townships not meeting 50-11-40 standards increases and is largely concentrated south of Roseburg, Oregon at year 2030. Conditions in this area improve by year 2040 but remain below current levels.

Figure 3-6 Percent of 1263 BLM Quarter-Townships Meeting 50-11-40 Standards Under BLM's Preferred Alternative - Oregon Cascade East Physiographic Province

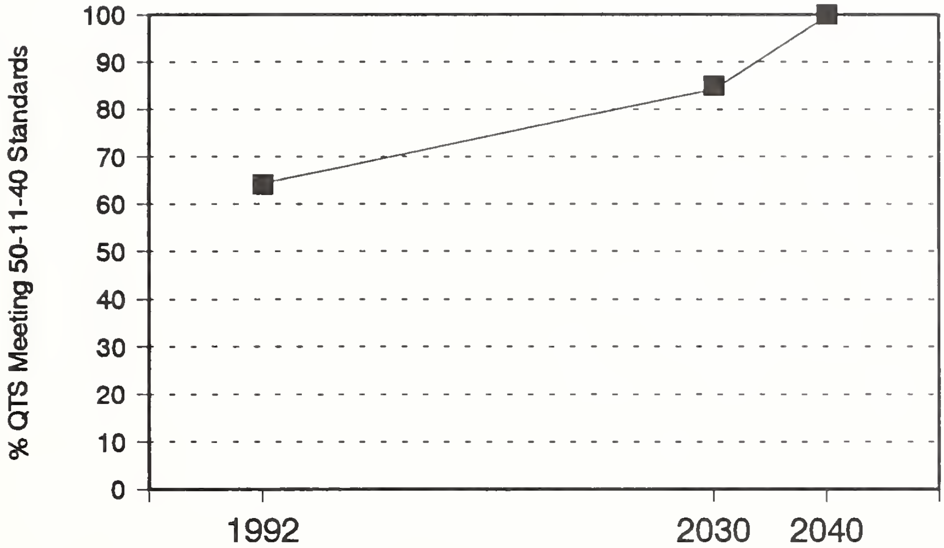
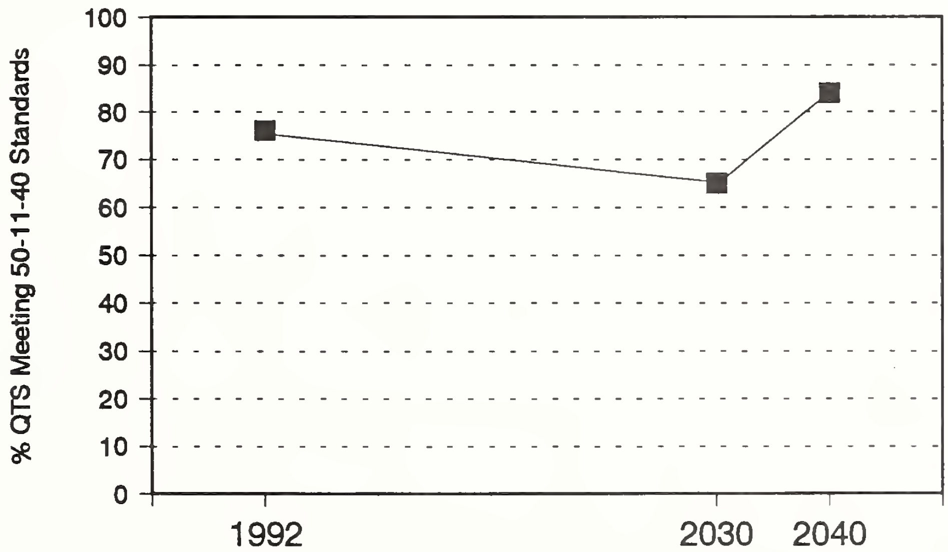


Figure 3-7 Percent of 1263 BLM Quarter-Townships Meeting 50-11-40 Standards Under BLM's Preferred Alternative - Klamath Mountain Physiographic Province (Oregon Portion)



In other portions of the Klamath Mountains Province, dispersal conditions, as reflected by analysis of quarter-townships, was anticipated to remain nearly constant until year 2030 when conditions improve in an area south and west of an Old-Growth Emphasis Area overlapping Habitat Conservation Area O-16. At year 2040, conditions for dispersal improve in an area between Old-Growth Emphasis Areas overlapping Habitat Conservation Areas O-16, O-26, O-24, O-20, O-21, and O-17. A band of Federally managed quarter-townships meeting 50-11-40 standards results between these Old-Growth Emphasis Areas. Dispersal habitat is important in this area because in a large area around Grants Pass and Medford, Oregon, there are no Old-Growth Emphasis Areas designated. Dispersal habitat in this area is likely a key in facilitating movement by owls between the Klamath Mountains and Oregon Cascades West Physiographic Provinces.

Bureau of Land Management quarter-townships in the Klamath Physiographic Province with potential to meet 50-11-40 standards represent 29 percent (n = 362 of 1263) of all quarter-townships on Bureau of Land Management administered lands in Oregon within the range of the northern spotted owl (Figure 3-3). A decision by the Bureau of Land Management to defer compliance with 50-11-40 standards for 40 years after implementation of the plan in concentrated areas within this province represents a significant divergence from the intent of the Interagency Scientific Committee's Strategy. These local areas may pose substantial dispersal obstacles to spotted owls (USDI 1992c).

Bureau of Land Management Alternative D incorporates the 50-11-40 rule across the landscape to respond to random dispersal of spotted owls as prescribed in the Interagency Scientific Committee's Strategy (Thomas et al. 1990). In contrast, in some areas, implementation of the Bureau of Land Management Preferred Alternative results in linear bands of quarter-townships meeting 50-11-40 standards.

Although some researchers support corridors of <u>continuous suitable habitat</u> (Thomas et al. 1990:303), Bureau of Land Management connectivity corridors occur in a fragmented ownership pattern, due to intermingling of other ownerships in a checkerboard pattern. This pattern will not likely result in the desired condition of bands of continuous suitable habitat. Even if the Bureau of Land Management meets 50-11-40 standards in all of its quarter-townships, the actual number of quarter-townships (all ownerships) meeting 50-11-40 standards across the landscape may range from less than 25 percent to 50 percent. Patches of habitat meeting 50-11-40 standards among Old-Growth Emphasis Areas may vary markedly in size and ability to provide connectivity. Ultimately, a reduction in quantity or quality of dispersal habitat for spotted owls may reduce probabilities of successful dispersal by owls. Reductions in successful dispersal by spotted owls are likely to result in higher death rates of dispersing owls and ultimately, reductions in population sizes, and an increasing inhibition to rescue effects (Thomas et al. 1990).

Criterion 5 - Spacing Between Areas Designated for Spotted Owl Management

Minor changes in acreages of Old-Growth Emphasis Areas in the Bureau of Land Management Preferred Alternative reduce distances between some of these habitat blocks which are assumed by the Scientific Analysis Team to be somewhat analogous to Category 1 Habitat Conservation Areas (capable of supporting 20 or more pairs of owls) and Category 2 Habitat Conservation Areas (capable of supporting 2 to 19 pairs of owls) in the Interagency Scientific Committee's Strategy (see Criterion 2). A nearest-neighbor analysis of Old-Growth Emphasis Areas and Habitat Conservation Areas on Federal lands indicated that differences in spacing between all

Habitat Conservation Areas in the Interagency Scientific Committee's Strategy and the Habitat Conservation Area/Old Growth Emphasis Area network occur only within the Oregon Coast Range Province. Here the average first nearest-neighbor distance decreased from 5.1 to 4.0 miles and the average second-nearest neighbor distance decreased from 9.3 to 8.1 miles. The third nearest-neighbor distance decreased from 15.7 to 14.6 miles in the province.

Overall, 10 percent (n = 5 of 50) of Old-Growth Emphasis Areas equivalent in size to Category 1 and 2 Habitat Conservation Areas in the State of Oregon would be closer together in the Bureau of Land Management Preferred Alternative than in Bureau of Land Management Alternative D. From this standpoint, the Bureau of Land Management Preferred Alternative is a slight improvement over Bureau of Land Management Alternative D so far as providing for successful dispersal of owls.

Criterion 6 - Patch Size of Habitat

Areas of contiguous habitat probably support a larger number of northern spotted owls than an equal amount of habitat distributed as small patches (USDA 1988, Anderson et al. 1990). Fragmentation of habitat blocks increases the ratio of edge habitat to interior habitat resulting in a smaller amount of interior habitat overall (Thomas et al. 1990:293). A primary objective in the design of Habitat Conservation Areas was to provide large blocks of nesting, roosting, and foraging habitat and offer areas which are expected to develop into superior owl habitat through time (Thomas et al. 1990:167). In this context, we equated patch size to Old Growth Emphasis Area size for a quantitative analysis.

The extent of density management of forest stands (i.e., selective cutting of trees) proposed in the Bureau of Land Management Preferred Alternative within Old-Growth Emphasis Areas varies by Bureau of Land Management district and by decade (Table 3-8). On a district-wide basis, the Medford District would cut trees within 8 percent (n = 16,700 of 207,600 acres) of Old-Growth Emphasis Areas during the first decade. In contrast, a greater proportion (32 percent, n = 50,168 acres) of Old-Growth Emphasis Areas would be subject to density management on the Roseburg District by the fifth decade. Total area of Old-Growth Emphasis Areas subjected to density management increases from 3 percent (24,417 acres) in the first decade to 20 percent (143,344 acres) of 719,500 acres comprised by Old-Growth Emphasis Areas over the next 50 years. The low percentage of acres scheduled for density management in the first decade is attributed to the age class distribution (an abundance of early- and late-aged stands) in Old-Growth Emphasis Areas (D. Dippon pers. comm.), i.e., the trees are not large enough to be commercially valuable.

Table 3-8 Acres of Density Control/Commercial Thinning in Old-Growth Emphasis Areas by Decade by District for Bureau of Land Management Preferred Alternative. (Numbers in Parentheses Represent Percentage of Total Area in Old-Growth Emphasis Areas by District.) Klamath Falls District has no Old-Growth Emphasis Areas.

District	10 Years	50 Years	Total area in OGEAs (Ac.)
Roseburg[1]	593 (<1%)	50,168 (32%)	155,200
Medford[2]	16,700 (8%)	33,400 (16%)	207,600
Eugene[2]	3,722 (3%)	28,832 (20%)	142,000
Salem [2]	2,799 (2%)	27,654 (21%)	134,200
Coos Bay[2]	603 (<1%)	3,290 (4%)	80,500
Total:	24,417 (3%)	143,344 (20%)	719,500

[1] J. Graham pers. comm.

[2] From Draft District Resource Management Plans.

Bureau of Land Management Draft Resource Management Plans assume stand management practices in Old-Growth Emphasis Areas will succeed in the development of characteristics of foraging habitat over the next 100 years. Consequently, patch size is expected to increase and fragmentation decrease over the long term. Draft Resource Management Plans do not discuss development of superior owl habitat as addressed by the Interagency Scientific Committee Conservation Strategy.

Available data on the extent of timber cutting (density management and regeneration cutting) within Old-Growth Emphasis Areas could not be directly translated into effects on Old-Growth Emphasis Area size. Optimistically, all proposed silvicultural treatments would produce desired results; all potential habitat would develop into suitable owl habitat, existing habitat would retain its suitability, and Old-Growth Emphasis Area size would not be adversely affected. Pessimistically, proposed silvicultural treatments would fail to produce desired results, potential habitat would not develop into suitable owl habitat, and existing habitat would loose its suitability, thus, reducing effective Old-Growth Emphasis Area size. The most likely event is that some proposed silvicultural treatments will succeed, others will fail. The likelihood of success or failure is unknown at this time, because the proposed silvicultural treatments have not been tested.

A comparison of overall patch size between Old-Growth Emphasis Areas and Habitat Conservation Areas (Table 3-9) indicates implementation of the Preferred Alternative Bureau of Land Management Draft Resource Management Plans would affect the Oregon Coast Range, Oregon West Cascades, and Klamath Mountains Physiographic Provinces. Mean Habitat Conservation Area size increases (range = 36 to 4,678 acres, n = 2) in two physiographic provinces, and decreases in the Oregon Cascades West Province approximately 980 acres. In theory, smaller Habitat Conservation Areas would reduce the probability of reaching the desired cluster size within each Habitat Conservation Area, and hence, the population goal for spotted owls within each province. On a range-wide basis, average Habitat Conservation Area size increases from 45,212 to 45,453 acres (Table 3-9). These changes are so minor (-0.005 percent) that we consider the difference to be inconsequential.

Although the above discussion suggests an optimistic outlook, the Scientific Analysis Team considers it probable that all such expectations for the development of suitable habitat will not be met (see Discussion Regarding Risk). If these expectations are not met, the effective size of Old-Growth Emphasis Areas will likely decrease over time.

Table 3-9 Comparison of Size (Acres) of Habitat Conservation Areas in Bureau of Land Management Alternative D to Deferred Old-Growth Emphasis Areas in the Preferred Alternative of Bureau of Land Management's Draft Resource Management Plans by Physiographic Province.

	BLM Alternative D		BLM Preferred Alternative	
Province	No. of HCAs	Mean HCA size (Ac.)	No. of OGEAs	Mean OGEA size (Ac.)
Oregon Coast Range	12	47,917	12	52,595
Oregon West Cascade	18	74,333	18	73,353
Oregon East Cascade	6	22,167	6	22,167
Klamath	43	44,279	43	44,315
CA Cascades/Modoc	12	21,283	12	21,283
No. CA Coast Range	31	7,435	31	7,435
WA Olympic Peninsula	1	676,000	1	676,000
WA West Cascade	22	67,727	22	67,727
WA East Cascade	13	39,000	13	39,000
Range-wide	158	7,143,462	158	7,181,498
Range-wide Mean HCA size:		45,212		45,453

The preceding analysis does not include six Old-Growth Emphasis Areas totaling 16,000 acres. These areas were excluded from our assessment because we assumed their size or configuration of habitat would preclude their functioning effectively as Category 1 or 2 Habitat Conservation Areas.

Criterion 7 - Clustering of Owl Pairs

The number of owl pairs within Old-Growth Emphasis Areas expected in the future was not available from the Bureau of Land Management (D. Dippon pers. comm.). Consequently, we were unable to complete an analysis of clusters of owl pairs. Based on the Bureau of Land Management's timber harvest data and projections of vegetative response to timber cutting designed to develop characteristics of owl habitat, results from the McKelvey model predicted that the ability of the landscape to support owl pairs under the Bureau of Land Management Preferred Alternative will be very similar to that of the Interagency Scientific Committee's Strategy (B. Noon pers. comm.). If the Bureau of Land Management's assumption about rate of habitat development in Old-Growth Emphasis Areas is correct, there would be no appreciable differences between Bureau of Land Management Alternative D and the Bureau of Land Management Preferred Alternative.

Some of the above information suggests that the Bureau of Land Management has taken an optimistic outlook, however we do not believe that all untested hypotheses about the development of suitable habitat for spotted owls through silvicultural treatments will be met (see Discussion Regarding Risk).

Table 3-10 summarizes short-term (10-50 years) and long-term (100 years) expectations for spotted owl habitat and trends for the Bureau of Land Management Preferred Alternative as compared to Bureau of Land Management Alternative D.

Table 3-10 Summary of Comparisons of Bureau of Land Management Preferred Alternative to Bureau of Land Management Alternative D of Bureau of Land Management's Draft Resource Management Plans Over the Short and Long Term, Assuming Implementation of the Preferred Alternative.

Short term	Long term
8% (71,000 acres) reduction in suitable spotted owl habitat in 50 years.	4% (46,000 acres) increase in suitable spotted owl habitat.
4% (12,100 acres) reduction in old growth in 10 years.	6% (31,000 acres) reduction in old growth.
A 1-6%[1] (1 to 10 pairs) increased capability of habitat to support pairs of spotted owls.	A 22-26%[1] (56 to 119 pairs) increased capability of habitat to support pairs of spotted owls.
Approximately 385 fewer (30% of 1,263) quarter-townships meeting the 50-11-40 standards after 30-40 years.	Estimated to be nearly equal to BLM Alternative D (approximately 90% of 1263 quarter-townships) in meeting 50-11-40 standards.
No quantitative data were provided, but BLM expects patch size to increase in OGEAs at least equivalent to increases associated with BLM Alternative D.	Same as short term.
No comparative data for clusters of spotted owl pairs were provided but based on estimated capability to support pairs the SAT assumed that BLM expects clustering in OGEAs to be equal to or better than BLM Alternative D.	Same as short term.
Standards for distribution of habitat and spacing are nearly identical.	Same as short term.

[1]Range of values is based on differing modeling assumptions about the quantity of suitable habitat present within a 2,500 acre home range sized polygon in the McKelvey model. The minimum and maximum values are based on an assumption that 60 percent and 40 percent, respectively, of the home range-sized polygon consists of suitable spotted owl habitat.

DISCUSSION REGARDING RISK

Assessment of Bureau of Land Management Alternative D and the Bureau of Land Management Preferred Alternative allowed quantitative comparisons where data existed. For many aspects of resource management planning, quantitative data were not generated or compiled. In such instances, assumptions regarding the expected consequences of particular actions or elements must be made to facilitate projection of the likelihood of success or failure of the plans.

Assumptions, however, introduce increased uncertainty into any assessment of a resource management strategy. The greater the number of assumptions made, the greater the uncertainty of attaining projected results. The Interagency Scientific Committee recognized that the plan that would entail the greatest probability of success, and hence embody the lowest degree of uncertainty, would be a strategy that protected all existing spotted owl habitat and made provisions to protect additional acres of young forest to develop into suitable habitat at the soonest possible time (Thomas et al. 1990:11, USDA 1991:9). Such an approach tends to minimize the role of assumptions regarding effects of additional human activities on suitable spotted owl habitat and expected reactions of owl populations. The Interagency Scientific Committee did not choose such an optimal approach. Instead, that group developed a strategy that increased risk to a level they considered acceptable. It must be noted that because of the associated risk and inherent assumptions and uncertainties, the Interagency Scientific Committee's Strategy was developed to be treated as a working hypothesis, to be validated and amended as indicated by research and monitoring and as experience accumulated.

Factors Associated With Increased Risk

The Bureau of Land Management Preferred Alternative differs from the Bureau of Land Management Alternative D, and therefore the Interagency Scientific Committee's Strategy, in three major ways. First, the Bureau of Land Management Preferred Alternative prescribes timber management actions which delay, for 40-50 years, the development of forest stand conditions that meet the dispersal standards set forth in the Interagency Scientific Committee's Strategy. Second, the Bureau of Land Management Preferred Alternative allows logging in the Old-Growth Emphasis Areas, which the assumed to be somewhat analogous in function to the Habitat Conservation Areas in providing owl habitat. Third, these plans do not afford protection for home range size areas for all known or future pairs of owls in the Oregon Coast Range area of special concern identified by Thomas et al. (1990). In our opinion, these variations from the Interagency Scientific Committee's Strategy introduce considerable additional risk as to the viability of spotted owls on Bureau of Land Management administered lands in Oregon.

The Scientific Analysis Team believes the Bureau of Land Management Preferred Alternative, specifically with Bureau of Land Management's intentions to selectively cut forest stands to create conditions favorable for spotted owls, represents increased risks to the viability of the spotted owl. In addition, the Scientific Analysis Team recognizes at least five factors which have been identified and may introduce uncertainty into applied habitat management strategies. There are likely others. A discussion of each factor and the elements of the Bureau of Land Management Preferred Alternatives related to the factor follows:

1. Description of Desired Future Conditions.

The Bureau of Land Management Preferred Alternative identified in the Draft Resource Management Plans calls for selective cutting of trees as a means to accelerate the development of old-growth characteristics and, therefore, create future conditions suitable for spotted owls. Current working definitions of spotted owl habitat at the stand level are general in scope and vary considerably among physiographic provinces. Thomas et al. (1990:146) identified nine variations of general definitions of stand conditions relative to spotted owl studies. These variations reflect geographic differences in habitat and a general lack of specific owl use data correlated to quantitative descriptions of the habitat used. Terms used to describe quality of habitat are equally varied. Examples of such terms for spotted owl habitat include "suitable habitat;" "nesting, roosting, and foraging habitat;" "optimal habitat;" "superior habitat;" "dispersal habitat;" "roosting and foraging habitat;" "foraging habitat;" and "marginal habitat." These terms reflect a recognition on the part of biologists that spotted owl habitat exists within a continuum with respect to its ability to provide for all the life needs of the spotted owl. The variability and generality combined with the lack of consistency in application of the definitions serve to illustrate the uncertainties associated with describing desired future conditions of habitat.

Although the term "suitable spotted owl habitat" is frequently used in the Draft Resource Management Plans it is not defined there. Instead, some plans define "optimal" spotted owl habitat (USDI 1992b:3-46) or discuss "nesting, roosting, and foraging habitat" (USDI 1992e:3-67). Both a definition and the amount of suitable spotted owl habitat are basic data necessary for the development of projected mean annual occupancy estimates of the McKelvey model (USDI 1992b:Appendix 4-107) and provide a gauge for assessing how well the Bureau of Land Management Preferred Alternatives provide for spotted owls, especially in the future. McKelvey (1992 in USDI 1992b; Appendix 4-107) defines suitable habitat for an organism as habitat in which the combination of birth and death rates allows for a stable or increasing population.

Whether site-specific variability of habitat required to meet McKelvey's definition were accounted for is unknown to the Scientific Analysis Team. To provide spatially explicit suitable spotted owl data required by the McKelvey model, Bureau of Land Management must have developed specific definitions. Otherwise the data used in the analysis must have been generic. The Draft Resource Management Plans do not, for the most part, acknowledge differences between the quality of habitat that might result from various silvicultural treatments or how the differences might affect assumptions about expected spotted owl population responses. Instead, it appears that Bureau of Land Management viewed all types of suitable spotted owl habitat equally in terms of their capability to provide for the balance between birth and death rates. Once forest stands were considered to have attained characteristics which would support spotted owls at any level they were apparently included in the category "suitable habitat" and used in the model. The model then viewed such stands as equivalent to older-aged stands. The model considers only the amounts and arrangement of habitat on the landscape and does not account for varying quality. The Scientific Analysis Team considers this approach particularly risky when assessing forest stands which develop in response to timber harvest. In the opinion of Scientific Analysis Team, assessments that do not account for the differential quality of habitats fail to fully assess the risks associated with habitat manipulation.

We conclude that, given current knowledge and without site-specific definitions of spotted owl habitat that account for variation (i.e., geographic, elevational, site productivity, climatic, vegetative community, and prey species), it is not likely that accurate descriptions of desired future conditions for suitable spotted owl habitat can be offered. Considerable additional research is likely required before this can be accomplished.

Although our assignment was to assess the implications of the Bureau of Land Management Preferred Alternative to the northern spotted owl only, we note here that the above discussions are even more applicable as they pertain to describing desired future conditions of habitat for the hundreds of other species associated with old growth. (See Chapter 5.)

2. Availability of Existing Mechanisms to Attain Desired Future Conditions.

Manipulation of spotted owl habitat through logging involves use of silvicultural prescriptions. Silvicultural prescriptions are developed to attain desired future conditions in forest stands by establishing methods and standards for harvesting these stands. Most existing silvicultural techniques and prescriptions have been developed with an objective of maximizing growth of commercial tree species and, therefore, wood production. Lacking experience with selective cutting designed to create spotted owl habitat, such practices must be considered as untested hypotheses requiring testing to determine their likelihood of success. Without empirical data to demonstrate expected chances of success, assumptions of probabilities of success must be made to predict amounts, quality, and arrangements of spotted owl habitat.

It appears that Bureau of Land Management analysts made some assumptions as to the probability of success of silvicultural systems and stand treatments used in developing spotted owl habitat. The Draft Resource Management Plan for Roseburg District (USDI 1992b:2-41) describes some attributes of this uncertainty in a discussion of timber management proposed in the Bureau of Land Management Preferred Alternative as follows:

> "Since this alternative includes some elements recognized to be substantially untested, modeling its sustainable timber yield is more difficult than with the alternatives that rely wholly on traditional forest management techniques. The level of confidence in the preceding numbers is therefore lower than the numbers for alternative A, B, D, and E".

The numbers referred to in the quote above were the numbers given for allowable sale quantity and expected acreages treated by various silvicultural techniques. Values for allowable sale quantity are closely associated with expected vegetative responses following forest management. Data used to derive expected timber yields are likely the same considered for projecting future habitat conditions for spotted owls.

Specific elements of the Bureau of Land Management Preferred Alternative in the Draft Resource Management Plans are associated with uncertainties regarding existing silvicultural systems and treatments expected to develop or maintain spotted owl habitat. Suitable spotted owl habitat, notwithstanding the lack of definition, is expected by Bureau of Land Management analysts to develop faster in some stands within Old-Growth Emphasis Areas scheduled for silvicultural treatment. Although the analysts did not factor such accelerated development into projected amounts of suitable habitat, it was offered as a reason for treating stands. In particular, density management is offered as a means of promoting stand diversification, developing old-growth like characteristics, and producing timber (USDI 1992b:2-41). Given the uncertainty of achieving such expectations, it is likely that some silvicultural treatments, which have been characterized as largely experimental, may well have an opposite effect from that expected. Consequently, such treatments may hinder the development of suitable habitat or they may only partially succeed, resulting in development of marginal habitat that may not fully provide for the needs of spotted owls. Results which fall short of the expected conditions could occur because of delay or failure to regenerate stands that have been cut, increased levels of windthrow of remaining trees, mechanical damage during logging to trees remaining in the logging unit, the spread of root rot and other diseases. Increased risk of wildfires associated with logging operations that increase fuels and usually employ broadcast burning to reduce the fuels also increase the risk of not attaining expected results. Such events may spread to areas adjacent to stands that are logged, thereby affecting even more acreage than those acres directly treated.

The Bureau of Land Management Preferred Alternative calls for regeneration patch cutting in the non-deferred Old-Growth Emphasis Areas and, after 80 years, in deferred Old-Growth Emphasis Areas. In non-deferred Old-Growth Emphasis Areas, such patch cuts are expected to accelerate development of suitable habitat for spotted owls, whereas patch cuts in deferred Old-Growth Emphasis Areas are not expected to alter the habitat suitability of the stands for spotted owls. Likewise, regeneration patch cuts are not expected to change the character of old-growth stands. There is a decided lack of empirical data to demonstrate effects of these types of treatments. The discussions above for density management, are equally applicable here. It seems to the Scientific Analysis Team that the Bureau of Land Management did not fully evaluate the effects of such regeneration cuts on habitat and subsequent use by spotted owls.

Data describing habitat components (e.g., numbers of snags and down logs–coarse woody debris) across a range of vegetative conditions are poorly developed or non-existent in the descriptions of the Bureau of Land Management Preferred Alternative. These components are believed to be required to provide structure for future spotted owl habitat in forest stands that develop following logging activities. The Bureau of Land Management Preferred Alternative calls for snags to be left "where feasible" and 4 logs, 20 inches in diameter and 50 feet long per acre, "where available". These standards are not site specific and are not rigorous enough to ascertain how often they will be met. In areas where it is not "feasible" to leave snags, or logs for retention are not "available", we expect that a greater amount of time would be required to return the forest stand to spotted owl habitat.

Uncertainties associated with the probabilities of successful manipulation of forest stands to maintain or create suitable spotted owl habitat combine to create additional risk. As a result, the amounts or quality of suitable habitat expected in the Bureau of Land Management Preferred Alternative are, in the opinion of the Scientific Analysis Team, not likely to be realized.

3. Implementation of Prescribed Activities.

Whenever a natural resource management activity is proposed by a Federal land managing agency it is developed through a planning process. Planning produces a description of desired future conditions or objectives and methods to be followed to attain those conditions. Silviculturally treating forest stands to create or maintain spotted owl habitat entails describing habitat characteristics and identifying one or more combinations of silvicultural treatments designed to attain the desired future condition for habitat. The planning process culminates in a final plan for a project which, for timber sales, involves legal contracts obligating the purchaser and the seller to specific provisions. The project is then implemented according to the provisions of the plan as incorporated into a contract. Our experience is that commonly not all provisions of the plan are thoroughly incorporated into such contracts, nor are all contract provisions thoroughly administered to ensure compliance. This situation further increases the probability that objectives for attaining desired future conditions for habitat will be met. The Bureau of Land Management Preferred Alternative does not describe whether such risk was considered in projections of suitable habitat.

4. Ascertaining Success or Failure.

Silvicultural treatments of forest stands designed to accelerate development of old-growth characteristics or to maintain suitable habitat for spotted owls will require aggressive monitoring to determine whether such treatments are successful. The Bureau of Land Management plans to monitor implementation of their Resource Management Plans (J. Lint pers. comm.). The monitoring plan is being developed and will be completed pending finalization of the Draft Resource Management Plans. No such plan has been completed to date. Therefore, the Scientific Analysis Team could not evaluate the likely effectiveness of such a monitoring plan. Such plans are integral parts of the ecosystem and adaptive management processes.

There are probabilities of success associated with any monitoring plan as to how well it will provide relevant and accurate data to demonstrate success or failure of a given plan. There are also probabilities associated with how well monitoring will identify "trigger points" that indicate a management plan may need modification. The more complex the plan (i.e., the more variables there are to monitor) the less likely the monitoring plan will successfully detect problems. Manipulation of forest stands to accelerate development of spotted owl habitat on a landscape scale, as prescribed in the Bureau of Land Management Preferred Alternative, is an extremely complex issue involving a myriad of variables over a very long timeframe. Development of a monitoring plan intensive enough to isolate the causes of observed variations for wide-scale implementation of the Bureau of Land Management Preferred Alternative seems unlikely to us.

The probability of carrying out a successful monitoring plan is totally affected by the availability of adequate and consistent funding. Our experience suggests that monitoring programs have been inadequate and will continue to be so until agencies fully evaluate the required effort and expense necessary to complete monitoring, and Congress provides a commitment through the budget process. If the status of monitoring does not improve dramatically over the current situation, it is misleading to minimize the risk of a course of action with promises of adequate monitoring to detect whether assumptions are indeed true. In other words, inadequate monitoring will increase, perhaps dramatically, the risk of failure of a plan that relies heavily on adaptive management.

5. Adaptive Management.

The term adaptive management has been used in the context of resource management to identify a strategy which essentially acknowledges the need to make decisions without perfect knowledge and provides a means to compensate for that lack of knowledge. Adaptive management entails monitoring the results of resource management and, where required (based on the monitoring feedback), modification of plans. Adaptive management is a means to reduce the risk of erroneous assumptions or decisions. A basic requirement for a viable adaptive management strategy is the existence of resources necessary to make the required adjustments. Adaptive management can only be expected to reduce risk if options to adjust management to fit new circumstances are not eliminated. Adaptive management, therefore, can be considered a means to reduce risk associated with a Resource Management Plan commensurate with the options for adjustment which remain during the time the plan is in effect.

Revisiting the Interagency Scientific Committee's Strategy

Consideration of the uncertainties and risk associated with the above discussed factors pertaining to the manipulation of spotted owl habitat, or younger stands expected to develop into spotted owl habitat, compelled the Interagency Scientific Committee to incorporate provisions into their strategy which did not allow timber harvest in Habitat Conservation Areas. Thomas et al. (1990:167) discuss the objectives for spotted owl habitat in Habitat Conservation Areas.

> "Given the current distribution of old forests, we see no alternative in the short-term but to protect significant amounts of the remaining superior habitat for northern spotted owls through the creation of Habitat Conservation Areas. Under the conservation strategy proposed here, most logging activities within Habitat Conservation Areas would cease. The ultimate management goal within Habitat Conservation Areas, therefore, is to recreate a relatively unfragmented, natural landscape. This strategy will ultimately maximize the amount of superior habitat and minimize the amount of marginal and unsuitable habitat... Until we can demonstrate that silvicultural treatments can benefit spotted owls, natural succession will be the primary means to achieve an unfragmented landscape within Habitat Conservation Areas."

In answers to questions from the United States Senate Subcommittee on Energy and Natural Resources (USDA 1991:53) members of the Interagency Scientific Committee provided additional background regarding the intent for habitat in Habitat Conservation Areas.

> "The intent of the Habitat Conservation Areas is to provide a network of large blocks of habitat for northern spotted owls until *reasonable certainty exists* (emphasis added) that forest practices are available for producing and maintaining equally good habitat. Such management can then be applied in Habitat Conservation Areas. *Proven technology to achieve that end does not currently exist* (emphasis added). Because extant populations will be greatly reduced (perhaps by 50 percent or more) by cutting, we believe that ensuring that the quality of the habitat retained within must be as high as possible... so the team recommended that existing old forests in Habitat Conservation Area should be left unmanaged, and that some previously harvested stands be allowed to develop in an unmanaged condition."

The Interagency Scientific Committee was primarily addressing logging and silvicultural practices (particularly the selective cutting of trees) when using the term "unmanaged." Prescribed fire was viewed by the Interagency Scientific Committee as a possible means to reduce wildfire frequency and magnitude. For that reason, the Interagency Scientific Committee called for the development of fire management plans for each Habitat Conservation Area.

The combined risks associated with treatment of spotted owl habitat or stands expected to develop into suitable habitat for spotted owls, as discussed above, will likely result in situations where either habitat development is inhibited or only marginal habitat for spotted owls is developed. The exact frequency of these partial successes or failures is unknown. Given the likely cumulative relationship among the risks for each factor, it appears to us that the overall risk of not meeting habitat objectives is high. (See Appendix 4-C for further discussion.)

In view of this anticipated high risk of Bureau of Land Management's proposed silvicultural treatment producing habitat conditions for spotted owls that are less than superior, an Interagency Scientific Committee response to a question from Congress about the desirability of low intensity management of habitat is especially pertinent. Members of the Interagency Scientific Committee indicated that, because a plan (the Interagency Scientific Committee's Strategy) was put forth which proposes to reduce the population of a threatened species by as much as 50 percent, providing the survivors with only marginal habitat would be extremely risky and certainly in their minds not "scientifically credible" (USDA 1991:45).

The Interagency Scientific Committee recognized the need for research designed to provide data regarding the applicability of silvicultural treatments for creating or maintaining superior spotted owl habitat. The Interagency Scientific Committee's Strategy called for this research to be conducted outside the Habitat Conservation Area . This approach allows for the questions to be addressed while risk in the keystone elements of the Interagency Scientific Committee's Strategy, the Habitat Conservation Areas, is reduced to acceptable levels.

SUMMARY AND CONCLUSIONS

The transition period (1-50 years) between implementation of the Interagency Scientific Committee's Strategy and achievement of an equilibrium of habitat and spotted owls is a critical consideration. After examination of the data available in the draft resource management plans for comparing Bureau of Land Management's Alternative D and the Bureau of Land Management preferred alternative of the draft resource management plans and weighing the elements of risk discussed above, the Scientific Analysis Team concluded that the Bureau of Land Management preferred alternative introduces significant additional risk to the viability of spotted owls compared to Bureau of Land Management Alternative D (Interagency Scientific Committee's Strategy). Increased risk to viability can be attributed to three basic elements of the Bureau of Land Management Preferred Alternative: (1) provisions allowing a delay of 40-50 years before meeting the dispersal standards put forth in the Interagency Scientific Committee's Strategy (the 50-11-40 rule) which occurs in a sensitive area at a landscape level and because of its checkerboard ownership; (2) plans to conduct density management (commercial thinning) in younger and still developing stands in Old-Growth Emphasis Areas and patch cuts in the non-deferred Old-Growth Emphasis Areas that overlap Habitat Conservation Areas; and (3) lack of provisions to protect home-range size areas for all currently known and future pairs of spotted owls in the Oregon Coast Range area of special concern. Given the existing risks that face owl populations and the sensitivity of the transition period, the short-term effect of these actions on habitat loss may be much more significant than the long-term predicted habitat gains.

We further conclude that, although research and monitoring studies are presently being initiated, no significant new data exist which suggest that the degree of certainty that is expressed in the Bureau of Land Management Draft Resource Management Plans for developing owl habitat silvicultural treatments is justified. Therefore, it is our opinion that the course prescribed in the Interagency Scientific Committee's Strategy, pertaining to timber harvest in Habitat

Conservation Areas, remains the most likely course to result in superior habitat conditions within reserves (i.e., Old-Growth Emphasis Areas). The approach prescribed by the Interagency Scientific Committee's Strategy preserves options for adjustments in the course of management under a philosophy of adaptive management.

Our conclusions indicate that the viability ratings for spotted owls in the Final Environmental Impact Statement alternatives will be adversely affected if the Bureau of Land Management implements Preferred Alternatives of their Draft Resource Management Plans. Therefore, reassessments of the viability ratings were deemed warranted and such assessments are described below.

REASSESSMENT OF VIABILITY RATINGS FOR EACH OF THE FINAL ENVIRONMENTAL IMPACT STATEMENT ALTERNATIVES

Contributions from lands administered by the Bureau of Land Management to northern spotted owl habitat affect the chances of success of each of the five alternatives in the Final Environmental Impact Statement. Discussion of each alternative and how the viability assessments associated with each scenario are affected are described below. For this reassessment the Scientific Analysis Team used a five-scale rating system instead of the three used in the Final Environmental Impact Statement. See Chapter 2 for a discussion of the rating system.

Assessments of viability ratings are presented for each Final Environmental Impact Statement alternative rather than each evaluation criteria in a manner identical to analysis completed for the Final Environmental Impact Statement. Interrelationships among all criteria were considered collectively when addressing populations.

Final Environmental Impact Statement Alternative A

Final Environmental Impact Statement Alternative A provides spotted owl habitat by using a network of habitat areas where nesting, roosting, and foraging habitat capable of supporting single pairs of spotted owls would be protected from logging. No provisions are made for dispersal habitat. This strategy was evaluated by the Interagency Scientific Committee and described as having a high risk of spotted owls being extirpated from significant portions of their range. The viability assessment therefore rated Final Environmental Impact Statement Alternative A as having a "low" likelihood of population viability.

Implementation of the Bureau of Land Management Preferred Alternative, rather than an alternative that employs single pair habitat areas, would slightly improve conditions for spotted owls in a range-wide context but would have no effect upon the overall viability rating assigned in the Final Environmental Impact Statement. No change on the "low" rating for overall viability is indicated (Table 3-11).

Final Environmental Impact Statement Alternative B

Final Environmental Impact Statement Alternative B is the Interagency Scientific Committee Conservation Strategy for application to National Forests within the range of the northern spotted owl. Since the Interagency Scientific Committee's Strategy was developed to include National Parks, National Forests, and Bureau of Land Management administered lands, deviations by any of those agencies from its standards and guidelines affect probabilities for a successful conservation strategy.

The Bureau of Land Management Preferred Alternative represents a considerable deviation from some of the criteria set forth in the Interagency Scientific Committee's Strategy (i.e., compliance with the 50-11-40 rule, exclusion of timber harvest within Habitat Conservation Areas, and protection of home range-size areas for all pairs in the Oregon Coast Range area of special concern). These deviations introduce additional risk beyond that inherent in the Interagency Scientific Committee's Strategy. In our opinion, the Bureau of Land Management's Draft Resource Management Plans do not adequately discuss or account for these increased uncertainties. Discussions in the sections of this report titled "Discussion Regarding Risk" and "Conclusions" are applicable here.

Cumulatively, the effects of implementing the Bureau of Land Management Preferred Alternative would lower the overall viability rating reported in the Final Environmental Impact Statement for Alternative B from "high" to "medium" (Table 3-11).

Final Environmental Impact Statement Alternative C

Final Environmental Impact Statement Alternative C is comprised of the standards and guidelines of the Interagency Scientific Committee's Strategy plus Critical Habitat designated by the USDI Fish and Wildlife Service under provisions of the Endangered Species Act. Final Environmental Impact Statement Alternative C was rated as having a "high" likelihood of providing for viable populations in the original viability assessment reported in the Final Environmental Impact Statement.

Managing the additional large blocks of habitat in designated Critical Habitat Units under the same standards and guidelines as Habitat Conservation Areas has several beneficial effects that tend to alleviate the negative effects of the Bureau of Land Management Preferred Alternative in Draft Resource Management Plans. These beneficial effects include:

1. Reducing loss of habitat by protecting more area. Approximately 800,000 more acres will be protected on National Forests in the Oregon Coast Range, Oregon Cascades West and Oregon portion of the Klamath Mountains Physiographic Provinces under Final Environmental Impact Statement Alternative C than Final Environmental Impact Statement Alternative B.

2. Numbers of pairs expected in the future on National Forests are increased by 18 percent compared to Final Environmental Impact Statement Alternative B.

3. Increasing patch sizes designated for protection and, hence, the number of clusters of more than 20 owl pairs are increased from 34 such clusters in Final Environmental Impact Statement Alternative B to 40 such clusters in Final Environmental Impact Statement Alternative C.

4. Reducing distances between Habitat Conservation Areas can be anticipated to facilitate movement of owls. This is particularly true in the Oregon Coast Range Province where first nearest neighbor distances decrease by 82 percent and second neighbor distances decrease by 65 percent. There are decreases in the Oregon Cascades West Province of 49 percent and 37 percent, respectively. Spacing in the Klamath Mountains province remains essentially unchanged, compared to Final Environmental Impact Statement Alternative B.

5. Increasing the distribution of spotted owl habitat to be protected in designated areas. The CHUs will create greater redundancy in the network, an important hedge against catastrophic loss of habitat which could cause loss of connectivity among components of the network.

Based on the above information, the Scientific Analysis Team believes the overall viability rating in the Final Environmental Impact Statement for Alternative C would remain "high" if the Bureau of Land Management implements their Preferred Alternative (Table 3-11). We do however, continue to be concerned about the increased risk of isolation of the Oregon Coast Range Province population of spotted owls resulting from Bureau of Land Management Preferred Alternative.

Final Environmental Impact Statement Alternative D

Final Environmental Impact Statement Alternative D entails applying the standards and guidelines of the Interagency Scientific Committee's Strategy plus to all remaining suitable habitat for northern spotted owls. This alternative provides some of the benefits ascribed to Alternative C above by adding significantly to the amount of spotted owl habitat protected. There are however, no provisions to allow young forests, outside Habitat Conservation Areas that are currently not suitable habitat, to develop into such habitat. It is probable that, because of the perpetuation of fragmentation in the added habitat, much will be degraded in the future. We therefore believe Alternative D has equivalent risk to viability compared to Alternative C. We determined that, if the Bureau of Land Management implements their preferred alternative, the rating would remain "high" for Final Environmental Impact Statement Alternative D (Table 3-11).

Final Environmental Impact Statement Alternative E

Final Environmental Impact Statement Alternative E, titled the "Multi-resource Strategy", incorporates certain elements of the Interagency Scientific Committee's Strategy. However, it decreases the size and number of Habitat Conservation Areas, thereby increasing distances between them. It further reduces the land base subject to the 50-11-40 rule. This alternative was rated in the Final Environmental Impact Statement as having a "low" likelihood of providing for population viability. The likelihood of maintaining viability for spotted owls would be somewhat improved if the Bureau of Land Management implemented their preferred alternative, rather than a strategy comparable to Alternative E, but not enough to raise the rating from "low" for Final Environmental Impact Statement Alternative E (Table 3-11).

Table 3-11 Viability Ratings of the Final Environmental Impact Statement Alternatives Based on Assumptions of the Final Environmental Impact Statement Compared to Ratings if Bureau of Land Management Alternative D or Bureau of Land Management Preferred Alternative (PA) of Bureau of Land Management's Draft Resource Management Plans are Implemented.

FEIS Alternative	FEIS Viability Rating	Revised Viability Rating If BLM Alternative D is Implemented	Revised Viability Rating if BLM PA is Implemented
A	LOW	LOW	LOW
B	HIGH	HIGH	MEDIUM
C	HIGH	HIGH	HIGH
D	HIGH	HIGH	HIGH
E	LOW	LOW	LOW

RECOMMENDED MITIGATION OPTIONS

Recommendations are offered as a means of offsetting the negative effects of the Bureau of Land Management implementing their Preferred Alternative of Draft Resource Management Plans on Final Environmental Impact Statement Alternative B. No recommendations for mitigation measures for Final Environmental Impact Statement Alternatives A or E are offered. Mitigation measures required to attain "high" viability ratings would cause these alternatives to lose their identities.

Table 3-12 lists brief summaries of the effects of the Bureau of Land Management Preferred Alternative and mitigation options. The options are discussed in greater detail following the table. Site-specific mitigation recommendations are delineated on the map in Appendix 3-A.

Table 3-12 Effects of Implementing the Bureau of Land Management Preferred Alternative of Western Oregon Bureau of Land Management District Draft Resource Management Plans on Final Environmental Impact Statement Alternative B, the Selected Alternative of the Final Environmental Impact Statement and Recommended Mitigations.

Effects	Recommended Mitigation
Increased risk of reducing nesting, roosting, and foraging habitat in designated areas (i.e., HCAs/OGEAs).	Increase numbers and/or sizes of HCAs throughout National Forests in Oregon.
Increased risk of reducing distribution of nesting, roosting, and foraging habitat.	Mitigate by increasing numbers or sizes of HCAS on National Forests in Oregon.
Increased risk of reducing the habitat capability to support pairs of spotted owls in the long term.	Increase numbers or sizes of HCAs on National Forests in Oregon.
Reductions in well-distributed dispersal habitat for 40-50 years.	Reduce distances between HCAs by increasing numbers or sizes of HCAs on National Forests in Oregon.
Higher risk of increasing distances between designated areas (i.e., HCAs/OGEAs).	Increase numbers or sizes of HCAs on National Forests in Oregon.
Increased risk of decreasing effective size of habitat patches protected in the long-term.	Increase sizes of HCAs on National Forests in Oregon.
Increased risk of decreasing numbers and sizes of clusters of pairs of spotted owls (multiple pairs).	Increase numbers and sizes of HCAs on National Forests in Oregon.
Increased risk of isolation of the Oregon Coast Range Physiographic Province subpopulation of spotted owls.	Partially mitigated by increasing protection of habitat to allow for increased numbers of spotted owls in the future to reduce risks of local extirpation.

Options for the Forest Service to mitigate the effects of the Bureau of Land Management implementing their Preferred Alternative of Draft Resource Management Plans are limited to increasing the intensity of spotted owl habitat management on National Forests. Increases in the number and size of Habitat Conservation Areas in National Forests would compensate to some degree for increased risk of losing habitat, and concomitant pairs of spotted owls, in Bureau of Land Management Old-Growth Emphasis Areas. Adjustments to numbers and sizes of Habitat Conservation Areas on National Forests alleviates additional risk of increased spacing between habitat reserves, loss of habitat, decrease in patch size, decreases in cluster size, and reduced future expected populations associated with the Bureau of Land Management Preferred Alternative as compared to Final Environmental Impact Statement Alternative B.

Decline in the quality and amount of well-distributed dispersal habitat on Bureau of Land Management administered lands between the Oregon Coast Range and the other physiographic provinces in Oregon can be only partially compensated for on National Forests. Increased number and size of Habitat Conservation Areas would improve probabilities of dispersal attempts, and perhaps success, between and among Habitat Conservation Areas. However, probabilities of successful movements of owls among and between the Oregon Coast Range, the Klamath Mountains, and Oregon Cascades West Physiographic Provinces will still be reduced by some significant but unquantifiable amount.

Bureau of Land Management administered lands, presently and potentially, provide integral links between the Klamath, Oregon Coast Range, and Oregon Cascades West Physiographic Provinces. Loss of attributes of the Interagency Scientific Committee's Strategy, specifically numbers and sizes of Habitat Conservation Areas and dispersal habitat on lands in Oregon administered by the Bureau of Land Management which bridged gaps between National Forests in the physiographic provinces of Oregon, was judged to increase the risk of isolating spotted owl populations in physiographic provinces. The Oregon Coast Range Physiographic Province is the most likely province population to be at risk of such isolation. Our recommended mitigation measures focus on increasing the size of Habitat Conservation Areas on the Siuslaw National Forest to increase the future population of spotted owls. We would expect a resulting increase in successful dispersal attempts of owls among physiographic provinces.

To further compensate for increased risks of isolation, and to hedge against risks of reductions in amount of habitat and numbers of pairs of spotted owls, we recommend the designation of additional Habitat Conservation Areas at locations near the critical links between physiographic provinces (Appendix 3-B). These critical links include the northern portion of Klamath Mountain Physiographic Province; the west and southwest portion of the Oregon Cascades West Physiographic Province and the Oregon Coast Range Physiographic Province.

Our recommended mitigation measures compensate for anticipated levels of risk associated with the Bureau of Land Management Preferred Alternative in Draft Resource Management Plans sufficiently to attain an overall viability rating of "high" for Final Environmental Impact Statement Alternative B. It is important to recognize that our proposed mitigation measures <u>have</u> <u>not</u> accounted for the Bureau of Land Management's proposed regeneration cutting within deferred Old-Growth Emphasis Areas. Although we are concerned about the possible effects on habitat and owls resulting from such regeneration cutting, our recommendations are based on the assumption that the Bureau of Land Management <u>will</u> <u>not</u> implement regeneration harvesting within deferred Old-Growth Emphasis Areas for 80 years, or until reliable data are available to demonstrate such practices can maintain or develop conditions of habitat suitable for northern spotted owls. Therefore, we do not believe that mitigation measures for activities planned for (80 years or more) in the future and which are dependent on demonstration of success prior to actual implementation is germane at this point. Deviations from this assumption must be evaluated for possible changes to our recommendations.

Appendix 3-B contains site-by-site discussions and rationales for mitigation recommendations.

Table 3-13 provides a summary of the viability ratings for the Final Environmental Impact Statement alternatives based on the results of our analysis and the viability ratings if the mitigation measures recommendations discussed above and in Appendix 3-B are implemented. The map in Appendix 3-A provides locations of the mitigation recommendation.

Table 3-13 Viability Ratings of the Final Environmental Impact Statement Alternatives of this Analysis Based on Implementation of the Bureau of Land Management Preferred Alternative (PA) in the Draft Resource Management Plans Compared to Viability Ratings if Mitigation Recommendations are Implemented.

FEIS Alternative	Viability Rating-BLM Implementation of PA	Viability Rating-If Mitigation Implemented
A	LOW	No mitigation was offered as this alternative would not retain its identity if mitigated to attain a high rating.
B	MEDIUM	HIGH
C	HIGH	HIGH
D	HIGH	HIGH
E	LOW	No mitigation was offered as this alternative would not retain its identity if mitigated to attain a high rating.

SUMMARY AND CONCLUSIONS

The viability ratings presented for the Final Environmental Impact Statement alternatives, with and without mitigation measures, are ratings for the northern spotted owl throughout its range. Although the overall viability ratings with mitigation measures are "high", it should be noted that ratings for individual physiographic provinces may vary. For example, the Oregon Coast Range Province alone would not attain a rating for "high". Increased reductions in probabilities of successful dispersal by spotted owls and the intermingled ownership patterns between Federally managed lands and private lands continue to result in conditions that increase risk to viability of northern spotted owls. These conditions persist regardless of the mitigation option presented or the alternative. There are simply no mitigation options that can fully compensate for habitat that may be lost on Bureau of Land Management administered lands. The recommended mitigations that we present are designed to compensate at a level necessary to attain a "high" viability rating - we believe they meet this objective but acknowledge these mitigation measures do not provide the security for spotted owls attainable if the Bureau of Land Management provided for spotted owl habitat at a level equal to or superior than, the Interagency Scientific Committee's Strategy.

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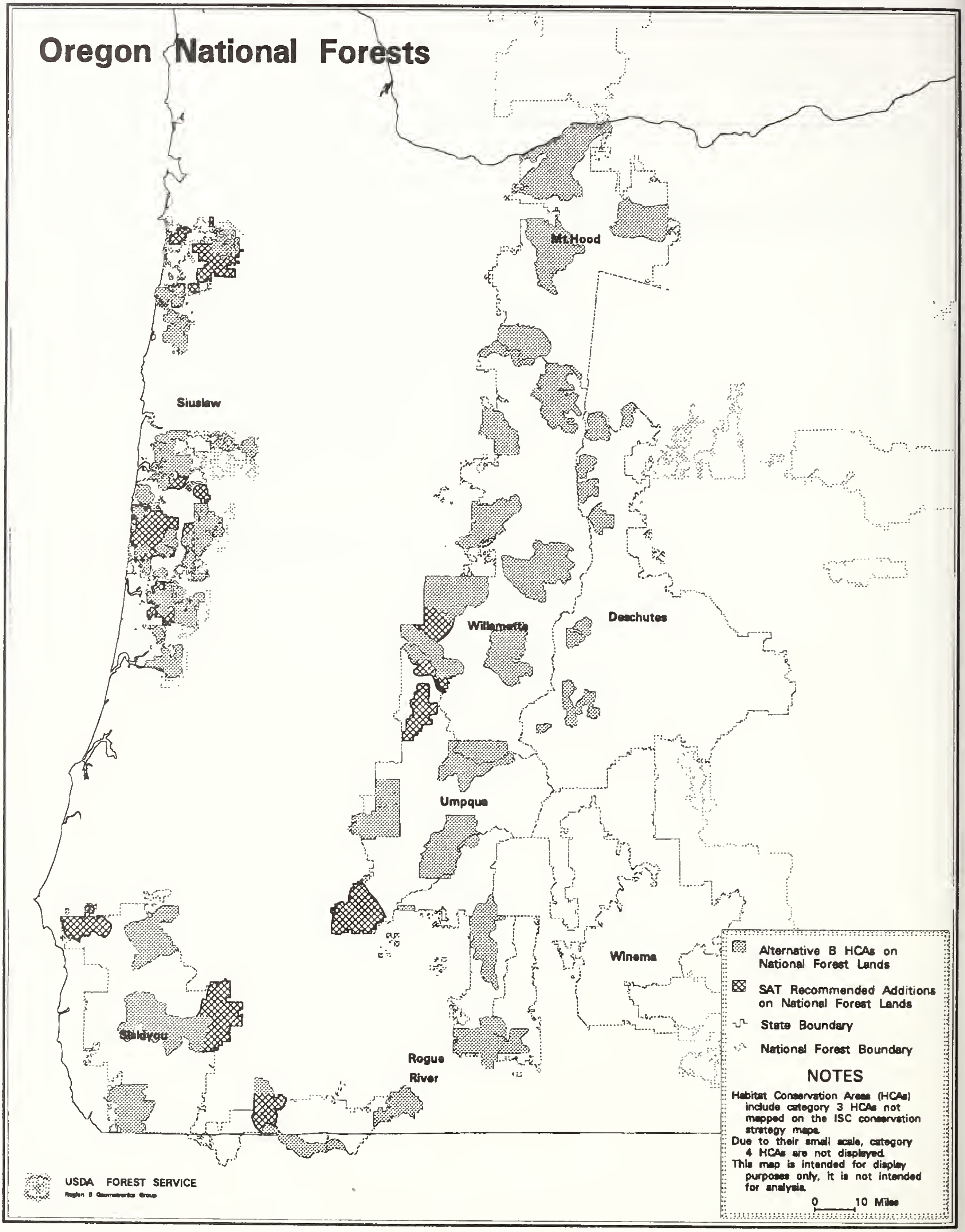
Appendix 3-A

Map of Mitigation Recommendations

Appendix 3-A
Map of Mitigation Recommendations if BLM Implements Preferred Alternatives



Appendix 3-B

Rationale for Recommended Mitigation Options

Appendix 3-B
Rationale for Recommended Mitigation Options

The following is a description of the mitigation measures recommended on National Forests to attain a "high" viability rating for Final Environmental Impact Statement Alternative B if the Bureau of Land Management implements the Preferred Alternative in their Draft Resource Management Plans. We expect these mitigation measures to remain in effect until such time the Bureau of Land Management either demonstrates their proposed habitat management results in (1) desired habitat structure and population goals at levels equal to or superior to the Interagency Scientific Committee's Strategy, or (2) the Bureau of Land Management adopts a management strategy for spotted owls that has a "high" viability rating. Should the Bureau of Land Management incrementally adjust its habitat management strategy, we expect the Forest Service to similarly reconsider our proposed mitigation measures on an incremental basis. Recommended mitigation measures are designed to compensate for the increased risk of loss of habitat and decrease of patch size in Old-Growth Emphasis Areas, and ultimately increased risk of loss of owl pairs and pair clusters, by increasing the size and number of Habitat Conservation Areas on National Forests.

Methods

Our rationale for mitigation through additions to the Habitat Conservation Area network is as follows: we identified a minimum of five critical areas of risk we assume are associated with managing spotted owl habitat through density control harvest. The five areas of risk are as follows:

1. Accurately describing the desired future condition of suitable spotted owl habitat.

2. Assuming the desired future condition can be adequately described, are mechanisms (e.g. silvicultural prescriptions) available to attain the desired future conditions?

3. Assuming proper silvicultural prescriptions are written, can prescriptions be successfully implemented?

4. Assuming prescription are successfully implemented, will monitoring be adequate to ascertain if prescriptions succeed or fail in achieving the desired future condition over time?

5. If monitoring shows that the desired future condition is not being met and adjustments are necessary, will options be foreclosed for an adaptive management strategy?

For each of these five areas of risk there is some unknown probability of success. Given the uncertainties, we are sure that the chances of success are less than 100 percent and likely considerably less for some of the areas of risk. Conversely, we are doubtful that the probability of failure is 100 percent. Complexity is added to the uncertainties associated with areas of risk, in that each area of risk is interactive with the others. We do not fully understand these relationships but believe they are likely cumulative. Failure to fully meet the objectives in some areas of risk has greater consequences than others and therefore indicates there probably should be some consideration given to weighting the areas of risk.

Appendix 3-B
Rationale for Recommended Mitigation Options (Continued)

Considering all of the above, it was not possible for us to develop a strict mathematical process for evaluating the risk associated with the Bureau of Land Management's plans to conduct silvicultural treatments inside Old-Growth Emphasis Areas. We do however believe that the overall risk of failure is high. To illustrate this, if we assume that the Bureau of Land Management will perhaps achieve a fairly high rate of success in each of the five risk areas – say 80 percent – and consider the rates of success to be cumulative with even weights, the overall rate of success is about 33 percent (.80 to the fifth power - .328). As discussed above, the actual rates of success for each risk area are unknown and probably vary widely depending on site-specific conditions. Additionally, we acknowledge that the rates of success may not be strictly cumulative. Based on professional judgement, we feel this assumed rate of success (33 percent) of attaining suitable spotted owl habitat is not unreasonable. The Bureau of Land Management plans to conduct density management on about 143,000 acres in the Old-Growth Emphasis Areas within the first 50 years. If we assume an average size of 40 acres for density management treatment units, there would be approximately 3,585 such units. If we assume an overall success rate of 33 percent, the objectives for spotted owl habitat would be met on 1,183 density management units. Objectives for spotted owl habitat would not be met on 2,402 such units. Forest stands adjacent to density management unit where the objectives for spotted owl habitat are not fully met will be adversely affected by conditions in the density management unit. We assumed a potential edge effect of 600 feet from the edge of each unit. Assuming density management units are shaped as squares, a total of 145 acres would be affected by each unit that failed to meet the objectives for spotted owl habitat. Multiplying the affected acreage by the 2,412 units totals approximately 348,300 acres likely to be adversely impacted by density management within the Old-Growth Emphasis Areas. In addition, there will be 62,000 acres less suitable spotted owl habitat under the Bureau of Land Management preferred alternative than under Bureau of Land Management Alternative D within the next 10 years. Rounded, this totals about 410,000 acres.

The 410,000 acre estimate represents a risk that we believe warrants mitigating actions on National Forests. We therefore used this acreage estimate as the basis for adding to the Habitat Conservation Area network on National Forests in Oregon. We used maps of habitat and owl pairs to select the recommended additions, focusing initially on the Oregon Coast Range. We then mapped additions in the Oregon Cascades West and Klamath Mountains Provinces until approximately 410,000 acres were added. The recommended additions to the Habitat Conservation Area network were placed to not only compensate for the acres at risk on Bureau of Land Management administered lands, but to also *partially* mitigate for delays in meeting 50-11-40 standards under the Bureau of Land Management Preferred Alternative. The recommended additions to the Habitat Conservation Area network on National Forests make Habitat Conservation Areas there closer together thereby increasing probabilities of successful dispersal among Habitat Conservation Areas on National Forests. While these additions increase the probability that Habitat Conservation Areas on National Forests will be occupied by spotted owls and that owls will interact, they only partially increase probabilities that owls will move among the three affected physiographic provinces.

Appendix 3-B
Rationale for Recommended Mitigation Options (Continued)

After we added the recommended additions, approximating 410,000 acres to maps, we reviewed the resulting "new" spotted owl Habitat Conservation Area network on National Forests. We assessed the "new" Habitat Conservation Area network to determine whether it, along with the Bureau of Land Management Preferred Alternative and the Interagency Scientific Committee's Strategy applied in Washington and northern California have a high viability rating. Based on our judgement, the resulting "new" network did meet that objective. The additions are designed to buffer against the risks associated with Bureau of Land Management's Preferred Alternative during the transition period, by preserving options on National Forests that may otherwise be lost.

Results

We mapped additions to Habitat Conservation Areas as recommended mitigations within the three physiographic provinces, the Oregon Coast Range, Klamath, and Oregon Cascades West, most affected by the Bureau of Land Management preferred alternative. Acreages of mapped additions were tallied from the automated database and totaled approximately 418,000 acres. A summary of mitigation in each province follows.

The Oregon Coast Range Province was identified in the Interagency Scientific Committee's Strategy as an area of special concern. The density of spotted owls is one-eighth of that recorded in other coastal areas (Thomas et al. 1990:67). As stated previously, there is concern that management of dispersal habitat and Old-Growth Emphasis Areas under the Bureau of Land Management Preferred Alternative may not meet the needs of the spotted owl. The Oregon Coast Range may be subject to increased risk of demographic isolation by year 2030 due to higher numbers of deficit quarter-townships on lands administered by the Bureau of Land Management than under Bureau of Land Management Alternative D.

An additional estimated 128,000 acres are mapped and recommended for the Oregon Coast Range Province to increase sizes of existing Category 1 Habitat Conservation Areas (0-31, 0-32, 0-34, 0-35, and 0-36) and create a new Habitat Conservation Area to reduce the likelihood of catastrophic events removing large blocks of suitable habitat. A single catastrophic event has a greater chance of eliminating an entire small designated area than a large designated area (Thomas et al. 1990).

Within the Klamath Province, approximately 142,000 additional acres are mapped and recommended for inclusions in Habitat Conservation Areas. A new Habitat Conservation Area west of 0-25 would be created along with a Habitat Conservation Area combining 0-23 and 0-24, and 0-21 and C-5 along the common boundary between lands managed by both the Forest Service and the Bureau of Land Management. These areas were identified as critical links in the Interagency Scientific Committee's Strategy for owl dispersal across province boundaries. We consider these additions important for increasing the likelihood of providing habitat for owls dispersing to the Oregon Coast Range and Oregon Cascades West provinces.

Appendix 3-B
Rationale for Recommended Mitigation Options (Continued)

Within the Oregon Cascades West Province 148,000 acres are mapped and recommended as mitigation. Inclusions are recommended for National Forests adjacent to Habitat Conservation Area 0-16. Under the Interagency Scientific Committee's Strategy, Habitat Conservation Area 0-16 is located entirely on Bureau of Land Management administered lands. Other additions are included for Habitat Conservation Areas 0-12 and 0-11. These areas are considered critical links for dispersal of spotted owls across province boundaries. Previously discussed concerns of Bureau of Land Management management of Old-Growth Emphasis Areas and dispersal habitat makes these Habitat Conservation Area additions important for spacing needs of habitat blocks. These areas represent the best available habitat on National Forests within the critical link area that would contribute to the needs of the spotted owl.

Our proposed additions to these Habitat Conservation Areas provide additional protection for pairs of owls and reduced distances between Habitat Conservation Areas. An additional 87 known pairs of owls are protected within Habitat Conservation Areas. In addition, nearest neighbor distances between Habitat Conservation Areas are reduced within all affected provinces as indicated in Table 3-C-1.

Table 3-C-1 National Forest Habitat Conservation Area Nearest Neighbor Analysis–Without Mitigation/With Mitigation by Physiographic Province (distance in miles).

Physiographic Province	1st Neighbor	Distance to: 2nd Neighbor	3rd Neighbor
Oregon Coast Range	8.2/2.8	19.6/7.3	25.4/18.1
Oregon Cascades	5.1/4.2	9.1/7.3	16.1/11.9
Klamath Mountains	4.2/4.0	7.8/6.8	12.8/12.3

Chapter 4

New Information on the Northern Spotted Owl

CHAPTER 4

New Information on the Northern Spotted Owl

Table of Contents

List of Tables

CHAPTER 4

New Information on the Northern Spotted Owl

INTRODUCTION

Since completion of the Interagency Scientific Committee's Conservation Strategy in 1990, a variety of new information has been released on the biology of the northern spotted owl (*Strix occidentalis caurina*), including estimates of demographic rates of the owl (Anderson and Burnham 1992), dispersal (Forsman et al. unpub.), and hybridization with the barred owl (Hamer et al. in press). This chapter contains a summary and assessment of new information released since January 1992, including updated information for most of the studies described by Anderson and Burnham (1992). Implications of the new information are discussed relative to the selected alternative, Alternative B, in the Final Environmental Impact Statement on Management for the Northern Spotted Owl on the National Forests (USDA 1992) (hereafter referred to as the Final Environmental Impact Statement). Information on location, size, and types of demographic studies that are being conducted on the spotted owl is provided in Appendix 4-A. An annotated list of reports and publications released since January 1992 is provided in Appendix 4-B.

DEMOGRAPHIC ANALYSES

The Anderson and Burnham Report

Between 1985 and 1987, researchers began five long-term demographic studies of spotted owls in Washington, Oregon, and northwestern California. These studies were designed to investigate demographic rates of spotted owls, including age-specific birth and death rates, and population trends. In September 1991, a group of researchers convened at Fort Collins, Colorado (hereafter called the Fort Collins workshop), to conduct an analysis of the demographic data from the five studies. The Fort Collins workshop was led by Drs. David Anderson and Kenneth Burnham of the Colorado Cooperative Fish and Wildlife Research Unit, and by two visiting French scientists John Dominique Lebreton and Mr. Rodger Pradel.

The Fort Collins workshop included an analysis of data from each individual study area as well as a "meta-analysis" in which data from all five areas were examined in combination to determine if any overall trends emerged from the data. The meta-analysis was conducted by John Dominique Lebreton, David Anderson, Kenneth Burnham, and Rodger Pradel. A synopsis of the Fort Collins workshop was written by Anderson and Burnham and provided to the Northern Spotted Owl Recovery Team in November 1991 for inclusion in the Draft Recovery Plan for the Northern Spotted Owl (USDI 1992) (hereafter referred to as the Draft Recovery Plan). The version of the report that appeared as Appendix C in the April 1992 Draft Recovery Plan is hereafter cited as Anderson and Burnham (1992). A copy of the report is provided in Appendix 4-C of this document. Results of the Fort Collins workshop were also presented at the Annual Meeting of the Cooper Ornithological Society in Seattle, Washington, on June 23, 1992.

Methods used to analyze the data at the Fort Collins workshop were based on Jolly-Seber open population models (Pollock et al. 1990) that provide estimates of age, sex, and time-specific survival rates based on the capture histories of marked animals. In this case, the marking technique consisted of placing color bands on the legs of owls and reobserving the owls on their breeding territories in subsequent years to develop their capture histories. A "capture history" is simply a row of zeros or ones, representing the year-by-year capture (or reobservation) history for an individual. A 1 means the animal was seen during a particular year, and a 0 means it was not seen. Based on multiple years of data, Jolly-Seber models estimate a recapture probability (the probability that a marked individual will be observed or recaptured in a given year, given that it is still alive). The recapture probability is then used to calculate an adjusted survival estimate, based on the number of individuals actually reobserved each year. Estimates of survival rates and reproductive rates are then used to calculate the population growth rate, which is referred to as "Lambda" or "λ". In a stationary population, Lambda is equal to 1. In a population that is declining or increasing, Lambda is less than or greater than 1, respectively. The reproductive parameter used to estimate age-specific birth rates at the Fort Collins workshop was fecundity, defined as the number of female young produced per year, per territorial female. Fecundity was determined by counting the number of young leaving nests and dividing by two (a 50:50 sex ratio was assumed). Females that did not nest or that nested and failed were assigned a fecundity value of zero.

The analysis performed at the Fort Collins workshop indicated that growth rates of territorial female populations on all five study areas were significantly less than 1, indicating that all five populations were declining. Estimated rates of decline on the individual study areas ranged from 6 to 16 percent per year, with a simple average rate of decline of approximately 10 percent per year (Anderson and Burnham 1992:Table C.4). Based on a meta-analysis of the combined data set, Anderson and Burnham (1992:327) concluded that, "...even with optimistic assumptions about juvenile survival rates, the best information suggests that the population of resident, territorial owls has declined, on average, at an estimated rate of 7.5 percent each year during the 1985-91 period..." This analysis estimated the rate of change of the population of territorial females rather than the entire population. Rates for the entire population were unknown, but are obviously strongly effected by the female segment of the population. Minor corrections in the data on two study areas were made after the Fort Collins workshop (Forsman pers. comm.), but were not considered significant enough to warrant a reassessment of the meta-analysis.

The meta-analysis indicated that not only were populations of territorial females declining on the individual study areas, but that female survival rates were declining over time. Anderson and Burnham (1992:325) concluded that, "Because the evidence strongly indicates that R decreased during the 1985-91 period, one must infer that λ also decreased over this period. That is, the rate of population decline was accelerating during the study period."

The indication of an accelerating rate of population decline was probably the most troubling finding of the Fort Collins workshop. Based on ecological theory it could be predicted that a population that has passed some sort of demographic threshold might begin to decline at an accelerated rate, either as a result of declining survival rates, or declining reproductive rates. Some ecologists and population experts suggested that the declining female survival rate was evidence that the northern spotted owl population had already passed such a threshold, beyond which it might be difficult to recover (Orians 1992, Kareiva 1992, Harrison 1992). Anderson and Burnham (1992:328) were more conservative in their assessment, concluding only that, during the time period of the studies, "...the rate of population decline has probably accelerated". Our assessment of these results is discussed later in the section titled Population Thresholds.

Update of Demographic Estimates on Study Areas Examined by Anderson and Burnham (1992)

Since the Fort Collins workshop in 1991, another year of data has been collected on each of the five study areas examined by Anderson and Burnham (1992). The Scientific Analysis Team contacted researchers on all five areas to see if they could update their estimates of survival and reproductive rates with 1992 data. Scientists conducting research on four of the five areas provided updated estimates of survival and fecundity. In addition, the Scientific Analysis Team requested that scientists conducting research on nine other study areas provide estimates of fecundity for spotted owls on their areas. The latter information was used to examine differences among areas.

For the four areas for which we received additional information on survival, adding one more year of data resulted in relatively minor changes in average survival rates (compare estimates in Table 4-1 with Table C.2 in Appendix 4-C). In two areas (Olympic Peninsula and Medford), survival rates of adult females increased slightly (2-4 percent), and in two areas (H.J. Andrews and Roseburg) they were essentially unchanged.

Table 4-1 Estimates of Age-Specific Annual Survival (ø) of Female Northern Spotted Owls on Four Study Areas in Oregon and Washington.

Study Area	First year		All later years	
	($ø_J$)	s.e.($ø_J$)	($ø_A$)	s.e.($ø_A$)
H.J. Andrews (Western Oregon)	0.190[a]	0.043	0.836[a]	0.016
Medford (Southwestern Oregon)	0.220[a]	0.031	0.826[a]	0.011
Roseburg (Southwestern Oregon)	0.266	0.046	0.860[a]	0.011
Olympic Peninsula (Western Washington)	0.143	0.034	0.846	0.018

[a] No sex-specific differences in adult survival rates were detectable, thus estimates are for males and females combined.

In 1992, reproduction by spotted owls was high on most areas for which data were available. As a result, average fecundity of territorial females increased slightly on all five study areas that were included in the Anderson and Burnham report (compare Table 4-2 below with Table C.3 in Appendix 4-C). Because population growth rate calculations are relatively insensitive to fecundity, however, we anticipate that this will have only a very slight positive effect on population growth estimates.

It should be noted that fecundity rates from some areas are considerably higher than those from the five study areas examined in Anderson and Burnham 1992 (see Appendix 4-C). The most notable differences were for studies on the Wenatchee National Forest on the east slope of the Cascades where fecundity averaged nearly twice the average reported in the Anderson and Burnham report (compare values for Wen-PNW and Wen-NACASI study areas in Table

4-2, with values in Table C.3 in Appendix 4-C). The Scientific Analysis Team cannot account for these differences except to hypothesize that weather conditions and prey populations may have been more conducive to reproductive success on the east slope of the Cascades during the years studied. It should also be noted that fecundity is relatively high for owls occupying predominantly young forests and mixed-age forests on private lands in northwestern California (Simpson and LP-Calif study areas in Table 4-2). In contrast, owls occupying predominantly young and mid-aged forests in western Oregon had relatively low fecundity (Siuslaw and Eugene Bureau of Land Management-east study areas in Table 4-2).

Table 4-2 Estimates of Age-Specific Fecundity (b) for Female Northern Spotted Owls on Study Areas in Oregon and Washington. Fecundity is defined as the number of female young produced per female owl per year.[a]

Study area	Subad 1 (12 mos.)		Subad 2 (24 mos.)		Adult (36 mos.)	
	(b_1)	s.e.(b_1)	(b_2)	s.e.(b_2)	(b)	s.e.(b)
Willow	0.115	0.058	0.344	0.023	0.344	0.023
H.J.A.	0.163	0.086	0.163	0.086	0.359	0.096
Medford	0.132	0.055	0.132	0.055	0.323	0.048
Roseburg	0.110	0.047	0.110	0.047	0.325	0.041
Olympic	0.223	0.089	0.223	0.089	0.396	0.087
Wen-PNW	0.262	0.178	0.262	0.178	0.763	0.081
Wen-NACASI	--	--	--	--	0.544	0.089
Eug-West	0.000	na[b]	0.000	na	0.366	0.130
Eug-East	0.000	na	0.000	na	0.181	0.078
Chetco-PSW	--	--	--	--	0.355	0.205
Coos BLM	0.204	0.102	0.204	0.102	0.477	0.139
Siuslaw	0.167	0.167	0.167	0.167	0.293	0.129
Simpson	0.139	0.042	0.139	0.042	0.414	0.021
LP-Calif.	0.000	na	0.000	na	O.571	0.051

[a] Summarized from annual reports and from information provided by researchers from September to November 1992. Individual study areas are described in Appendix 4-A.
[b] Sample too small to calculate standard error.

The Scientific Analysis Team examined general trends in fecundity on 15 different study areas. Fecundity varied considerably among years on some study areas, while remaining fairly stable on others (Table 4-3). An empirical examination of these data revealed no consistent increases or decreases in fecundity over time. Although quantitative information is lacking, we suspect that annual variation in fecundity is strongly influenced by variations in food supply and weather conditions.

Table 4-3 Yearly Variation in Fecundity of Adult Female Northern Spotted Owls on 15 Demographic Study Areas.[a]

Study area	Year							
	1985	1986	1987	1988	1989	1990	1991	1992
Willow Cr.	0.296	0.350	0.330	0.325	0.367	0.306	0.273	--
H.J. Andrews			0.400	0.486	0.025	0.276	0.250	0.717
Medford	0.234	0.500	0.158	0.457	0.213	0.356	0.344	--
Roseburg	0.196	0.552	0.279	0.300	0.364	0.378	0.240	0.458
Olympic			0.075	0.283	0.548	0.510	0.304	0.653
Simpson-Calif						0.423	0.373	0.445
L.P.-Calif						0.611	0.470	0.630
Coos Bay						0.530	0.141	0.580
Siuslaw						0.460	0.037	0.378
Siskiyou						0.375	0.375	0.316
Wen-USFS					1.000	0.672	0.567	0.814
Wen-NACASI						0.474	0.439	0.722
Eugene West						0.447	0.111	0.539
Eugene East				0.214	0.000	0.450	0.056	0.186
Warm Springs							0.820	

[a]Compiled from progress reports and unpublished data provided by researchers from September to November 1992. Fecundity was defined as the number of female young produced per female owl per year. A 50:50 sex ratio was assumed for juveniles. Study areas are described in Appendix 4-A.

We anticipate that new estimates of population growth rates will be calculated from the 1992 data during 1993 as research scientists complete their analyses of those data. Because our update of demographic rates on four of the five individual study areas indicated little change in estimates of survival and reproduction from Anderson and Burnham (1992), we do not anticipate that the outcome of the new analysis will differ appreciably from the 1992 results. We stress that the reanalysis of the 1992 data on four study areas that we have reported here is preliminary in nature, and that further analysis may result in changes in the estimates of population parameters.

Limitations of Demographic Estimates

Since the results of the Fort Collins workshop were released, there has been considerable discussion within the scientific community concerning possible biases in the demographic data that were used to make assessments of population growth rates. These potential biases were also discussed at length at the Fort Collins workshop and in Anderson and Burnham (1992). Potential sources of bias in the data have also been discussed or reviewed at several scientific meetings, in unpublished manuscripts (Franklin 1992, Forsman 1992a,b), and in a computer simulation model that is in preparation (J. Bart pers. comm.).

The main concern that has been raised regarding the banding data is that emigration of juveniles and adults may result in underestimates of survival rates. In a Jolly-Seber analysis, undetected emigrants are considered to be dead. In fact, some of them are probably still alive. To the extent that banded birds emigrate, survive, and go undetected, Jolly-Seber models will overestimate recapture rates and underestimate survival.

It is known that undetected emigration of banded juvenile owls occurs, based on results of radio-telemetry studies (see the section on Dispersal Studies), and there is evidence that the bias caused by such movements may be greater in some study areas than in others. For example, on the Olympic Peninsula the demographic study area surrounds the Olympic National Park, and is in turn surrounded by extensive private lands. If juvenile owls disperse into the Park or onto adjacent private lands, there is a high likelihood they will go undetected by research scientists. In contrast, the Roseburg Bureau of Land Management study area is surrounded on three sides by other demographic study areas, and bias caused by emigration is likely to be less because emigrants are likely to be detected if they move onto adjacent study areas.

Although there is less evidence to indicate significant emigration by adult owls, this is a matter of concern because estimates of population trends for spotted owls are most sensitive to changes in adult survival rates (Noon and Biles 1990). Even a small bias in estimates of adult survival can have a considerable effect on estimates of population growth. Telemetry studies of adult spotted owls have indicated little emigration of adult owls (Thomas et al. 1990:237), but there are exceptions. For example, (Meslow et al. 1989) noted two radio-marked females that emigrated from the H.J. Andrews study area. Emigration of adult owls will lead to an underestimate of adult survival rates.

Adult and subadult fecundity estimates among the five study areas in Anderson and Burnham (1992) were remarkably similar, ranging from 0.327 to 0.358 for adults and 0.094 to 0.229 for subadults (Appendix 4-C, Table C.3). We believe these estimates are reasonable, although several sources of counteracting bias may be influencing results. For example, breeding pairs may be more readily detected than non-breeding pairs because they tend to be more vocal. If breeding pairs are over-represented in the sample, this would cause an overestimate of fecundity. We believe this source of bias to be slight because a concerted effort was made each year by the research teams on each study area to verify the status of all females, regardless of whether or not they were breeding. The absence of information on the fecundity of non-territorial birds probably had little impact on results of the population trend analysis, as that analysis focused only on territorial females.

Another potential bias in the estimates of fecundity was that broods were rarely located immediately after they left the nest. If some mortality occurred after the young left the nest but before they were observed, this would produce an underestimate of fecundity. Again, because research personnel made a concerted effort to locate broods as soon as possible after the young left the nest, we believe bias from post-fledging mortality to be minor.

Another concern with the accuracy of data from banded birds is that capture and banding of owls could influence survival or fecundity. Based on the experience of the persons on the Scientific Analysis Team who have conducted such studies, and our conversations with other researchers, we do not believe this to be a significant problem. Spotted owls are extremely tame around humans and, in general, do not seem much disturbed by the banding process or by the bands themselves. Despite the fact that thousands of spotted owls have been banded, we know of no physical wounds or abrasions caused by bands.

Another concern regarding the results of the Fort Collins workshop was that all five of the demographic studies examined had been conducted over relatively short periods of time (5 to 8 years). Because the spotted owl is a long-lived species it is not clear that 5-8 years of study is sufficient time to establish population trends.

Probably the most important consideration with the demographic studies (described in Anderson and Burnham (1992)) is that estimates from those studies are derived from data that were collected during a period during which the amount of habitat was gradually declining (see Rates of Habitat Loss). Regardless of whether the estimates of demographic rates are biased, we believe that demographic data collected during a period of declining habitat are likely to reveal little about whether the population will eventually stabilize and remain viable once the amount of habitat stabilizes and is arranged on the landscape in a manner thought to be appropriate to minimize the risk associated with such a level of habitat (Thomas et al. 1990, Lamberson et al. 1992). This limitation is discussed further in the section on Population Thresholds.

DISPERSAL STUDIES

A study of radio-marked juvenile spotted owls was initiated on three study areas within the range of the northern spotted owl in 1991 (Forsman et al. unpub.). Based on the first year of study, it appeared that 22 to 45 percent of juveniles that survived the first year of life left the study areas. These birds would not have been detected and would have been presumed to have died had they not been wearing radio transmitters (Table 4-4). It is probable that some of these emigrants from the study areas will be detected by conventional calling and banding techniques as they move around and acquire territories in the future, thus reducing the amount of undetected emigration. Nevertheless, the relatively high proportions of juveniles that emigrated from the demographic study areas do indicate that undetected emigration is causing a negative bias in juvenile survival estimates derived from banding data. Areas that adjoin Congressionally designated Wilderness and National Parks (e.g., the Olympic Peninsula study area) appear to be the most likely to be influenced by undetected emigration (Table 4-4).

Table 4-4 Proportion of Radio-Marked Juveniles That Emigrated From Demographic Study Areas, Survived for One Year, and Went Undetected by Conventional Calling and Banding Techniques on Three Study Areas in Oregon and Washington, 1991-1992.[a]

Study area	n	Proportion emigrating
Roseburg BLM	18	0.22
Olympic Peninsula	11	0.45
Wenatchee N.F.	5	0.40

[a]Unpublished data from studies conducted by E. Forsman, Stan Sovern, and Janice Reid at the Forest Service Pacific Northwest Research Station, Corvallis, OR.

Survival estimates based on the radio-marked juvenile owls were considerably higher than the average values estimated from banding data (compare Table 4-5 below with Table C.2 in Appendix 4-C). High survival of the radio-marked cohorts may reflect the reduction of bias caused by emigration, but could also be the result of a particularly mild fall, winter and spring in 1991-1992. It should also be noted that transmitters were not placed on juvenile owls until July or August. Thus, survival estimates are based on the period from July-August of the first summer to July-August of the second summer, and did not include the first 1 to 2 months that young owls spent out of the nest. Forsman et al. (1984) and Miller (1989) reported high mortality rates for juvenile owls during the first several months of life. Thus, it is possible that survival estimates based on radio-telemetry results are biased high because they do not include the period of particularly high mortality that immediately follows fledging. It should be noted that this bias also applies to estimates from banding data, since many juveniles are not banded until July or August.

Because of concerns that some types of radio transmitters may lower survival (Paton et al. 1991, Foster et al. 1992), the studies of juvenile dispersal described above used small (6 gram) transmitters mounted on the tail feathers. Even with this precaution, there is no guarantee that the transmitters have no effect on juvenile survival rates.

Because of the above uncertainties, we believe it will require modification of techniques and several more years of study before more accurate estimates of juvenile survival can be acquired.

Table 4-5 Annual Survival Estimates (ø) of Radio-Marked Juvenile Spotted Owls on Three Study Areas in Oregon and Washington, 1991-1992. Estimates from programs SURVIV and MICROMORT are compared.[a]

Study area	n	Program SURVIV		Program MICROMORT	
		($ø_J$)	95% CL	($ø_J$)	95% CL
Roseburg BLM	27	0.70	0.50-0.91	0.66	0.50-0.88
Olympic N.F.	16	0.75	0.51-1.00	0.73	0.54-0.99
Wenatchee N.F.	16	0.31	0.09-0.72	0.24	0.10-0.56

[a]Starting dates for annual estimates were July 1, 1991, for Roseburg Bureau of Land Management and Wenatchee National Forest, and August 1, 1991, for the Olympic Peninsula. Starting dates differed among areas because transmitters were not installed at the same times on all areas. Unpublished data from studies conducted by E. Forsman, Stan Sovern and Janice Reid at the Forest Service Pacific Northwest Research Station, Corvallis, OR.

DENSITY STUDIES OF SPOTTED OWLS

Summary of Recent Studies

An alternative method of evaluating population trends is to examine actual changes in the number of territorial owls per unit area over time. A number of demographic studies of spotted owls have included "density study areas" in which research biologists have attempted to locate and band *all* territorial owls that are present within a prescribed boundary each year. This requires a complete search of the study area, with repeated surveys to ensure that territorial owls do not go undetected. The objective of surveys for owls in density study areas is to monitor trends in the territorial population over time. Trends can be analyzed between time periods in terms of total numbers of owls, numbers of pairs and single owls, or numbers of females per unit area. In the following summary, we present information on the total number of adult and subadult owls detected in each density study area by year. We refer to this estimate as the "crude density" of owls.

We summarized density estimates for 12 density study areas (Table 4-6). An analysis of these data by Franklin and Ward (1992) indicated that of the 10 areas with 3 or more years of data, only two areas near Medford, Oregon, appeared to be undergoing significant declines. Crude densities were essentially stable on seven areas, and increasing on one area. However, a meta-analysis of the combined data suggested that the overall population was declining at a rate of 3.2 percent per year (Franklin and Ward 1992).

Table 4-6 Estimates of Crude Density (Number of Individuals/km^2) of Adult and Subadult Owls on 12 Density Study Areas Within the Range of the Northern Spotted Owl.[a]

Study area	Year 1985	1986	1987	1988	1989	1990	1991	1992
Willow Cr	0.232	0.233	0.233	0.246	0.257	0.267	0.243	0.274
H.J. Andrews				0.197	0.200	0.200	0.217	0.223
Medford								
Butte Falls						0.103	0.093	0.084
Evans Cr						0.107	0.095	0.104
Elk Cr						0.264	0.253	0.245
Williams							0.148	0.159
Roseburg								
Drain			0.090	0.122	0.112	0.140	0.140	0.137
Cow Cr						0.114	0.108	0.106
Siuslaw NF						0.071	0.084	0.087
Olympic			0.051	0.068	0.070	0.070	0.076	0.068
Eugene BLM						0.078	0.076	0.063
Wenatchee NF							0.117	0.112
Simpson-Calif[b]							0.252	

[a]Summarized from annual reports and unpublished data provided by researchers from September to November 1992.
[b]Not initially designed as a density study area but minimum density is presented to indicate comparatively high densities in this area even without complete surveys.

Limitations of Density Studies

Estimates of population trends based on density data are likely subject to a number of biases, and only apply to a certain segment of the population. In particular, studies of spotted owl density apply only to the territorial population, because non-territorial birds cannot be consistently detected. In addition, spotted owls are long-lived animals that may concentrate in the remaining habitat as the amount of habitat declines. This may produce short-term densities that are not sustainable in the long term. This phenomenon is referred to as "packing". Therefore, densities within a density study area could remain inordinately high during a period of habitat decline, thus masking the actual rate of population decline.

Another limitation of density studies is that the number of surveys to count owls were not the same in all studies. In some studies, investigators used a minimum of three surveys per year, whereas others used six. Such differences in survey effort may bias comparisons among study areas, but should not influence estimates of trends within individual study areas, as long as the number of surveys per year remain consistent within each study area.

Another question regarding density studies is how well they represent the population as a whole. If a density study area does not include habitats and landscapes typical of some larger area, it may not be a good indicator of what is happening to the population in that larger area. If a density study area is not located within a Habitat Conservation Area (Thomas et al. 1990) for example, it may be managed differently than the Habitat Conservation Area, and may, therefore, not represent what is happening there. The density study areas included in this review were selected because they were considered typical of forested areas within the landscapes in which they were located.

However, none of the density study areas were laid out to conform to exact Habitat Conservation Area boundaries. Thus, most density study areas overlap Habitat Conservation Areas and a variety of other land use classifications. At present, data summaries for density study areas have not been subdivided for areas inside and outside Habitat Conservation Areas, so the Scientific Analysis Team can only provide estimates for density study areas as a whole. We do not consider this a serious problem. At this point, the Interagency Scientific Committee Conservation Strategy has been in effect for such a short period of time (3 years) that treatments inside and outside the Habitat Conservation Areas have not diverged appreciably.

Another possible bias associated with density studies of spotted owls is that observers may become increasingly efficient at locating owls as they become more familiar with the study areas and learn more about the distribution of resident pairs. This could mask a decline in numbers of territorial owls or partially explain the gradually increasing number of owls detected on some study areas.

An additional problem encountered with density studies is that very small changes in population size (e.g., 1 to 2 percent per year) are difficult to detect until many years of data have been collected. In short-term studies, variation due to demographic variability, observer effort, differing observers, and other factors can mask gradual changes in population size. Thus, in a gradually declining population it is highly unlikely that a short-term density study will produce a clear picture of long-term trends in the population.

Probably the most significant limitation on the interpretation of the density data is that the density studies have been conducted during a period when the amount of habitat has been gradually declining. For the same reasons described in the discussion of demographic studies, estimates of trends in owl density during a period of gradual habitat loss tell us nothing about whether the population will eventually stabilize at a new equilibrium.

RATES OF HABITAT LOSS

Although it is commonly assumed that spotted owl populations are declining as a result of habitat loss [Thomas et al. 1990, USDI Fish and Wildlife Service 1992], correlations between rates of habitat loss and rates of population decline are poorly understood. To compare rates of habitat loss with rates of population change on the five demographic study areas described by Anderson and Burnham (1992), the Scientific Analysis Team used two methods.

In the first approach, we compiled Forest Service and Bureau of Land Management records of the amount of owl habitat cut each year on Federally administered lands within density study areas. We also examined habitat loss on Forest Service and Bureau of Land Management administered lands within a buffer area around three of the density study areas to determine if harvest rates inside and outside the density study area were similar.

In cases where there were multiple density study areas in the same vicinity (e.g., Medford Study), we examined the density study areas and their corresponding buffer areas as one combined unit. To estimate the amount of habitat present at the beginning of the study period, we estimated the area currently covered by spotted owl habitat, and then added the number of acres of suitable owl habitat cut during the study period.

Average annual rates of habitat removal were estimated by dividing the number of acres of suitable habitat cut during the study period by the calculated amount of habitat present at the beginning of the study period, and then dividing the result by the number of years in the study period.

An additional confounding factor in assessing rates of habitat loss on lands administered by the Bureau of Land Management was that, in southern Oregon, considerable timber cutting involved removal of selected trees rather than clearcutting. This often made it difficult to determine if a stand should still be considered owl habitat after logging had occurred. We relied on the opinion of local biologists as to whether such stands should be considered owl habitat. Although these estimates are crude, we believe them to be reasonable. We stress that this analysis was restricted to Federally administered lands, as harvest records were unavailable for other ownerships.

The team's second method of analysis was to use Landsat imagery (digital satellite photos) to examine rates of habitat loss on three of the five demographic study areas from 1977 to 1988. This analysis covered the same geographic areas examined in the harvest records analysis, but included an examination of all lands, not just Federally managed lands. Landsat Multispectral Scanner data was used for the 1977 time period while Landsat Thematic Mapper imagery was used for the 1988 time period.

All image processing was conducted using ERDAS (ERDAS, Inc., Atlanta, GA). The Multispectral Scanner sensor had a nominal resolution of 79x56 meters while the Thematic Mapper imagery had a resolution of 30x30 meters. The Multispectral Scanner data was rectified to the Thematic Mapper imagery and both data sets were resampled to 50x50 meter resolution. Initially, an unsupervised classification approach (ISODATA clustering) was used that defined 20 initial spectral signatures by clustering spectral reflectance values.

Spectral signatures were identified using digital stand information from the Bureau of Land Management (Forest Operations Inventory data), digital habitat data from air photo interpretations, and visual inspection of the imagery. Many of these spectral signatures did not represent a unique informational class (i.e., they lumped young forest pixels with older forest pixels).

New spectral signature files were created by selecting (or combining) the best of the initial 20 spectral signatures that represented four distinct information classes: non-forest, open canopy young forest, closed canopy young forest, and closed canopy mature/old forest. A fifth class (water) was added where large rivers, lakes, or ponds were present. The new spectral signature files were used as input to a maximum likelihood classification algorithm that classified all pixels in the imagery into one of the five classes. Infrared wavelength bands were included in the classification to improve discrimination between vegetated and non-vegetated areas. Classified files were subsetted ('clipped') to the boundaries of the density study area and to the boundary of a buffer area around each density study area. The width of buffer areas was set equal to the average width of spotted owl home ranges in each province (estimates from Thomas et al. 1990).

The analysis of records of timber cutting indicated that the amount of spotted owl habitat was declining at a rate of 0.9 to 1.5 percent per year on Forest Service study areas and 1.3 to 3.1 percent per year on Bureau of Land Management study areas (Table 4-7). Analysis of rates of habitat loss using Landsat data indicated rates of habitat loss between 1.1 percent and 5.4 percent per year (Table 4-8). Rates of loss within density study areas and surrounding buffer areas were relatively similar for both the timber cutting analysis and the Landsat analyses except on the Roseburg study area, which had a much higher level of habitat loss in the buffer area than in the density study area (Table 4-8). The highest rate of habitat loss was on the Bureau of Land Management Medford District, which was also the area in which spotted owl populations appeared to be declining most rapidly.

Table 4-7 Rates of Removal of Owl Habitat on Five Study Areas Within the Range of the Northern Spotted Owl[a]. All area measurements in hectares (1 hectare = 2.471 acres).

	Willow Creek	Medford[b]	Roseburg[c]	Andrews	Olympic[d]
Density areas					
Total Area	30302	36949	45914	30490	29761
Years examined	82-92	79-92	79-91	82-92	82-92
Starting habitat	12058	19411	28032	18013	14651
Current habitat[e]	10606	11085	23419	15245	12202
Hectares harvested	1453	8326	4613	2768	2449
Percent change	12.05	42.89	16.46	15.36	16.71
Avg. annual loss(%)	0.86	3.06	1.27	1.40	1.52
Buffer areas[f]					
Starting habitat		86,511		16823	8127
Current habitat		43,259		15120	6965
Hectares harvested		43,252		1704	1162
Percent change		50.00		10.13	14.30
Avg. annual loss		4.55		0.92	1.30

[a]Unpublished data from studies by M.G. Raphael, J.A. Young, and E.D. Forsman, Pacific Northwest Research Station, Olympia, Washington.
[b]Summarized from harvest records provided by the Forest Service and Bureau of Land Management. Estimates of rates of removal apply to lands managed by both the Forest Service and Bureau of Land Management.
[c]Summarized from harvest records provided by the Bureau of Land Management. Estimated rates apply to lands administered by the Bureau of Land Management.
[d]Estimates apply only to lands managed by the Forest Service.
[e]Estimated by multiplying area of study area by the estimated proportion of study area currently covered by owl habitat.
[f]Width of buffer areas was scaled to correspond to the average diameter of a home range within the study area. Widths were: Andrews = 4.0 km, Medford = 5.6 km, Olympic = 7.2 km.

Table 4-8 Rates of Removal of Owl Habitat on Three Study Areas Within the Range of the Northern Spotted Owl, 1977 to 1988[a]. Estimates based on Landsat imagery. All area estimates in hectares (1 hectare = 2.471 acres).

	Study Area		
	Medford	Roseburg	Andrews
Density Areas			
Size (ha)	90911	105304	30490
Habitat[b] in 1977	45142	48148	16025
Habitat in 1988	18242	42375	13457
total % loss	59.59	11.99	16.02
annual % loss	5.42	1.09	1.46
Buffer areas[c]			
Size (ha)	144195	94031	32262
Habitat in 1977	61095	34893	19449
Habitat in 1988	28955	22383	16054
total % loss	52.61	35.85	17.46
annual % loss	4.78	3.26	1.59

[a]Unpublished data from studies by M.G. Raphael, J.A. Young, and E.D. Forsman, Pacific Northwest Research Station, Olympia, Washington.
[b]Habitat was classified as mature and older, closed-canopy forest as identified from Landsat imagery.
[c]Width of buffer areas was scaled to correspond to the average diameter of a spotted owl home range within the study area. Widths were: Andrews = 4.0 km, Roseburg = 4.8 km, Medford = 5.6 km.

The two methods used to examine rates of habitat loss are not directly comparable because they measure different things and are subject to different types of bias. For example, the analysis that was based on Landsat data examined all ownerships within the study areas, whereas the analysis that examined cutting rates focused on Federally administered lands. The analysis of cutting records was also influenced by the initial estimate of the amount of habitat currently present.

Although we believe that the analysis of Landsat data was a reasonable first attempt to examine rates of habitat loss, several qualifying statements should be made. These are: (1) the effects of deeply shadowed areas were not specifically addressed and may cause an overestimation of the older age classes in areas of high relief, such as the Olympic Peninsula and the H.J. Andrews Experimental Forest, (2) classification was based primarily on unsupervised clustering of spectral values; therefore, some classification error must be expected in classifying different seral stages with similar spectral responses, (3) even though digital habitat information was used to guide the classifications, the results have not been subjected to a detailed assessment of accuracy and some error in classification must be expected, and (4) the wavelength characteristics of each band differ between sensors; therefore, differences in reflectance from objects on the ground may influence comparisons of classifications between years.

Despite these qualifications, the above analyses indicate that rates of habitat loss are considerably lower than rates of population decline estimated from demographic studies (Anderson and Burnham 1992). Conversely, rates of habitat loss on most study areas were greater than rates of population decline based on empirical observations of changes in spotted owl numbers on density study areas (Franklin and Ward 1992). The one exception was the Medford area where both the rate of decline based on changes in owl numbers (4.7 percent) and rate of decline based on Landsat analyses (5.42 percent in density study areas and 4.78 percent in buffer areas) were similar.

It is apparent that demographic studies and density studies suggest quite different relationships between habitat loss and population response. One method (demographic studies) suggests that territorial populations are declining faster than the rate of habitat loss. The other method (population density studies) indicates that populations of territorial birds are either stable or declining at about the same rate as habitat loss.

Given that packing may be occurring as the habitat declines, we do not find it surprising or unlikely that the rates of decline in numbers of territorial birds on density study areas might lag behind rates of habitat loss. Conversely, given that banding data may underestimate survival rates, we are also not surprised that estimates of lambda indicate a population declining faster than the rate of habitat loss. Either result could be predicted, given the biases that are likely to influence the different methods of assessing population trends.

POPULATION THRESHOLDS

Population models described by Thomas et al. (1990) indicated that two distinct population thresholds occur, either of which can lead to the eventual extirpation or extinction of a species. One of these thresholds occurs as a result of habitat loss. If the amount of habitat is reduced to an excessively small fraction of the landscape, then (1) it becomes difficult for owls to find suitable territories, and (2) the resulting small populations are subject to random demographic and environmental effects. Both of these factors cause the overall population to exhibit precipitous declines.

The other threshold occurs as a result of the Allee effect. If population numbers fall below a certain level, it becomes so difficult to find a mate that reproductive rates fall below the level needed to maintain a stable population. Thomas et al. (1990:253) emphasized that, although mathematical models indicated the presence of thresholds, knowledge was inadequate to, "accurately predict the population size, suitable habitat, or amount of habitat fragmentation thresholds that, once crossed, would lead to a population crash." This situation has not changed (Lamberson et al. 1992, Carroll and Lamberson [in press]). In all likelihood the exact locus of such thresholds will be impossible to predict with accuracy because they are moving targets that change over time and location with a changing environment (Lamberson et al. 1992).

After the release of the Anderson and Burnham report (1992), some observers (e.g., Harrison 1992, Kareiva 1992, Orians 1992) suggested that the declining survival rates of female spotted owls might be indicative of a population that had dropped below a demographic threshold. The testimony and depositions given by these respected scientists in this matter indicated to us that they were unfamiliar with the data and with the possible biases in the data. They also chose not to address one of the key cautions in the report of the Interagency Scientific Committee (Thomas et al. 1990:249) in which the authors stated that "assessing population trends from data collected during periods of declining carrying capacity (for example, the harvest of suitable owl habitat) may be very difficult because of the difficulty of distinguishing a collapsing population ... from one that eventually reaches a long-term stable equilibrium..." This point was also emphasized by Lamberson et al. (1992).

Thus, it is important to realize that a population that declines as its habitat declines is entirely likely to stabilize when the point is reached where habitat recruitment equals or exceeds the rate of habitat loss. The Interagency Scientific Committee proposed its conservation strategy under the assumption that populations would stabilize at a lower population level.

Other data that may provide insights relative to whether the spotted owl population has gone beyond some demographic threshold are estimates of fecundity and density. We have already discussed the absence of significant changes in density on most density study areas. It could be predicted that if the Allee effect was causing a population to fall below a threshold, a reduction in fecundity would be observed as females would have an increasingly lower probability of finding mates as habitat is lost. As described earlier, an examination of fecundity on 14 study areas did not reveal any consistent downward trends in fecundity for adult females (Table 4-3). While this does not indicate evidence of an Allee effect, it cannot be assumed from this that no Allee effect is present. In a long-lived species like the spotted owl it is possible that the Allee effect would not become detectable until some time after a habitat threshold was exceeded. Another method of examining whether the Allee effect is influencing spotted owls would be to examine trends in the proportion of territorial adults that are paired. Data for such an analysis were not available for our review, although we anticipate that such analyses will be conducted by individual researchers in the near future.

POPULATION VIABILITY MODELS AND ASSESSING THE TRANSITION PERIOD

Alternatives in the Final Environmental Impact Statement were ranked using seven biological criteria (Chapter 2). Subsequently, the Forest Service was criticized for not using more quantitative, spatially explicit models to rank alternatives (Doak 1992, Kareiva 1992). We agree that the use of quantitative, spatially explicit models to examine alternatives is a good idea. There are several reasons however, why the Forest Service has not done so to date. First, at the time the spotted owl Final Environmental Impact Statement was written, the only spatially explicit owl/habitat model that we are aware of was still in development and not fully tested. Second, and more importantly, the use of a spatially explicit model requires detailed maps of the present and projected future forest conditions, including all successional stages. Geographic Information System maps (i.e., computerized maps) of the current distribution of older forest types within the range of the spotted owl have been produced by the Wilderness Society, National Audubon Society, and by Pacific Meridian Resources under contract with the Forest Service. Unfortunately, these maps were produced using different criteria and are in many respects not comparable. Johnson et al. (1991) experienced considerable difficulty resolving differences between these maps when attempting to map late-successional and old-growth forests in the Pacific Northwest (J.W. Thomas, per. comm.). In addition, spatially explicit computer maps of most other forest age classes are incomplete or lacking, as are spatially explicit maps of proposed future harvest patterns. The lack of spatially explicit maps of all forest age classes and of present and projected future forest management activities makes it nearly impossible to project future habitat conditions for spotted owls. Thus, use of spatially explicit models at this point would involve many assumptions about the amount and distribution of habitat and harvest areas that are unsubstantiated by currently available data. In other words, we consider the data available for such an analysis to be of poor quality and inadequate in scope. Because no model is any better than the data fed into it, we believe an extensive modeling effort would be of little benefit at this time.

Since the release of the Final Environmental Impact Statement, there has been considerable refinement of spatially explicit models designed to examine relationships between spotted owl populations and changes in habitat (e.g., McKelvey et al. 1991, McKelvey et al. 1993, Lamberson et al. 1992, Carroll and Lamberson 1992). Whereas these models are incapable of identifying exact thresholds, they are useful for examining general relationships between spotted owls and their habitat, and for ranking the relative effectiveness of different management alternatives. We encourage the Forest Service to begin as soon as possible to develop: (1) spatially explicit maps of forest age classes and harvest alternatives, and (2) vegetation change and growth models that can be used to assess alternatives for managing habitat for the spotted owl and other species. Although we do not believe that the results of these modeling efforts can or should overshadow the judgement of biologists and land managers, the use of spatially explicit models will, when adequate data is available, undoubtedly provide additional insights into biological processes and will allow the Forest Service to better identify areas that are particularly at risk.

A key point about the Interagency Scientific Committee's proposed strategy that was not addressed in the Final Environmental Impact Statement was the transition period during which habitat in the Habitat Conservation Areas recovers from the present condition to the desired future condition. It was assumed in the Final Environmental Impact Statement that, because of the redundancy of protective measures built into the selected alternative to ensure viability of the owl, and because of the relatively large size of the existing population, owls would persist in adequate numbers during the transition period to eventually reach the projected long-term equilibrium level. Whereas population viability models (e.g., McKelvey et al. 1991) indicate that the transition period is one of risk in terms of population persistence, we believe it is unlikely that spotted owls will reach population levels during the transition period from which they cannot recover, provided that the Bureau of Land Management adopts a management plan that is equal or superior to the strategy proposed by the Interagency Scientific Committee (Thomas et al. 1990), or that the Forest Service adopts measures to mitigate if the Bureau of Land Management adopts a less suitable plan (see Chapter 2).

For the reasons described in previous sections, we do not believe that estimates of crude density or demographic rates shed much light on the issue of whether the spotted owl population will eventually reach equilibrium at the target levels set by the Interagency Scientific Committee and the Forest Service Final Environmental Impact Statement. However, we believe that if Federal land management agencies manage for a network of relatively large blocks of habitat, spaced at relatively close intervals across the range of the spotted owl, as proposed by the Interagency Scientific Committee, the owl population will eventually stabilize at a lower equilibrium population level, and will have a high likelihood of long-term viability. We base our opinion on the information that was compiled by Thomas et al. (1990:283-302) on persistence times of small populations, and on the results of models that show that metapopulations of animals distributed in large clusters are likely to remain viable for long periods of time (Thomas et al. 1990, McKelvey et al. 1991). The conclusions of Carroll and Lamberson (in press) are also supportive.

They stated that, "The optimal conservation plan probably results from a reserve philosophy similar to that described by Thomas et al. (1990) in their conservation strategy for the northern spotted owl, which is many moderately large reserves broadly distributed throughout the range of the species with distance between reserves small enough to maintain connectivity."

HYBRIDIZATION WITH THE BARRED OWL

Since 1989, hybrid crosses between barred owls and spotted owls have been confirmed at four widely separated locations within the range of the northern spotted owl (Hamer et al., in press). The four cases included two male hybrids that were found paired with female barred owls, one female hybrid that was found paired with a male spotted owl, and one case in which a 1-year-old spotted owl paired with a female barred owl and produced a hybrid offspring.

In all cases, the adult hybrids that were observed were believed to be first generation (F1) crosses based on plumage characteristics. One of the hybrid males that was paired with a female barred owl produced young in at least two separate years, thus demonstrating that first generation hybrid males, at least, are capable of back-crossing. First generation hybrids are characterized by very distinctive plumage and vocalizations, which include attributes of both of the parent species. These observations have been described in a draft manuscript by Hamer et al. (in press) who concluded that the Mayr and Short (1970) classification of the spotted owl and barred owl as a superspecies (two species that only recently diverged from a common parental stock) is probably correct.

Although records of hybridization between barred owls and spotted owls are an interesting biological phenomenon, we cannot predict the ultimate outcome. Hybridization is common in nature, having been recorded in about 10 percent of the non-marine bird species in North America (Mayr and Short 1970) and between two other owl species of the genus *Strix* (the same genus as the spotted owl) in Europe (Scherzinger 1983). In most species where hybridization occurs it tends to be an uncommon event, and thus has little effect on the parental species - that is, the species still continue as distinct species for very long periods of time.

We suspect that hybridization between spotted and barred owls is rare for the following reason. During the last 15 years, hundreds of observers have surveyed and banded spotted owls and have confirmed several thousand pairs of spotted owls and hundreds of pairs of barred owls. Despite this massive effort, only four F1 hybrids have been observed. This suggests that the behavioral isolating mechanisms that normally keep the two species from hybridizing are relatively effective. Nevertheless, the barred owl is rapidly invading the range of the northern spotted owl and the incidence of hybridization could increase as the numbers of barred owls increase. We do not know what the ultimate outcome will be. In a recent report prepared for the association of O&C Counties, Vincent (1990:42) expressed the view that the "...prognosis is poor for the spotted owl to maintain an undiluted gene pool." Although he could be right, we feel his view is conjectural.

Even in the absence of interbreeding, the barred owl may represent a serious threat to the spotted owl from the standpoint of competition or displacement. But that is highly uncertain, as discussed by Hamer et al. (1989) and Vincent (1990). At this point, barred owls are relatively uncommon in many upland areas in Washington, Oregon and California, and it remains to be seen whether they will eventually become common enough to displace significant numbers of spotted owls.

Currently, we believe that there is little the Forest Service or other forest management agencies can or should do to influence the eventual outcome of the barred owl range extension. It is not at all clear that the range extension is the result of forest management practices. It is equally unclear whether a change in management practices (e.g., saving all the old-growth forests or stopping all timber harvest) will have any effect on the rate or extent of the range extension. In light of this uncertainty, we believe that the most reasonable course of action is to continue to manage habitat for a reasonably large population of spotted owls, widely dispersed within the historical range of the species (as proposed by the Interagency Scientific Committee, the selected alternative in the Final Environmental Impact Statement, and by the Draft Recovery Plan).

OWL NUMBERS AND DISTRIBUTION

Since the release of the Final Environmental Impact Statement, additional surveys of spotted owls have been completed. This information has been summarized by state agencies and by the Northern Spotted Owl Recovery Team, and is briefly summarized below.

Canada

In Canada, the historical range of the spotted owl is limited to the southwest mainland of British Columbia. Dunbar et al. (1991) described results of surveys of spotted owls and barred owls in British Columbia from 1985 to 1988. During those surveys, which covered a large portion of the historical range of the northern spotted owl in British Columbia, spotted owls were found at only six locations, including pairs at two sites and single owls at four sites. The authors concluded that the spotted owl was rare in British Columbia, with an estimated population of less than 100 pairs. They also hypothesized that the population had probably declined as a result of habitat loss and displacement by barred owls. Since 1988, additional surveys have been conducted in British Columbia and the total number of sites where spotted owls have been located has increased to 14 pairs and 12 individuals (Blackburn and Bryant 1991, Dunbar pers. comm.).

United States

Numbers of owl pairs located in Washington, Oregon and northwestern California during surveys conducted from 1987 to 1992 are summarized in Table 4-9. These data were summarized from personal communications with persons responsible for maintaining state wildlife agency data bases in the three states, and with Fred Seavey of the Northern Spotted Owl Recovery Team. The total number of owls reported in the three-state area included 3,591 pairs, and approximately 1,000 sites where single owls were observed but status was not confirmed. These counts should not be considered a minimum population estimate because: (1) not all landowners and agencies reported their annual summaries of 1992 data in time to be included in the population estimate; and (2) the counts included only owls located since 1987-88, and undoubtedly did not include some pairs that were still occupying sites not visited since 1986-87. It is also possible that some of the pairs found in 1987-91 may have been displaced by habitat loss.

Table 4-9 Numbers of Spotted Owl Pairs Located Within the Range of the Northern Spotted Owl[a].

Area	USFS[c]	BLM[c]	Private	State or Province	Nat'l Parks	Tribal Lands	Total
California	471	17	414	14	1[c]	37	954
Oregon	1,164	608	128[b]	33	8[b]	36	1,977
Washington	486		45[b]	33	64[c]	32	660
Canada				14			14
Totals	2,121	625	587	94	73	105	3,605

[a]Summarized from personal communications with state biologists and with Fred Seavey of the Northern Spotted Owl Recovery Team.
[b]Five-year survey period = 1988-1992
[c]Five-year survey period = 1987-1991

Although actual population counts are unknown, data compiled by the Northern Spotted Owl Recovery Team indicate that 40-73 percent of the potential owl habitat on lands administered by both the Forest Service and the Bureau of Land Management was searched for owls between 1987-91 (Table 4-10). The fact that not all habitat has been searched suggests that the actual population is larger than the confirmed population. However, it is also likely that at least some of the owls documented between 87-91 have been displaced by habitat loss. It is also likely that this summary does not include some areas that were surveyed prior to 1987, but that have not been searched in recent years.

Table 4-10 Percent of Spotted Owl Habitat Surveyed for Owls on Lands Administered by Both the Forest Service and Bureau of Land Management Between 1987-91.[a]

Landowner	State		
	Washington	Oregon	California
Forest Service			
Reserved lands	22	46	17
Non-reserved lands	45	77	54
Total FS lands	40	73	44
Bureau of Land Management			
Total BLM lands		61	

[a]These data were obtained from summaries compiled by the Northern Spotted Owl Recovery Team. For purposes of this analysis, habitat is defined as any forested area with trees at least 11 inches in diameter with at least 40 percent canopy closure.

Two points should be emphasized here. First, the increase in the number of confirmed owl pairs should not be interpreted as evidence of a population increase. Data from the density study areas and the demographic studies clearly do not support such an interpretation. The obvious explanation for the increase in the number of known owls is that survey effort has greatly increased during the last 10 years, including: (1) a greatly expanded effort to inventory owls in Habitat Conservation Areas, (2) the initiation of numerous demographic studies across the range of the owl, and (3) increased survey associated with timber sales in order to comply with Section 7 consultation requirements of the Endangered Species Act. Given the dramatic increase in survey effort since 1985, we are not surprised that more owls are being located as new areas are being searched.

The second important point to emphasize is that the total number of owls that exist under current conditions is not particularly relevant in the long term. What is much more important is the total number of owls projected to occur when the selected management plan is fully implemented. The Conservation Strategy proposed by the Interagency Scientific Committee assumed that most pairs of owls outside the Habitat Conservation Areas would eventually disappear as habitat was removed by logging and natural events, eventually resulting in an estimated future population of about 2,200 pairs of northern spotted owls in Habitat Conservation Areas. This estimated number will not likely change very much, regardless of the size of the current population. What does change as a result of the larger current population size is that we are more confident that the population will survive through the short-term transition period during which the plan is implemented.

SUMMARY AND CONCLUSIONS

Analyses of data from ongoing demographic studies of spotted owls suggest that the territorial female population is declining at a rate of 7.5 percent per year (Anderson and Burnham 1992). By comparison, density estimates of spotted owls indicate territorial populations that are either stable or declining slightly. Because of the potential biases that may influence estimates from banding studies and density studies, the Scientific Analysis Team concluded that banding studies are likely to result in overestimates of rates of decline whereas density studies are likely to result in underestimates of rates of decline. Therefore, it is our opinion that the actual rate of decline in the territorial population is intermediate between the estimates produced by the two methods.

A declining territorial population during a period of declining habitat is to be expected. Under these conditions, we also believe that a declining female survival rate (Anderson and Burnham 1992) might also be expected given the density dependent factors (e.g., packing) that might be in effect during the transition period.

Regardless of the biases that may effect estimates from demographic studies and density studies of spotted owls, we believe that demographic rates or trends observed during a prolonged period of habitat loss will provide little insight as to whether the population will eventually reach a new stable equilibrium when the rate of habitat loss is equaled by the rate of habitat gain (Noon and Biles 1990, Lamberson et al. 1992). For that reason, the Scientific Analysis Team disagrees with those (e.g., Kareiva 1992, Orions 1992, Harrison 1992) who have inferred from the demographic data that the approach proposed by the Interagency Scientific Committee is inadequate. In fact, our review of recent modeling efforts (e.g., Carroll and Lamberson [in press]) leads us to conclude that the strategy proposed by the Interagency Scientific Committee of maintaining a network of large blocks of suitable habitat, distributed across the range of the owl, will have a high likelihood of maintaining a viable population of spotted owls in the long term. This viewpoint reflects our collective professional judgement based on a review of the evidence. There simply are no data that can guarantee that any plan that has never been tried will prove successful. It is well to note that after prolonged deliberation, the Northern Spotted Owl Recovery Team proposed a strategy that is nearly identical with the strategy proposed by the Interagency Scientific Committee.

Using records of timber cutting, we estimated that rates of habitat loss ranged from 0.9 to 3.1 percent per year on five study areas in which densities of territorial spotted owls were being monitored. A different analysis, using Landsat data from three of the same areas, indicated that potential owl habitat declined at rates of 1.1 to 5.4 percent per year. Estimates of rates of decline in the population of territorial female owls based on demographic studies (6-16 percent per year) generally exceeded rates of habitat loss. Estimates of rates of decline in the territorial population based on density studies generally indicated populations that were stable or declining slightly.

Results from population models indicated that population thresholds exist, and that once the habitat is reduced below a threshold level, the population will eventually decline to extinction (Thomas et al. 1990, Carroll and Lamberson [in press]). Unfortunately, these models cannot tell us where those thresholds are. For reasons stated above, we believe that the Interagency Scientific Committee strategy and the preferred alternative in the Final Environmental Impact Statement will maintain owl habitat above the levels that might be likely to cause a threshold response.

A review of habitat databases indicated that the Forest Service does not have Geographic Information Systems coverage of all forest age classes and of spatially explicit present or future harvest plans. This makes it impossible to use spatially explicit population viability models to compare different alternatives in the Final Environmental Impact Statement without making numerous assumptions about present and future conditions. Although we have no expectations that population viability models will provide exact estimates of thresholds, we do think they are a very useful tool for ranking alternatives and for exploring general relationships between animals and their environment. Therefore, we recommend that the Forest Service begin to develop the Geographic Information Systems databases necessary to conduct such analyses.

Our review of the available information leads us to believe that hybridization between barred owls and spotted owls is uncommon. However, we do not know if hybridization between the two species will increase as the barred owl continues to increase and expand its range. There is no evidence to indicate that saving more old forest will have any effect on the barred range extension, or on the ability of the spotted owl to compete with the barred owl. At this point we feel that there is little the Forest Service can or should do to influence this relationship, except to provide the spotted owl with a network of secure habitat areas like those proposed by the Interagency Scientific Committee strategy.

Recent surveys indicate that the current spotted owl population is larger than was estimated by the Interagency Scientific Committee. We attribute this to a more complete survey, rather than a population increase. It is important to emphasize that the size of the current population is not particularly relevant. What is important is the size of the population that will exist when the proposed management plan is fully implemented, and the population has stabilized at the lower equilibrium target that was established by Interagency Scientific Committee (about 2,200 pairs).

Although the northern spotted owl population in Canada is probably less than 100 pairs, we believe it is important to protect that population for two reasons. First, the risk of extinction to a species is reduced by maintaining the widest possible distribution (Den Boer 1981, Thomas et al. 1990). Second, groups of individuals near the edge of the range are likely to be best adapted to the unique climatic/habitat conditions that prevail in those areas, and could be better able to persist if similar conditions eventually become prevalent in other portions of the range (Peters and Darling 1985:707-717).

We emphasize that a key part of the strategy proposed by the Interagency Scientific Committee and the Final Environmental Impact Statement is to continue to track owl numbers through monitoring, inventory and demographic studies, and to conduct experiments to assess the extent of bias in methods used to assess population trends. And finally, we call for the adoption of an adaptive management process to facilitate the orderly review and synthesis of new information as it becomes available.

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Appendix 4-A

Description of Banding Studies

Appendix 4-A
Description of Banding Studies

This appendix contains a description of banding/demographic studies being conducted on the northern spotted owl. As of the end of the 1992 field season, a total of 4,066 adults/subadults and 2,784 juveniles had been banded.

OREGON

H.J. Andrews - Meslow/Miller/Swindel/DeStefano
A cooperative study between the Oregon Cooperative Wildlife Research Unit and the Pacific Northwest Forest and Range Experiment Station. This study was initiated in 1987. It includes a 116 mi^2 (300 km^2) density study area encircled by a 655 mi^2 (1,696 km^2) general study area that includes most of the Blue River and McKenzie Ranger Districts of the Willamette National Forest. The study area includes a variety of forest age classes and landscapes typical of lands managed by the Forest Service on the west slope of the Cascades, including a portion of the Three Sisters Wilderness. A total of 306 adults/subadults and 228 juveniles were banded as of 1992. This was one of the five areas described in the Anderson and Burnham report (1992).

Eugene Bureau of Land Management - Western Side - Thrailkill and Meslow
A cooperative study between the Bureau of Land Management and the U.S. Fish and Wildlife Service Oregon Cooperative Wildlife Research Unit. This study officially started in April 1990. However, Bureau of Land Management personnel had already banded about 40 owls in 1989 before the formal study began. This study includes a 178 mi^2 (461 km^2) density study area called the "Wolf Creek Density Study Area", as well as a 540 mi^2 (1,399 km^2) general study area that encompasses the west half of the Eugene District of the Bureau of Land Management (Coast Range and South Valley Resource Areas). The Wolf Creek Density Study Area is included in the general study area. A total of 92 adults, 12 subadults, and 64 juveniles were banded as of 1992.

Eugene Bureau of Land Management - East Side - Irwin/NCASI
A cooperative study between Bureau of Land Management and the National Council for Air and Stream Improvement. This was initially started as a habitat use study in 1988. Following completion of the habitat use study in 1991, the scope of the project was expanded to include a demographic study on private lands and those managed by Bureau of Land Management. The study area includes the east half of the Eugene District, as well as adjacent private lands. A total of 94 adults, 9 subadults, and 23 juveniles were banded as of 1992.

Coos Bay Bureau of Land Management - Pacific Southwest Forest and Range Experiment Station - Noon/Zabel/Brown
A cooperative study between Bureau of Land Management and the Pacific Southwest Forest and Range Experiment Station in Arcata, California. This study was initiated in 1990 on the Coos Bay District of the Bureau of Land Management. However, small samples of owls were also banded on the district from 1986 to 1989, before the formal study began. The study area includes the entire Coos Bay District and intervening private lands. Total area is approximately 400 mi^2 (1,036 km^2). The study is designed to examine population growth rates from mark-recapture analyses. Although it does not include a density study area, conversations with Barry Noon and Mark Brown indicate that most of the study area is being thoroughly searched for owls. A total of 248 adults/subadults and 153 juveniles were banded as of 1992.

Appendix 4-A
Description of Banding Studies (continued)

Siskiyou National Forest - Noon/Zabel/Pacific Southwest Forest and Range Experiment Station
A cooperative study between the Chetco Ranger District of the Siskiyou National Forest and the Pacific Southwest Forest and Range Experiment Station at Arcata, California. Initiated in 1990, this mark-recapture study includes a general study area that encompasses the Chetco Ranger District. It does not include a density study area. A total of 66 adults, 8 subadults, and 30 juveniles was marked as of 1992. The study will likely be discontinued after 1992 because of lack of funding (Zabel pers. comm.).

Siuslaw National Forest - Pacific Northwest Forest and Range Experiment Station - Forsman/Loschl/Forson
A cooperative study between the Siuslaw National Forest and Pacific Northwest Forest and Range Experiment Station. Initiated in March 1990. Includes 1) a 261 mi^2 (676 km^2) density study area that encompasses the north half of the Mapleton Ranger District, and 2) a general study area that includes the entire Siuslaw National Forest. This study encompasses a broad range of landscapes typical of the Oregon Coast Ranges. A total of 132 adults, 17 subadults, and 62 juveniles was banded as of 1992.

Roseburg Bureau of Land Management - Forsman/Reid/Mires/Oliver/Witt/Foster/Lint/et al.
A cooperative study between Bureau of Land Management and the Pacific Northwest Forest and Range Experiment Station. This mark-recapture study was initiated in 1985 and includes the entire Roseburg District of Bureau of Land Management as well as interspersed private lands (roughly 1,700 mi^2 or 4,403 km^2). It includes a 390 mi^2 (1,010 km^2) density study area that encompasses most of the Drain Resource Area. Another 190 mi^2 (492 km^2) density study area was added in 1991 on the Dillard Resource Area. Includes landscapes typical of three geographic provinces, the Coast Ranges, Western Cascades, and Klamath Mountains. A total of 438 adults, 117 subadults, and 453 juveniles was banded as of 1992. This was one of the five areas described in the Anderson and Burnham report (1992). In addition to banding studies, 37 juvenile owls were fitted with 6 gram tail-mount transmitters on this area in 1991 and 1992 to examine survival rates and dispersal.

Medford Bureau of Land Management - Wagner/Meslow/Harper/Wright/et al.
A cooperative study between Bureau of Land Management, the U.S. Fish and Wildlife Service Oregon Cooperative Wildlife Research Unit, and several National Forests. This mark-recapture study was initiated in 1985. Initially it included only a portion of the Medford District of Bureau of Land Management, but in 1990 it was expanded to encompass most of the Medford District as well as portions of the Winema, Umpqua, Siskiyou and Rogue River National Forests. The study includes four density study areas [Butte Falls = 120 mi^2 (311 km^2), Evans Creek = 126 mi^2 (326 km^2), Elk Creek = 105 mi^2 (272 km^2), Williams = 119 mi^2 (308 km^2)]. The general study area covers approximately 4,050 mi^2 (10,490 km^2). A total of 803 adults, 108 subadults, and 564 juveniles was banded as of 1992. This was one of the five areas described by Anderson and Burnham (1992).

Appendix 4-A
Description of Banding Studies (continued)

Salem Bureau of Land Management - Logan/England/Hopkins/Licata

This mark-recapture study was initiated in 1986. It includes a general study area that encompasses the entire Salem District of Bureau of Land Management. It includes two density study areas. Although a few spotted owl responses have been heard in the Nestucca density study area, no owls have been visually located or banded there in three years of surveys (1990-1992). The Nestucca density study area is covered by young and mid-aged forests and cutover areas. A new density study area was initiated in 1992 on Mill Creek, just south of the Nestucca density study area. Both density study areas are located in the Oregon Coast Ranges. The Nestucca density study area will probably be dropped in 1994 assuming that no owls are found there in 1993 (W. Logan pers. comm.). A total of 154 adults/subadults, and 100 juveniles was banded on the district as of 1992.

Warm Springs Indian Reservation - AG Crook Company

The tribe hired the AG Crook Consulting company to mark owls on the reservation in 1992. A total of 47 adults, 4 subadults, and 14 juveniles was banded.

WASHINGTON

Olympic Peninsula - Forsman/Moorehead/Seaman/Anthony

This mark-recapture study was initiated by the Pacific Northwest Forest and Range Experiment Station in 1987 and focuses primarily on Olympic Peninsula lands managed by the Forest Service. Since that time, the Olympic National Park and the Washington Department of Natural Resources have joined in the banding effort, expanding the coverage to portions of the Olympic National Park and to State lands. While the general study area includes the entire Olympic Peninsula, large areas of the Olympic National Park and privately owned forest lands are not surveyed. A 137 mi^2 (355 km^2) density study area is located on the south half of the Quinault Ranger District of the Olympic National Forest on the west side of the Peninsula. The total study area is roughly 965 mi^2 (2,500 km^2). As of 1992, a total of 226 adults, 43 subadults, and 223 juveniles were banded. In addition, a sample of 18 juveniles was marked with tail-mount radio transmitters in 1991 and 1992 to examine survival rates and dispersal patterns. This was one of the five study areas examined by Anderson and Burnham (1992).

Wenatchee National Forest - Forsman/Sovern/Taylor/Pacific Northwest Forest and Range Experiment Station

A cooperative study between the Pacific Northwest Forest and Range Experiment Station and the Wenatchee National Forest. Initiated in 1989 on the Cle Elum Ranger District of the Wenatchee National Forest, the study started as a habitat use study and then continued as a demographic study after the habitat use study was completed in 1991. The study includes a 76 mi^2 (197 km^2) density study area in the Swauk Valley, and a general study area that includes the entire 696 mi^2 (1,803 km^2) Cle Elum Ranger District and adjacent private lands. The Cle Elum study area includes extensive areas that have been selectively logged or burned during the last 80 years. As of 1992, a total of 121 adults, 26 subadults, and 168 juveniles was banded. In addition, 29 juveniles were radio-marked with tail-mount transmitters in 1991 and 1992 to determine survival rates and dispersal patterns.

Appendix 4-A
Description of Banding Studies (continued)

Wenatchee National Forest - Irwin/Flemming/Martin/NCASI/Pacific Northwest Forest and Range Experiment Station
A cooperative study between the National Council For Air and Stream Improvement and the Pacific Northwest Forest and Range Experiment Station in Wenatchee. Initiated in 1990, this mark-recapture study includes most of the Wenatchee National Forest, with the exception of the Cle Elum Ranger District. It does not include a density study area. A total of 173 adults, 21 subadults and 170 juveniles was marked as of 1992. This study was designed to compare demographic parameters of owls living in managed and unmanaged habitats.

Yakima Indian Nation - Eric Hanson
This study was initiated in 1991 as a habitat use study but also includes a sample of banded owls. The study area includes the forested portions of the Yakima Indian Reservation on the east slope of the Washington Cascades. This study abuts the demographic studies that are being conducted on the Wenatchee National Forest. A total of 26 adults, 2 subadults, and 13 juveniles was banded as of 1992.

CALIFORNIA

Willow Creek Study - Franklin/Gutierrez/Noon
A cooperative study between Humboldt State University, the California Department of Fish and Wildlife, and the Pacific Southwest Forest and Range Experiment Station at Arcata, California. This mark-recapture study was initiated in 1985 on the Six Rivers National Forest in northwestern California. It includes a 113 mi^2 (293 km^2) density study area on Willow Creek as well as a series of smaller density study areas distributed in a satellite network around the Willow Creek area. The study area includes landscapes typical of the Six Rivers National Forest. A total of 254 adults/subadults and 276 juveniles was banded as of 1992. This was one of the five areas examined by Anderson and Burnham (1992).

Simpson Timber Company - Lowell Diller
This study was started as a habitat use study in 1989, then continued as a mark-recapture demographic study after the habitat use study was completed in 1991. The 300 mi^2 (777 km^2) study area includes primarily Simpson Timber Company lands within the redwood belt of northwestern California. Although not designed as a density study per se, an area of approximately 220,608 acres (893 km^2) had been surveyed well enough to estimate minimum density of owls as of 1992. The study area includes mostly young-growth and mid-aged redwood forest and areas that have been recently clearcut. A total of 250 adults, 62 subadults, and 197 juveniles was banded as of 1992.

Appendix 4-A
Description of Banding Studies (continued)

Louisiana Pacific Timber Company - Malcom Pious
This study was started in 1990 as a mark-recapture study. The study area covers approximately 650 mi^2 (1,683 km^2) of predominantly private land along the northern California coast. Much of which is covered by young to mid-age redwood forest. A total of 154 adults/subadults and 35 juveniles was marked as of 1992.

Hoopa Valley Indian Reservation - Mark Higley
This study was started in 1991 by the Hoopa Valley Tribal Council in mixed-conifer forests in northwestern California. A total of 47 adults, 6 subadults, and 11 juveniles was banded in 1991-92.

Appendix 4-B

Annotated List of Publications and Draft Reports that Provide New Information on the Northern Spotted Owl

Appendix 4-B
Annotated Bibliography

Annotated Bibliography of Recent Research Information on Northern Spotted Owls

This annotated bibliography contains references on selected scientific studies that have been published or are still unpublished since the completion of the Final Environmental Impact Statement on Management for the Northern Spotted Owl in the National Forests. References contained within this bibliography became generally available between January 1992 and November 1992. Because additional studies may be in an unpublished form and therefore not readily available, it is probable that some literature relating to this subject and completed within the dates given were not included in this annotated bibliography. Some of the unpublished literature is still in draft form and not ready for public distribution. The Scientific Analysis Team was permitted to review these drafts for the purpose of assessing new data since the Interagency Scientific Committee report.

The major conclusions of the Interagency Scientific Committee Report regarding spotted owl biology, demography and habitat use have not changed substantially after a review of the literature included here. Research on spotted owl habitat use, particularly for northern California and the east slope of the Washington Cascades should continue to add to the existing information. The review of new studies and the incorporation of information into habitat management planning should continue through accepted scientific research processes, including publication peer review.

This appendix is divided into two sections. The first section is a list of studies that have been published since the Final Environmental Impact Statement. In the second section, unpublished references available since completion of the Final Environmental Impact Statement are listed. For most references, in addition to the literature citation, the abstract is included when available. For annotations which come from author written abstracts, summaries, and conclusions, an index code of (A) is given at the end of the quote. For compiler generated annotations, an index code of (C) is found at the end of the paragraph.

Published Literature

Anderson, D.R.; Burnham, K.P. 1992. Demographic analysis of northern spotted owl populations. Pages 319-328 in: Recovery plan for the northern spotted owl, appendix C - draft. Portland, OR: U.S. Department of the Interior. 662 p.

"The 1990 Status Review Northern Spotted Owl (USDI 1990) provided estimates of the rate of population change for populations of northern spotted owls in northern California (Willow Creek and surrounding regional study area) and southern Oregon (the Roseburg study area). The population of resident female owls in these areas was shown to be declining at a significant rate. By the fall of 1991, there were 2 additional years of capture-recapture data on these two populations, and three new areas (Medford in southern Oregon, H.J. Andrews near Corvallis, Oregon and the Olympic Peninsula in northwestern Washington) had sufficient years of capture-recapture data to warrant an intensive analysis (Table C.1). More than 2,000 owls had been marked and the resighting probability for adult females was approximately 0.8 to 0.9 percent."

"This appendix provides estimates for the rate of population change of resident, territorial females in these five large study areas. Analysis methods (e.g., model building, model selection, tests of model fit, parameter estimation, and inference procedures concerning the rate of population change) are those used in USDI (1990) with some extensions. The key references on methodology are Burnham and Anderson (In Press) and Lebreton et al. (In Press). The analyses of data were done during September-October, 1991, during one intensive workshop held in Ft. Collins, Colorado. The analyses were completed by six biologists working on the northern spotted owl - two French scientists, two professors from Colorado State University with special expertise in the analysis of capture-recapture data, and two U.S. Fish and Wildlife Service employees from the Colorado Cooperative Fish and Wildlife Research Unit." (A)

Bart, J.; Forsman, E.D. 1992. Dependence of northern spotted owls *Strix occidentalis caurina* on old-growth forests in the western USA. Biological Conservation. (62): 95-100.

Abstract. "Habitat requirements of northern spotted owls *Strix occidentalis caurina* have become the focus of a major controversy over how much old-growth forest in the western United States should be preserved. Analysis of three large data sets showed that the subspecies was rare or absent in areas with little older (i.e. > 80-year-old) forest but with extensive stands nearing harvest age. The owls were also rare in areas with the small amount of old-growth typically left after harvest operations. Old-growth stands in Wilderness Areas supported sparse populations of northern spotted owls, and their reproductive success was only about half that of owls outside Wilderness Areas. The results indicate that timber harvest operations, as currently practiced, lead to declines in numbers of northern spotted owls, and that currently protected old-growth stands are unlikely to provide enough high-quality habitat to maintain self-supporting populations of northern spotted owls." (A)

Bias, M.A.; Gutierrez, R.J. 1992. Habitat associations of California spotted owls in the central Sierra Nevada. Journal of Wildlife Management. 56(3): 584-595.

"Abstract: Habitat requirements of spotted owls (*Strix occidentalis*) are controversial, particularly with respect to private lands. Therefore, we studied the distribution and roosting and nesting habitat of California spotted owls (*S. o. occidentalis*) throughout a 355-km^2 study area in the central Sierra Nevada, Eldorado and Placer counties, California, from May to August 1986 and 1987. Fewer ($P \leq 0.001$) owls were detected on private land than expected from its relative land area. Slope; total canopy closure; number of possible nest trees; maximum shrub height; basal areas of old-growth, medium, pole and live trees; percent ground cover by litter; and small and large dead or dying woody vegetation were different ($P \leq 0.05$) between public and private land. Habitat types of mixed-conifer, large-tree successional stage, with $\geq$ 70 percent total canopy closure were most abundant (38.1 percent) on public land; whereas mixed-conifer, pole-medium successional stage with $\geq$ 70 percent total canopy closure habitat types dominated private land (44.1 percent). Roost sites occurred in habitats with relatively greater total canopy closure, and basal areas of snags, medium, and old-growth trees than found in the abundance of habitat. Twenty-six of 29 observed roosts (89.7 percent) and all 11 owl nests were on public land. Our results provide forest managers with a direction towards appropriate silvicultural and logging practices for the conservation of California spotted owl roost and nest habitats. These include adequate representation of all tree size classes, especially mature and old-growth, combined with essential habitat elements (e.g., nest trees)." (A)

Blakesley, J.A.; Franklin, A.B.; Gutierrez, R.J. 1992. Spotted owl roost and nest site selection in northwestern California. Journal of Wildlife Management. 56(2): 338-392.

"Abstract: We directly observed roost and nest site selection in a population of northern spotted owls (*Strix occidentalis caurina*) in northwestern California during 1985-89. Because of potential biases caused by use of radio telemetry in previous studies, we examined habitat use relative to habitat availability at a level not previously reported for spotted owls. Spotted owls selected coniferous forest characterized by trees >53.3 cm in diameter more often ($P<0.05$) than it was available. Hardwood stands and coniferous forest dominated by smaller trees were used less than ($P<0.05$), or in proportion to, their availability. The owls selected forests at 300-900 m elevations for roosting ($P<0.05$), selected the lower third of slopes within a specific drainage ($P<0.05$), and avoided the upper third for both roosting and nesting ($P<0.05$). These observations support the findings of earlier workers who used radio telemetry and to assess habitat selection in the northern spotted owl" (A)

Carey, A.B.; Horton, S.P; Biswell, B.L. 1992. Northern spotted owls: influence of prey base and landscape character. Ecological Monographs. 62(2): 223-250.

"Abstract. We studied prey populations and the use and composition of home ranges of 47 Northern Spotted Owls (*Strix occidentalis caurina*) over 12 mo in five landscapes in two forest types in southwestern Oregon. We measured 1-yr home ranges of 23 owl pairs, 2-yr home ranges of 13 owl pairs, and 3-yr home ranges of 3 pairs. The landscapes differed in the degree to which old forest had been fragmented by wildfire and logging. Prey populations were measured at 47 sites in southwestern Oregon. Further data on prey populations were gathered on 14 sites on the Olympic peninsula in northern Washington, where owls use larger ranges than in Oregon."

Carroll, J.E.; Lamberson, R.H. 1992. [In press]. The owl's odyssey. A continuous model for the dispersal of territorial species. Society of Industrial and Applied Mathematics Journal of Applied Mathematics. 52(6).

"Abstract. In this paper, a composite model is developed that consists of a continuous model for dispersal set within a difference equation model for the life history of territorial species. Two dispersal models are considered: one that assumes that suitable habitat is uniformly or randomly distributed throughout the range of the population, and one that assumes that home ranges are concentrated in clusters of suitable habitat. These models explicitly consider the cost of dispersal by including ongoing rates of mortality due to predation and starvation while birds search for a territory. The cluster model also differentiates between mortality within and outside of clusters. An analysis of the difference equation model demonstrates a threshold for density of suitable habitat below which the population must decrease to extinction, and above which the population tends monotonically to a stable positive equilibrium size. In addition, it is established that the equilibrium size of the population can be increased by consolidating the reserves of suitable habitat into larger clusters." (A)

Dunbar, D.L.; Booth, B.P.; Forsman, E.D., [and others]. 1991. Status of the spotted owl, *Strix occidentalis*, and barred owl, *Strix varia*, in southwestern British Columbia. Canadian Field Naturalist. 105(4): 464-468.

Abstract. "Calling surveys were used to assess the relative abundance and distribution of Spotted and Barred owls in southwestern British Columbia from 1985 to 1988. Spotted Owls were located at 14 sites, including pairs at 7 sites and single birds at 7 sites. One Spotted Owl nest was located. Barred Owls were located at 57 sites, including pairs at 14 sites and single birds at 43 sites. The average number of individuals responding per km of survey transect was 0.04 and 0.15 for Spotted and Barred Owls, respectively. The low response rate for Spotted Owls indicates that the species is rare in British Columbia. We estimated the population at not more than 100 pairs. Although the Spotted Owl has probably never been abundant in British Columbia, we hypothesize that the population has declined because of habitat loss and displacement by the Barred Owl." (A)

Foster, C.C.; Forsman, E.D.; Meslow, E.C., [and others]. 1992. Survival and reproduction of radio-marked adult spotted owls. Journal of Wildlife Management. 56(1): 91-95.

"Abstract: We compared survival, reproduction, and body mass of radio-marked and non-radio-marked spotted owls (*Strix occidentalis*) to determine if backpack radios influenced reproduction or survival. In most study areas and years, there were no differences ($P<0.05$) in survival of males and female or in survival of radio-marked versus banded owls. There was no difference ($P = 0.31$) in mean mass of owls before and after they had worn radio transmitters. Radio-marked owls produced fewer ($P<0.01$) young than did owls that were not radio-marked. Because of the possible relationship between lower productivity and large (>19-g) backpack style transmitters, we recommend that researchers consider the use of smaller transmitters mounted on the tail." (A)

Franklin, A.B. 1992. Population regulation in northern spotted owls: theoretical implications for management. Pages 815-827 in: McCullough, D.R.; Barrett, R.H., eds. Wildlife 2001: populations. London, England: Elsevier Applied Science. 1163 p.

"Abstract. A marked population of northern spotted owls was examined within a bounded, 292 km^2 study area in northwestern California over a six-year period (1985-1990). Observed and predicted finite rates of population change (λ) for males spotted owls were significantly stable. Predicted λ for females indicated a significant decline even though observed λ indicated stability. Observed stability in numbers of territorial males was maintained by recruitment, whereas stability in numbers of females was maintained by immigration. Most recruits did not become territory holders until several years after their birth. I hypothesized that the study area population was regulated by territorial behavior. Under this mechanism, spotted owl populations may be declining even though observed numbers of territorial birds appear to be stable. Using a computer model, I examined the effects of "floaters" on the stability of territory holders, and suggest warning signals which may predict imminent instability for the population." (A)

Ganey, J.L. 1992. Food habits of Mexican spotted owls in Arizona. The Wilson Bulletin. 104(2): 321-326.

"Results. - Between May 1984 and August 1990, I identified 1434 prey items from pellets or kills of 34 pairs of spotted owls. The diet included at least 19 species of mammals, seven species of birds, two species of reptiles and an unknown number of insect species. Vertebrates dominated the diet in all five regions, comprising 84-96% of total prey and 99% of prey biomass (Table 1). Mammals accounted for 73-96% of total prey and 91-99% of prey biomass. Owls consumed prey ranging in mass from beetles (Coleoptera) and moths (Lepidoptera) (ca 1 g) to adult cottontail rabbits (*Sylvilagus* spp; ca 650 g). Mean prey mass ranged from 63-118 g in various regions."

"Woodrats, white-footed mice (*Peromyscus* spp.), and voles (*Microtus* spp.) accounted for 61-83% of the total prey and 59-88% of total biomass in various regions (Table 1). Cottontails and pocket gophers (*Thomomys* spp.) accounted for another 3-14% of total prey and 7-36% of total biomass. Birds and reptiles contributed little to prey numbers or biomass except in Southeast Arizona. Insects were relatively common in the diet (3-16% of total prey) but contributed little to prey biomass. Diurnally active mammals such as squirrels and chipmunks (Scuridae) accounted for <3% of total prey or biomass." (A)

Ganey, J.L.; Duncan, R.B.; Block, W.M. 1992. Use of oak and associated woodlands by Mexican spotted owls in Arizona. Pages 125-128 in: Ecology and management of oak and associated woodlands: perspectives in the southwestern United States and northern Mexico: Proceedings of a symposium; 1992 April 27-30; Sierra Vista, AZ. Gen. Tech. Rep. RM-218. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 224 p.

"Abstract - Although the spotted owl is often associated with coniferous forests, oak and associated woodlands also provide habitat for spotted owls. In Arizona, Mexican spotted owls are year-round residents in Madrean oak-pine forests, encinal woodlands, and ponderosa pine-Gambel oak forests, while some spotted owls winter in pinyon-juniper woodlands. Oak and associated woodlands present unique management challenges to resource managers charged with maintaining viable populations of Mexican spotted owls." (A)

Johnson, D.H. 1992. Spotted owls, great horned owls, and forest fragmentation in the central Oregon Cascades. Corvallis, OR: Oregon State University. 138 p. M.S. thesis.

"Nocturnal surveys were conducted in February - May 1989 and January - May 1990 to locate great horned owls (*Bubo virginianus*) and northern spotted owls (*Strix occidentalis caurina)* throughout the range of forest fragmentation levels in the Central Cascades of Oregon. Forest fragmentation levels ranged from landscapes ($\geq$ 500 ha in size) containing intact stands of mature/old-growth forest (0% fragmentation) to landscapes containing younger stands with no mature/old-growth forest (100% fragmentation). Six survey visits were made to each of 469 calling stations located along 28 roadside survey routes. Total length of survey routes was 535.8 road km; relative abundance for great horned owls and spotted owls was 0.069 and 0.139 owls/road km, respectively. Owl response rates were examined for differences 1) during the night, 2) by moon phase, and 3) by month during the survey period. Great horned owls responded less than expected before midnight and more than expected after midnight, less than expected during full moon and more than expected during new moon phases, and less than expected during January and April of the survey period. Spotted owls responded more than expected from 1800-1959 hr, more than expected during full moon phases, and generally more than expected during May of the survey period."

"Thirteen habitat/landscape variables within 500-ha circular landscape plots surrounding 77 great horned owl, 103 spotted owl, 70 no-owl and 70 random points were assessed. Significant differences existed between great horned and spotted owl landscapes for 6 variables: great horned owl landscapes contained more shrub/forb and shelterwood, less mature/old-growth and interior habitat, had a higher linear edge-to-mature/old-growth area ratio, and were higher in elevation than spotted owl landscapes. The amount ($\bar{x}$ $\pm$ SE) of mature/old-growth forest was 48% $\pm$ 2% around great horned owls, 60% $\pm$ 2% around spotted owls, 53% $\pm$ 3% around no-owl points, and 53% $\pm$ 2% around random points. The greatest number of great horned owl responses were associated with landscapes containing 10-20% old forest. Great horned owl responses generally declined with increasing amount of old forest, and few (11%) great horned owls were detected in landscapes containing $\geq$ 70% old forest. The majority (62%) of spotted owls were detected within landscapes containing $\geq$ 60% old forest. Spotted owl responses generally declined with declining amounts of old forest, and few (7%) spotted owls were detected within landscapes containing $\leq$ 20% old forest."

"The spatial distribution of old forest stands was compared to dispersed (checkerboard) and clumped landscapes; 95% of great horned owl, 88% of spotted owl, 89% of no-owl, and 86% of random landscapes were classified as dispersed. Clearly, the forests of the Central Cascades are very highly fragmented. A method for linking owl biology and landscape level plot size is described." (A)

Johnson, D.H.; Miller, G.S.; Meslow, E.C. 1992. Edge effects and the northern spotted owl. Spotted owls, great horned owls, and forest fragmentation in the central Oregon Cascades, appendix C. Corvallis, OR: Oregon State University. 138 p. M.S. thesis.

"Distance-to-edge measurements derived from 1,159 telemetry locations and 51 nest sites indicated that owls avoided young stands and preferentially selected locations within old forest stands. Owl telemetry and nest locations were consistently farther into old forest stands than were randomly selected points ($P \leq 0.01$). Although owls may forage up to an edge, they prefer areas $\geq$ 90 [m] from an edge during the night. For daytime roost locations and nest sites, owls have indicated a decided preference for location $\geq$ 100 m from an edge into old forest stands. Based on determinations presented here, researchers and managers concerned with edge should use an "edge effect " distance of $\geq$ 100 m for northern spotted owls." (A)

LaHaye, W.S.; Gutierrez, R.J.; Call, D.R. 1992. Demography of an insular population (*Strix occidentalis occidentalis*). Pages 803-814 in: McCullough, D.R.; Barrett, R.H., eds. Wildlife 2001: populations. London, England: Elsevier Applied Science. 1163 p.

"Abstract. We studied the dynamics of an insular California spotted owl (*Strix occidentalis occidentalis*) population in the San Bernardino Mountains of southern California, USA. We located owls at 128 sites and banded 367 individuals between 1987-1990. We captured and color banded at least 70% of the territorial spotted owls in the mountain range. We measured territory occupancy, social status, nesting rate, fledging rate, fecundity, territory turnover and replacement rates, and survivorship. California spotted owls in the San Bernardino Mountains had variable annual reproduction. Survival rates were the lowest yet reported for a spotted owl population. We calculated λ=0.769 using a two stage Leslie projection matrix and this value was significantly different than 1.0. In this paper we assess the effect of sample size on the estimates of vital rates of this owl population. We discuss the relevance of insular studies of spotted owl populations to the understanding of the demographics of continuous spotted owl populations." (A)

McKelvey, K. 1992. A spatially-explicit life-history simulator for the northern spotted owl. USDI Bureau of Land Management Eugene District resource management plan and environmental impact statement, appendix 4-P. Eugene, OR: U.S. Department of the Interior, Bureau of Land Management, Region 1. 33 p. 2 vol + 4 maps.

"A spatial model was created to simulate the impact of forest management on populations of the northern spotted owl. The basic premise of the model is that an organism's survival and reproduction can be linked explicitly to its immediate habitat and that habitat's context within the larger landscape. That is, a population's rates of survival and fecundity will vary based on map configuration. In addition, the model allows for habitat areas that are unsuitable or marginally suitable for nesting. Lastly, the model assumes that each organism must search the landscape to find a mate."

"The model is a single-organism simulator. Each organism is born, moves, attempts to find a mate and breed, and dies. This format allows the behavior of each individual to be simulated by following a series of probabilistic rules rather than through the abstraction of an equation set. The model is flexible, allowing for the analysis of individual characteristics as well as population dynamics. The average distance moved by individual birds before death or pairing, for example, can be output, and thus compared with data from banding or telemetry studies to determine if the simulated movement produces a path-length similiar in magnitude to the observed behavior." (A)

National Forest Products Association and American Forest Council. 1992. A multi-resource strategy for the conservation of the northern spotted owl. Compiled by the Spotted Owl Subgroup of the Wildlife Committee of the National Forest Products Association and the American Forest Council. 60 p. + 1 map.

"This strategy is offered as a management alternative that we believe can safeguard the long-term survival of the northern spotted owl (*Strix occidentalis caurina*) while simultaneously allowing the sustained yield of forest products. It combines several approaches and defines both public and private landowner roles for the conservation of the northern spotted owl."

"Our strategy was developed to provide technical input to the various processes (critical habitat proposals, recovery plan development, state regulations, etc) surrounding the management of the northern spotted owl in the Pacific Northwest. We relied heavily on the summary of biological information presented in Thomas et al. (1990) and employed many of the same key biological principles (such as a system of protected habitat for multiple pairs and provisions for connectivity between them). We also incorporated new survey and research information that has become available in the last two years."

"By studying the most recent available data, including land use classification, suitable habitat maps, and owl locations (provided by the U.S. Forest Service and other agencies), we developed a concept that will specify a zone of owl habitat that stretches from British Columbia to northern California." (A)

Murphy, D.D.; Noon, B.R. 1992. Integrating scientific methods with habitat conservation planning: reserve design for northern spotted owls. Ecological Applications. 2(1): 4363-4378.

"Abstract. To meet the requirements of Congressional legislation mandating the production of a 'scientifically credible' conservation strategy for the threatened Northern Spotted Owl (*Strix occidentalis caurina*), the Interagency Spotted Owl Scientific Committee employed scientific methods to design a habitat reserve system. Information on the current and historical distributions of the owl and its habitats was reviewed in light of economic, political, and legal constraints; results were used to develop a preliminary reserve system of habitat 'polygons'. A map representing these polygons and their attendant properties served as a set of hypotheses that were tested. Statistical analyses of empirical data, predictions from ecological theory, predictions from population dynamics models, and inferences drawn from studies of related species were used to test properties of the preliminary map, including the number and sizes of habitat conservation areas (HCAs), their distribution, configuration, and spacing, and the nature of the landscape matrix between Habitat conservation areas. Conclusions that failed to confirm specific map properties were used to refine the reserve system, a process that continued iteratively until all relevant data had been examined and all

map properties had been tested. This conservation planning process has proven to be credible, repeatable, and scientifically defendable, and should serve as a model for wildlife management, endangered species recovery, and national forest planning." (A)

Simpson Timber Company. 1992. Habitat conservation plan for the northern spotted owl on the California timberlands of Simpson Timber Company. Arcata, CA: Simpson Timber Company. Addendum. 323 p.

"Simpson Timber Company (Simpson), a privately held corporation, is seeking a permit from the U.S. Fish and Wildlife (USFWS) for the incidental take of northern spotted owls (*Strix occidentalis caurina*) in connection with timber harvesting on the properties of its California subsidiaries, Arcata Redwood Company and Simpson Redwood Company. This habitat conservation plan (HCP) has been prepared as part of the application for that permit, pursuant to Section 10(a)(1)(B) of the Federal Endangered Species Act (ESA) of 1973 as amended. Upon approval of the permit, the plan also will be used to demonstrate compliance with the current spotted owl provisions of California's Forest Practice Rules." (A)

Thomas, J.W.; Verner, J. 1992. Accomodation with socio-economic factors under the Endangered Species Act - more than meets the eye. Proceedings of the 57th North American wildlife and natural resource conference. 627-641 p.

"We intend to explore myths and realities about how much attention is paid to socio-economic consequences when applying the Endangered Species Act (ACT) of 1973 (U.S. Laws, Statutes, etc. Public Law 93-205). We will examine the circumstances surrounding the development and adoption of a conservation strategy for the northern spotted owl (*Strix occidentalis caurina*) and other activities, including the listing of the subspecies as "threatened," delineation of critical habitat, development of a recovery plan, development of Habitat Conservation Plans (HCPs) and other actions (Corn and Baldwin 1990). Our objective is to point out that what is perceived by many as relentless and inexorable process solely based on biology to protect imperiled species without consideration of socio-economic impacts is, in fact, a procedure subject to repeated accomodation between the listed species welfare and the associated socio-economic consequences."

"This analysis is based on our experiences as members of the Interagency Scientific Committee to Address the Conservation of the Northern Spotted Owl (ISC)." (A)

USDA. 1992. Final environmental impact statement on management for the northern spotted owl in the National Forests. Portland, OR: U.S. Department of Agriculture, Forest Service, National Forest System. 2 vol.

"The Forest Service has prepared an environmental impact statement to disclose the environmental consequences of five different management alternatives to provide habitat for the northern spotted owl in National Forests. Four of these alternatives would amend the Regional Guides and approved Forest Plans for the Pacific Northwest Region and the Pacific Southwest Region of the Forest Service."

"The proposed action is to manage National Forests within the range of the northern spotted owl in accordance with the Interagency Scientific Committee's report 'A Conservation Strategy for The Northern Spotted Owl'. This proposed action would apply only to lands administered by the Forest Service" (A)

USDI. 1992. Recovery plan for the northern spotted owl - draft. Portland, OR: U.S. Department of the Interior. 662 p.

"The northern spotted owl draft recovery plan provides a comprehensive basis for management actions to be undertaken by forest landowners and wildlife agencies to alleviate conditions threatening the species. Primary actions will be taken by Federal land management agencies in the Pacific Northwest – the U.S. Forest Service, the U.S. Bureau of Land Management, and the National Park Service. The U.S. Fish and Wildlife Service will oversee implementation of the plan through its authorities under the Endangered Species Act."

"State forest management and wildlife agencies in Oregon, Washington, and California also will take actions that contribute to recovery under the plan. These state agencies have an important role in managing state forests and in regulating forest practices on private land within their jurisdiction. Contributions from habitat on Indian lands also were considered in formulating the draft plan." (A)

USDI Bureau of Land Management. 1992a. Coos Bay District resource management plan and environmental impact statement. Coos Bay, OR: U.S. Department of the Interior, Bureau of Land Management, Region 1. 2 vol. + 4 maps.

"Abstract: This Draft Resource Management Plan/Environmental Impact Statement addresses resource management on 329,583 acres of Federal land and 12,152 acres of reserved mineral estate administered by the Bureau of Land Management in its Coos Bay District. Seven alternatives including no action (no change in the existing plan) are analyzed. These alternatives range in emphasis from high production of timber and economically important values to management and enhancement of values such as biological diversity, spotted owl habitat, old-growth forests, dispersed recreation opportunities, and scenic resources. The preferred alternative would: provide for a planned annual timber sale level of 20.1 MMCF (124 MMBF) from 309,000 acres of commercial forest land; maintain air quality, water quality, and long term soil productivity; retain 52,400 acres of old-growth forest; provide habitat to support a carrying capacity of 16 to 24 pair of northern spotted owls and provide for protection of other Federally listed animal species; designate eight new Areas of Critical Environmental Concern on 7,490 acres; provide opportunities to develop 27 recreation areas/sites or trails; designate five Back Country Byways; provide for visual resource management on 7,200 acres; and provide for mineral exploration and development on 322,200 acres. No rivers would be found suitable for designation under the Wild and Scenic Rivers Act. Long term management (100 years) under the Preferred Alternative would increase the amount of old-growth to 56,300 acres and increase the carrying capacity for the northern spotted owl to between 41 and 58 pair." (A)

USDI Bureau of Land Management. 1992b. Eugene District resource management plan and environmental impact statement. Eugene, OR: U.S. Department of the Interior, Bureau of Land Management, Region 1. 2 vol. + 4 maps.

"Abstract: This Draft Resource Management Plan/Environmental Impact Statement addresses resource management on 316,592 acres of Federal land and 1,299 acres of reserved mineral estate administered by the Bureau of Land Management in its Eugene District. Seven alternatives including no action (no change in the existing plan) are analyzed. These alternatives range in emphasis from high production of timber and economically important values to management and enhancement of values such as biological diversity, spotted owl habitat, old-growth forests, dispersed recreation opportunities, and scenic resources."

"The Preferred Alternative would: provide for a planned annual timber sale level of 19.9 mmcf (119 mmbf, Scribner Short Log) while maintaining water quality in all watersheds. Old-growth forest acreage would be reduced by about 2,700 acres (7%) in the short-term, five additional Areas of Critical Environmental Concern (ACECs) would be designated, and three segments of river would be found suitable for designation under the Wild and Scenic Rivers Act." (A)

USDI Bureau of Land Management. 1992c. Medford District resource management plan and environmental impact statement. Medford, OR: U.S. Department of the Interior, Bureau of Land Management, Region 1. 2 vol. + 4 maps.

"Abstract. "This Draft Resource Management Plan/Environmental Impact Statement addresses resource management on 866,300 acres of Federal surface estate and approximately 4,700 acres of reserved mineral estate administered by the Bureau of Land Management in its Medford District. Seven alternatives including the No Action alternative (no change from the existing plan) are analyzed. These alternatives range in emphasis from high production of timber and other commodity values to management and enhancement of values such as biological diversity, spotted owl habitat, old growth forests, dispersed recreation opportunities, and scenic resources. The Preferred Alternative would provide for a planned annual timber sale level of about 18 mmcf (105 mmbf) on a sustained yield basis while maintaining water quality in all watersheds and long-term biological diversity. Old growth forest acreage would be increased by about 4,000 acres (4%), 22 additional areas of critical environmental concern would be designated, and 5 stretches of river would be found suitable for designation under the Wild and Scenic Rivers Act." (A)

USDI Bureau of Land Management. 1992d. Roseburg District resource management plan and environmental impact statement. Roseburg, OR: U.S. Department of the Interior, Bureau of Land Management, Region 1. 2 vol. + 4 maps.

"Abstract: This draft resource management plan/environmental impact statement addresses resource management on 419,400 acres of Federal land administered by the Bureau of Land Management in its Roseburg District. Seven alternatives including no action (no change in the existing plan) are analyzed. These alternatives range from management of timber and other resources vital to the economy, to management and enhancement of values such as biological diversity, spotted owl habitat, old-growth forests, recreation opportunities, and scenic resources. The preferred alternative would provide a planned annual timber sale level of 16.3 mmcf (105 mmbf), while meeting established water quality criteria in all watersheds. Also, 91,700 acres of old-growth forest would be retained at the end of the first decade; three additional areas of critical environmental concern would be designated; and no river segments would be found suitable for designation under the Wild and Scenic Rivers Act." (A)

USDI Bureau of Land Management. 1992e. Salem District resource management plan and environmental impact statement. Salem, OR: U.S. Department of the Interior, Bureau of Land Management, Region 1. 2 vol. + 4 maps.

"Abstract: This draft resource management plan/environmental impact statement addresses resource management on 393,600 acres of Federal land and 27,800 acres of reserved mineral estate administered by the Bureau of Land Management in its Salem District. Seven alternatives including no action (no change in the existing plan) are analyzed. These alternatives range from management of timber and other resources vital to the economy, to management and enhancement of values such as biological diversity, spotted owl habitat, old-growth forests, recreation opportunities, and scenic resources. The preferred alternative would provide a planned annual timber sale level of 21.5 mmcf (136.5 mmbf), while meeting established water quality criteria in all watersheds. Also, 28,000 acres of old-growth forest would be retained at the end of the first decade; seven additional areas of critical environmental concern would be designated; and two river segments would be found suitable for designation under the Wild and Scenic Rivers Act. " (A)

USDI Fish and Wildlife Service. 1992f. Endangered and threatened wildlife and plants: determination of critical habitat for the northern spotted owl; final rule. Washington, DC: Federal Register. 50(17): 1795-1838.

"The Fish and Wildlife Service (Service) designates critical habitat for the northern spotted owl (*Strix occidentalis caurina*), a subspecies Federally listed as threatened under the Endangered Species Act of 1973, as amended (Act). The northern spotted owl, referred to herein as spotted owl or owl, is a forest bird that inhabits coniferous and mixed conifer-hardwood forests over a range that extends from southwestern British Columbia through western Washington, western Oregon, and northwestern California south to San Francisco Bay."

"This critical habitat designation provides additional protection requirements under section 7 of the Act with regard to activities that are funded, authorized, or carried out by a Federal agency. As required by section 4 of the Act, the Service considered the economic and other relevant impacts prior to making a final decision on the size and scope of critical habitat. The Service excluded some areas from designation due to economic and other relevant information. Final critical habitat units are designated solely on Federal lands." (A)

USDI Fish and Wildlife Service. 1992g. Protocol for surveying proposed management activities that may impact northern spotted owls. Rev. 2nd ed. Portland, OR: U.S. Department of the Interior, Fish and Wildlife Service, Region 1. 17 p.

"The enclosed protocol was designed for surveying areas where Federal or non-Federal activities may remove or modify northern spotted owl habitat. The U.S. Fish and Wildlife Service (Service) endorses the use of this protocol for gathering information on spotted owl occupancy in proposed project areas for assessing affects of the proposed actions. Note that any information on owl presence within and/or adjacent to the proposed planning or activity areas is important, even if it does not meet the guidelines described below. However, if the only information available for a particular activity was acquired through less intensive surveys, the Service must conservatively assess (i.e. a worst-case analysis) the impacts of the action on northern spotted owls. It is always useful to document reasons for not adhering to the recommended protocol."

"This protocol is based on several existing protocols and, when implemented, should serve two primary purposes: (1) provide adequate coverage and assessment of the area for the presence of spotted owls, and (2) ensure a high probability of locating resident spotted owls and identifying owl territories that may be affected by a proposed management activity, thereby minimizing the potential for unauthorized incidental take. It is not appropriate to use this protocol to monitor yearly trends of spotted owls or for many other research applications."

"In this document, management activities are defined as those activities which may impact northern spotted owls. The most common activity is harvest or modification of spotted owl habitat. Also included under management activities are various types of disturbance not necessarily associated with timber harvest activities."

"This protocol was peer-reviewed by scientists, biologists, and managers who work on various issues pertinent to the ecology and management of northern spotted owls." (A)

Zabel, C.J.; Steger, G.N.; McKelvey, K.S., [and others]. 1992. Home-range size and habitat-use patterns of California spotted owls in the Sierra Nevada. Gen. Tech. Rep. PSW-GTR-133. U.S. Department of Agriculture, Forest Service. 141-155 p.

"Estimates of home range size among California spotted owls are extremely variable. All available data indicate that they are smallest in habitats at relatively low elevations that are dominated by hardwoods, intermediate in size in conifer forests in the central Sierra Nevada, and largest in true fir forests in the northern Sierra Nevada." (A)

Unpublished Literature

Anderson, D.R.; Burnham, K.P. 1992. Model building and statistical inferences for adult female northern spotted owls. Proceedings of the 62nd annual meeting of the Cooper Ornithological Society symposium; 1992 June 22-28; Seattle, WA.

"Inference concerning population parameters of the northern spotted owl from capture-recapture data rests on the proper analysis of multiple data sets. The primary methodological issue is one of intense model building and model selection. Given a model, maximum likelihood provides a framework for optimal inference, at least for large samples."

"This paper stresses the importance of a global model for the analysis of capture-recapture data. Akakie's Information Criterion (AIC) provides a useful method for proper selection within the Principle of Parsimony. Goodness-of-fit must be evaluated and quasi-likelihood methods are often used to obtain good estimates of sampling variances and covariances."

"An example is given for the northern spotted owl whereby 64 interrelated models are considered for the analysis of female data collected on five large study areas. The paper emphasizes analysis philosophy, model selection and statistical inference." (A)

Anthony, R.G.; Desimone, S.E.; Apfelbeck, K., [and others]. October 1991. Patterns of distribution and abundance of small mammals in old- and second-growth Douglas-fir forests in the Central Cascades. Pages 1-4 in: Wildlife habitat relationships in western Washington and Oregon. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Wildlife Ecology Team; annual report. 119 p.

"Study Objective(s): a. Compare small mammal abundance in old- and second-growth Douglas-fir forests. b. Describe the population dynamics of flying squirrels in old-growth Douglas-fir forests. c. Relate spotted owl reproduction to prey abundance. d. Collaborate with other researchers in the spotted owl RD&A Program in synthesizing the results of the owl prey ecology studies across the Pacific Northwest." (A)

Anthony, R.G. 1992. Single-species versus ecosystem management: lessons for the future. Raptor Research Foundation 1992 annual meeting: Proceedings of a spotted owl symposium; 1992 November 11-15; Bellevue, WA.

"The spotted owl/old-growth issue has often been portrayed by the news media as owls versus people or jobs versus conservation of older coniferous forests. Actually, the spotted owl serves as an indicator species for late-successional forests to many environmentalists and managers. However, we know from basic ecological principles that different species occupy different ecological niches, therefore a single species can not possibly represent all the requirements of a host of other species. Such is true for the spotted owl."

"The Northern Spotted Owl Recovery Team was charged with considering other species and older-forest ecosystems in developing a recovery plan for the northern spotted owl.

In fulfilling this charge, we emphasized species that were listed Federally as threatened or endangered, candidates for Federal listing, state sensitive or species of special concern, and those associated with older forests. A list of 350+ species of plants and animals that occur within the range of the northern spotted owl was assembled. This list is comprised of 24 species of birds, 18 mammals, 26 amphibians and reptiles, 28 fish, 58 mollusks, 59 arthropods, 144 vascular plants, and 8 fungi and lichens. Five species are listed Federally as threatened or endangered, and 155 species are candidates for Federal listing. At the state level, over 100 species are listed as threatened or endangered, or designated as sensitive or species of special concern. More than 100 species are narrowly or broadly endemic to the Pacific Northwest and 190+ are associated with older forests. This effort also substantiated the importance of riparian ecosystems as approximately one third (130+) of the species are associated with riparian areas. In addition, the 28 species of fish include approximately 800 stocks that are considered at risk and may become candidates for listing. Eighteen priority species were identified, of which the marbled murrelet and the numerous fish stocks were considered the highest priority."

"Information on the distribution, biology, and habitat relationships of the priority species and the ecology of riparian ecosystem were used to influence the location of some of the conservation areas for the owl. However, the extent to which this exercise could be carried out was influenced by economics and the preponderance of non-biologists on the recovery team. Consequently, the recovery plan for the northern spotted owl can not be portrayed as a conservation plan for late-successional forests in the Pacific Northwest." (A)

Bart, J.; Holthausen, R. 1992. Listing, critical habitat designation, and development of the northern spotted owl recovery plan. Raptor Research Foundation 1992 annual meeting: Proceedings of a spotted owl symposium; 1992 November 11-15; Bellevue, WA.

"The northern spotted owl (*Strix occidentalis caurina*) was listed as a threatened species by the U.S. Fish and Wildlife Service in 1990. Following the listing, the Fish and Wildlife Service, acting under court order, designated critical habitat for the species."

"Concurrently, the Department of the Interior named a team to begin work on a Recovery Plan for northern spotted owls. This Recovery Plan was published as a draft in May 1992, and a final is expected in early 1993. The basic principles underlying the Plan are based on the 1990 report of the Interagency Scientific Committee. It recommends the establishment of 196 Designated Conservation Area (DCAs) on Federal lands, and contains guidelines for silviculture and salvage operations within those Designated Conservation Areas. It also contains a series of recommendations to provide dispersal habitat in the Federal forest matrix between Designated Conservation Areas. It recognizes the contribution that can be made to recovery by private lands, and suggests ways for the contribution to be made more effective."

"Major issues that must be dealt with before publication of the final Plan includes: (1) a consideration of demographic data which indicate an accelerating decline in the spotted owl population; (2) a review of models that might be used to evaluate the Recovery Plan and other options; and (3) a detailed description of the procedures that could be used to continually update the Plan based on new information. Success of the final Plan will depend on close coordination among Federal and state agencies." (A)

Buchanan, J.B.; Irwin, L.L. 1992. Variation in spotted owl nest site characteristics within the Wenatchee National Forest. Raptor Research Foundation 1992 annual meeting: Proceedings of a spotted owl symposium; 1992 November 11-15; Bellevue, WA.

> "Spotted Owls (*Strix occidentalis caurina*) nest in a broad range of forest stand conditions in the Wenatchee National Forest (WNF). Nearly half of the known nests occur in evenaged patches or stands 65-135 years old, and 21 percent of the nest sites were partially harvested several decades prior to our study. A predictive model developed to distinguish between nest and random sites at the stand level correctly identified 70 percent of the study sites. Diagnostic evaluation of the model indicated that the low classification rate reflected variation in habitat conditions with the WNF. To identify factors that could improve the model, we developed pairs of predictive models based on north- and south-facing slopes and on sites with and without evidence of previous partial harvest. The aspect and harvest models correctly classified 65-93 percent of the sites; however, none of the models were stable, as determined by cross-validation. Following this we examined variation among nest sites within the WNF by comparing mean habitat values among 4 of the 5 Fire Management Analysis Zones (FMAZ) identified by the Forest Service for fire control purposes. The FMAZ areas were defined primarily in terms of topography, annual precipitation, and estimates of fuel loading and fire frequency. We found significant differences among the FMAZ for nearly half of the 60 habitat features we compared at nest sites. It may be possible to develop predictive models within each FMAZ using the original or other models. For example, the harvest model (with a larger sample) may be useful to researchers and managers who wish to conduct adaptive management experiments in stands managed for timer and/or fire protection. The use of such models within the FMAZ framework would likely be more powerful and allow better management throughout the region." (A)

Carey, A.; Biswell, B.; Brown, B., [and others]. October 1991. Patterns of spotted owl prey abundance in the Oregon Coast Ranges and western Washington. Pages 5-9 in: Wildlife habitat relationships in western Washington and Oregon. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Wildlife Ecology Team; annual report. 119 p.

> "Study Objective(s): a. Determine pattern of abundance of flying squirrels and woodrats in the types of forest stands found within the home ranges of spotted owls, particularly young Douglas-fir stands, old-growth Douglas-fir stands, and riparian hardwood or mixed hardwood and conifer stands. b. Determine structural features of the environment that account for significant amounts of the variation in flying squirrel and woodrat abundance within and among stands. c. Determine seasonal changes (fall vs. spring) in patterns of flying squirrel and woodrat abundance. d. Relate flying squirrel patterns of abundance to spotted owl foraging (as measured in a companion study) and relative abundance to spotted owl reproductive efforts (as measured in a companion study of owl demographics). e. Determine the patterns of abundance exhibited by ancillary prey species, especially deer mice and red-backed voles. f. Explore additional techniques to study the abundance and habitat use patterns of bushy-tailed and dusky-footed woodrats." (A)

Carey, A.B.; Miller, R.E.; Wunder, L., [and others]. October 1991. Experimental manipulation of managed stands to provide habitat for spotted owls and to enhance plant and animal diversity. Pages 10-11 in: Wildlife habitat relationships in western Washington and Oregon. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Wildlife Ecology Team; annual report. 119 p.

"Study Objective(s): a. Determine the feasibility of accelerating development of spotted owl habitat in managed forests, by increasing plant and animal diversity, and the abundance of spotted owl prey. b. Determine if populations of flying squirrels can be increased by increasing the number of cavities available. c. Determine if thinning can increase the abundance and diversity of food available to flying squirrels." (A)

Carey, A. 1992. Prey ecology and northern spotted owl diet. Raptor Research Foundation 1992 annual meeting: Proceedings of a spotted owl symposium; 1992 November 11-15; Bellevue, WA.

"Mammals constitute 90 percent of the spotted owl's diet; diets vary locally and seasonally, but are consistent annually at larger geographic scales. *Glaucomyx sabrinus* (GLSA) is the single most important prey, accounting for 16-46 percent of the prey items consumed. GLSA is the only species to occur with frequency of >15 percent in all parts of the owl's range. In western hemlock and Douglas-fir forests, GLSA constitutes 47-58 percent of the biomass consumed. In fall and winter, GLSA comprises 60-72 percent of the biomass consumed. *Peromyscus* spp. and juvenile lagomorphs are 12-18 percent and 7 percent respectively, of summer diets. In mixed-conifer forests in the southern part of the owl's range, *Neotoma fuscipes* may be up to 70 percent of the biomass consumed, and GLSA as little as 14 percent. Other species (percent items consumed) are important locally: *Phenacomys longicaudus* (0-25 percent), *Neotoma cinerea* (0-15 percent), *Lepus americanus* (0-10 percent), *Clethrionomys* spp. (0-21 percent), *Peromyscus* spp. (5-31 percent), and *Thomamys mazama* (0-10 percent). There appears to be definite selection of prey based on (1) nocturnality - otherwise *Tamiasciurus* and *Tanias* would be common prey; (2) mass of 100-400g-adult - lagomorphs are generally not taken and shrews, voles, and mice are low in frequency in diets relative to their abundance in forest; (3) arboreality - GLSA is arboreal, *Neotoma* spp. are semi-arboreal, and *Phenacomys longicaudus* (27 g) is strictly arboreal and more frequently taken when available than the semi-arboreal *Peromyscus* (20 g) and the terrestrial *Clethrionomys* (23 g); arboreality probably relates to detectability of the prey; and (4) social behavior - the colonial *N. fuscipels* is locally concentrated in large numbers whereas the funle-harem *N. cinerea* is locally concentrated in small numbers; *P. longicaudus* is also colonial, whereas *Peromyscus*, *Clethrionomy*, and GLSA are not. These characteristics seem to outweigh abundance: GLSA densities (mean number per ha $\pm$ standard error) in old growth are 0.21 ± 0.09 in the North Cascades of Washington, 0.5 ± 0.2 on the Olympic Peninsula, 2.3 ± 0.3 in the Western Cascades in Oregon, and 1.9 ± 0.1 in the Oregon Coast Ranges and Klamath Mountains, yet GLSA constitutes a greater percentage of the diet in Washington than in southwestern Oregon. But GLSA is probably the most consistently available nocturnal species weighing 100-300g in old-growth western hemlock and Douglas-fir forests. GLSA reaches its highest densities in old growth (3.7/ha) and is more than twice as abundant in old forest than other types in Washington and southwestern Oregon. The amount of old forest encompassed by spotted owls in their home ranges reflects the biomass of the medium-sized prey (GLSA and *Neotoma* spp.) in old growth. Spotted owls can depress GLSA population densities by almost 50 percent in areas intensively used for foraging." (A)

Diller, L.V. 1992. A private landowner's habitat conservation plan: the Simpson Timber Company HCP. Raptor Research Foundation 1992 annual meeting: Proceedings of a spotted owl symposium; 1992 November 11-15; Bellevue, WA.

"In July, 1990 the listing of the northern spotted owl (*Strix occidentalis caurina*) as threatened under the Federal Endangered Species Act prohibited "taking" of the species. In response to this listing, the California Board of Forestry adopted regulations to avoid a take of the owls. Among other things, these regulations required retention of 500 acres of spotted owl habitat within a 985-acre (0.7-mile) circle centered on a known pair. High densities of owls (gross density approximately 1 pair/1000 acres) in and adjacent to a situation in which continuing timber harvest and avoiding a take were not possible. This prompted Simpson to seek a permit from the U.S. Fish and Wildlife Service to allow take of spotted owls incidental to its timber harvest operations. As part of the permit application, the company draft a Habitat Conservation Plan (HCP) for the owl."

"Intensive surveys and analysis of nesting sites and stands indicated that spotted owls on and adjacent to Simpson property were recolonizing and successfully reproducing in stands as early as 35-45 years following harvest. The results of these studies were used to project future owl habitat and develop the major premise of the HCP: that even when timber harvest was accounted for, potential owl habitat would more than double over a 30-year planning period. In addition,the plan included several other conservation strategies including setting aside 39 areas totalling 13,000 acres where timber harvest would not occur, establishing a 35,000 acre 'Special Management Area' that would maintain at least 20 pairs of owls and where 'no take' of owls would occur, continuing the spotted owl research program, and managing stands to accelerate the development of future owl habitat." (A)

Dippon, D. 1992. Linking the BLM's RMP planning process with a spatial demographics model for the northern spotted owl. 26 p.

"While the Noon/McKelvey Owl Model is at the heart of the BLM's analysis of alternatives, the development of the necessary input data can be just as important to the model's simulations. Spatially accurate renditions of the expected vegetation dynamics associated with any given plan must be projected if the model is to perform properly."

"This information memorandum will focus on the procedure used to project the pattern of habitat change as input to the Noon/McKelvey Owl Model used in the BLM's analysis of effects." (A)

Folliard, L.B.; Diller, L.V.; Reese, K.P. 1992. Occurrence and nesting habitat of northern spotted owls in managed young-growth forests in northwestern California. Raptor Research Foundation 1992 annual meeting: Proceedings of a spotted owl symposium; 1992 November 11-15; Bellevue, WA.

> "From 1989 through 1992, approximately 120,000 ha of managed, young-growth forests were surveyed for northern spotted owls (*Strix occidentalis caurina*) in coastal northern California. To date, 169 owl sites have been identified and over 500 birds banded (including 197 juveniles). The relative density of owl sites was greatly influenced by the amount of acreage of forest greater than 45 years old. The region with the highest density (about 0.46 owl sites/km^2) had 37 percent of the landscape in this older age class. Habitat analysis of 60 nesting pairs revealed that owls nested in stands that varied from pure conifer to those dominated by hardwoods, with no apparent selection for a particular cover type. The median nest stand age was 59 years, with 83 percent of pairs nesting in stands 35-80 years old. On average, conifer nest stands were dominated by trees 53-90 cm dbh in size. Although the density was low, there was a higher density of large (greater than 90 cm dbh) conifers ($P = 0.010$) in nest stands in comparison with randomly selected stands. In general, hardwood nest stands had smaller trees than conifer stands. In comparison with old-growth forest structure, the most distinctive difference was the low density of trees greater than 90 cm dbh in these managed stands. Favorable conditions in the redwood (*Sequoia sempervirens*)/Douglas-fir (*Pseudotsuga menziesii*) coastal region such as rapid tree growth rates and an abundant prey base, make these second-growth forests suitable spotted owl habitat at an early age. Development of spotted owl habitat in this region can occur at an accelerated rate following timber harvest in comparison with other regions of the species' range." (A)

Forsman, E.D. 1992a. Demographic studies of northern spotted owls. Raptor Research Foundation 1992 annual meeting: Proceedings of a spotted owl symposium; 1992 November 11-15; Bellevue, WA.

> "Between 1985 and 1987, 5 different demographic studies were initiated to determine population parameters of northern spotted owls. These studies include the Willow Creek Study in northwestern California, Medford BLM Study in southwestern Oregon, Roseburg BLM and H. J. Andrews Studies in western Oregon, and the Olympic Peninsula Study in western Washington. All five studies used mark-recapture techniques to assess age and sex-specific survival rates. Fecundity was assessed by counting the numbers of young that left the nest. Population growth rates (lambda) were calculated based on birth and death rates of females." (A)

> "Estimates of lambda indicated that populations in all 5 study areas were declining. Furthermore, a meta-analysis in which estimates form all 5 areas were examined together, indicated a decreasing trend in annual adult female survival. This suggested that the rate of population decline was accelerating."

> "Although the results of these analysis are alarming, I believe that they should be viewed with caution. A number of potential biases exist that could make things look worse than they really are. Probably the biggest concern is that survival rates may be underestimated if significant undetected emigration occurs. Emigration is probably most problematic with respect to juvenile survival estimates because juveniles disperse

considerable distances from their natal sites. It is also likely that some emigration of adults and subadults occurs as well."

"To better understand population trends of spotted owls, we need more years of data and we need to develop methods to test the magnitude of possible biases in mark-recapture estimates. One way to determine the extent of undetected emigration is to compare survival estimates from radio-marked and color-banded samples. This will be very expensive and time-consuming as it will involve radio-marking large samples of owls." (A)

Forsman, E.D. 1992b. Life history characteristics of the spotted owl. Proceedings of the 62nd annual meeting of the Cooper Ornithological Society symposium; 1992 June 22-28; Seattle, WA.

"The Spotted Owl is a medium-sized Strigid that occupies forested areas along the Pacific Coast, the southwestern United States, and Mexico. This paper describes the life history characteristics of the species, focusing primarily on the northern subspecies, which occupies coniferous forests from southwestern British Columbia south to northwestern California."

"Spotted Owls are unique in that they occupy very large home ranges, and show little fear of humans. They nest primarily in trees in either large cavities or on platforms. They typically lay 2 eggs (range = 1-4). Nesting is sporadic, and is not synchronous across the range. The young leave the nest in May or early June, and are fed by the adults until August or September. The young disperse in the fall (September-November). Most do not disperse more than 40 km, although distances up to 120 km have been recorded. Subadults may breed at 1 year of age, although most do not breed until they are 2-3 years old."

"The diet of the northern spotted owl is dominated by medium-sized arboreal mammals, especially Flying Squirrels and Woodrats. Other prey include a variety of small mammals, birds, and insects." (A)

Forsman, E.D.; Forson, R.; Grayson, S., [and others]. October 1991a. Habitat use and home range characteristics of spotted owls on the Olympic Peninsula, Washington. Pages 12-16 in: Wildlife habitat relationships in western Washington and Oregon. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Wildlife Ecology Team; annual report. 119 p.

"Study Objective(s): a. Determine characteristics of spotted owl home ranges, including total area, seasonal changes, and amount of overlap between paired individuals and their neighbors. b. Compare home range characteristics of nesting and non-nesting owls. c. Describe the diet of the radio-tagged owls. d. Determine types of vegetation structure selected for foraging and roosting. e. Describe foraging behavior (frequency of foraging by type of stand, distance traveled to forage, etc.) and changes in foraging behavior with breeding status and season. f. Explore the usefulness of a variety of home range and habitat selection models for evaluating home rangesand habitat use. g. Relate owl use of home range and stand types to information collected in prey base studies." (A)

Forsman, E.D.; Forson, R.; Hearty, M.; Loschl, P. October 1991b. Demographic characteristics of spotted owls on the Siuslaw National Forest. Pages 45-54 in: Wildlife habitat relationships in western Washington and Oregon. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Wildlife Ecology Team; annual report. 119 p.

> "Study Objective(s): Elucidate the population ecology of the spotted owl on the Siuslaw National Forest, to include population age structure, and age and sex specific birth and death rates." (A)

Forsman, E.D.; Lowell, R.; Maurice, K., [and others]. October 1991c. Demographic characteristics of spotted owls on the Olympic Peninsula, Washington, 1987-1991. Pages 17-23 in: Wildlife habitat relationships in western Washington and Oregon. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Wildlife Ecology Team; annual report. 119 p.

> "Study Objective(s): a. Elucidate the population ecology of the spotted owl on the Olympic Peninsula, to include population age structure, and age specific birth, death, and reproductive rates. b. Compare survival and reproductive rates of color-banded and radio-tagged owls." (A)

Forsman, E.D.; Maurice, K.; Otto, I., [and others]. 1992. Demography of spotted owls on the Olympic Peninsula, Washington. Proceedings of the 62nd annual meeting of the Cooper Ornithological Society symposium; 1992 June 22-28; Seattle, WA.

> "A capture-recapture study of spotted owls was conducted on the Olympic Peninsula in 1987-1991. The study population included owls located on commercial forest lands, wilderness areas, and the Olympic National Park. The sample of owls marked during the study period included 182 adults (89 males, 93 females), 39 subadults (13 females, 26 males) and 156 juveniles. Sex and age-specific models indicated no significant differences in male and female survival rates. Analysis of time-specific models indicated little annual variation in survival rates, and a slight time effect on recapture probabilities. The selected time-specific model ($\emptyset$, P_t) produced survival rates of 0.8820 (s.e. = 0.033) for females, 0.9351 (s.e. = 0.02410) for males, and 0.9124 (s.e. = 0.0197) for both sexes combined. Juvenile survival rates could not be estimated because of low recapture rates. Average fecundity was 0.344 (s.e. = 0.086) for adult females and 0.134 (s.e. = 0.009) for subadult females. Mean life span for adults was 10.6 years, conditional on surviving to age 1."
>
> "Estimated population growth rate (λ) was 0.–. This estimate was based on the assumption that juvenile survival rates were comparable to rates in our other study area in Oregon, where , = 0.–, s.e. = 0.–) This estimate also assumed that subadults and adults had similar survival rates. Although our analysis indicated a declining population, we are concerned that our estimate of the rate of decline may be biased. Until we obtain better estimates of juvenile and subadult survival rates, and assess the impact of emigration on adult and subadult survival rates, we feel that our analysis should only be used to indicate the direction of the population growth rate rather than an exact estimate." (A)

Forsman, E.D.; Reid, J.; Horn, R., [and others]. October 1991d. Demographic characteristics of spotted owls on the Roseburg District of the Bureau of Land Management, Roseburg, Oregon: 1985-1991. Pages 33-44 in: Wildlife habitat relationships in western Washington and Oregon. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Wildlife Ecology Team; annual report. 119 p.

"Study Objectives: a. Elucidate the population ecology of the spotted owl in the Oregon Coast range, to include population age structure, and age specific birth, death, and reproductive rates. b. Compare survival and reproductive rates of color-banded and radio-marked owls." (A)

Forsman, E.D.; Sovern, S.; Taylor, M., [and others]. October 1991e. Demography of spotted owls on the east slope of the Cascade Range, Washington. Pages 27-32 in: Wildlife habitat relationships in western Washington and Oregon. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Wildlife Ecology Team; annual report. 119 p.

"Study Objective(s): Determine demographic characteristics of spotted owls in forests on the east slope of the Cascade Range." (A)

Forsman, E.D.; Sovern, S.; Taylor, M., [and others]. October 1991f. Habitat use and home range characteristics of spotted owls on the east slope of the Cascade Range, Washington. Pages 22-26 in: Wildlife habitat relationships in western Washington and Oregon. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Wildlife Ecology Team; annual report. 119 p.

"Study Objective(s): a. Determine characteristics of spotted owl home ranges in forests on the east slope of the Cascade Range, including home range area, seasonal changes, and amount of overlap between paired individuals and their neighbors. b. Determine forest types selected for foraging and roosting, c. Describe the diet of radio-tagged owls, to include seasonal changes in diet." (A)

Forsman, E.D.; Sovern, S.; Taylor, M., [and others]. October 1991g. Demography of spotted owls on the east slope of the Cascade Range, Washington. Pages 27-32 in: Wildlife habitat relationships in western Washington and Oregon. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Wildlife Ecology Team; annual report. 119 p.

"Study Objective(s): Determine demographic characteristics of spotted owls in forests on the east slope of the Cascade Range." (A)

Franklin, A.B. 1992a. Future direction in spotted owl population biology. Proceedings of the 62nd annual meeting of the Cooper Ornithological Society symposium; 1992 June 22-28; Seattle, WA.

"Sampling of northern spotted owl populations has increased substanstially since the inception of the 5 study areas discussed in this symposium. It is critical that future study designs incorporate the lessons learned from previous research. We discuss considerations in designing studies, the need for integrating demography and population ecology, and the need for understanding how spotted owl populations are regulated. We also discuss important features of spotted owl population biology which we feel should be emphasized in future studies." (A)

Franklin, A.B.; Ward, J.P. 1992b. Density of northern spotted owls. Raptor Research Foundation 1992 annual meeting: Proceedings of a spotted owl symposium; 1992 November 11-15; Bellevue, WA.

"Density is a useful measure for estimating population size, monitoring spatial and temporal population trends, and examining mechanisms of population regulation. We examined density estimates for northern spotted owls from 10 study areas on public lands distributed throughout northern California, Oregon and Washington. Density was estimated based on banded individuals on these study areas which ranged from 300 to 1000 km^2 in size. Densities on individual study areas were measured over periods ranging from 2 to 8 years. Crude density (number of owls/km^2 of total area) ranged from 0.067 to 0.250 owls/km^2. We tested hypotheses concerning temporal and spatial trends in density estimates. Trends in density appeared stable while there appeared to be geographic differences. We also evaluated density estimates from public lands with those form private land managed for timber production. We discuss the problems inherent in estimating density and the utility of density in monitoring programs. We also discuss considerations for estimating density such as sampling design, study area size, and survey effort." (A)

Franklin, A.B.; Ward, J.P.; Gutierrez, R.J. 1992c. Demography of spotted owls in northwestern California. Proceedings of the 62nd annual meeting of the Cooper Ornithological Society symposium; 1992 June 22-28; Seattle, WA.

"A central question in management of northern spotted owl populations concerns the current stability of these populations. We tested the null hypothesis that local and regional populations are stable by 1) estimating age- and sex-specific survival and fecundity rates, 2) incorporating these estimates in a modified Leslie matrix to estimate the finite rate of population change (λ) and 3) testing against population stability ($\lambda = 1$). Based on this analysis, we found that females were significantly declining ($\lambda = 0.9146$, s.e. $= 0.0374$) whereas males were not ($\lambda = 0.9938$, s.e. $= 0.0472$). We further examined demographic parameters in terms of factors such as age-structure and movements to evaluate whether key parameters such as juvenile and adult survival were adequately estimated." (A)

Fredrickson, R.J.; Seaman, D.E.; Moorehead, B.B.; Houston, D.B. 1992. Northern spotted owl inventory and monitoring in Olympic National Park. Port Angeles, WA: U.S Department of the Interior, National Park Service, Olympic National Park; progress report. 7 p.

"Progress is reported on northern spotted owl (*Strix occidentalis caurina*) inventory and monitoring in Olympic National Park during 1992. Field work was completed in Year 1 of a 3-Year research project to estimate spotted owl densities in the park. Intensive surveys were conducted by a crew of 17 persons on off-trail transects that were established across 5 randomly located census blocks (totalling 4947 ha) in the park interior. Thirty-four "historic" sites where owls had previously been banded elsewhere in the park were also monitored."

"A total of 96 spotted owls were detected, including 28 pairs, 15 single birds, and 29 juveniles. Forty owls were also newly banded. Eight owl pairs, 5 single birds and 4 juveniles were found within the census blocks. Crude density estimates in the census blocks suggested a mean pair density of 0.18 owl pairs/km^2 and a mean total density (pairs and single birds) of 0.49 owls/km^2. Such estimates are preliminary, representing only 1 year of data and a portion of the habitat that will be surveyed during the project. A reproduction rate of 0.50 female offspring per adult or subadult female spotted owl was estimated for 28 pairs that were located. Twenty-two barred owls (*S. varia*) were also detected, including 8 birds in the census blocks."

"A separate technical report is also in preparation for a peer-review of the project's research design and methods by an independent panel of experienced research scientists in December 1992. A number of timely administrative recommendations are proposed for future project work (see pp. 11-12)." (A)

Ganey, J.L.; Balda, R.P. 1992. Habitat selection by Mexican spotted owls in northern Arizona. Raptor Research Foundation 1992 annual meeting: Proceedings of a spotted owl symposium; 1992 November 11-15; Bellevue, WA.

"Although the Spotted Owl (*Strix occidentalis caurina*) has been the object of considerable attention in the Pacific Northwest, little is known about the habitat requirements of the Mexican Spotted Owl (*S. o. lucida*). We compared use of broad habitat types to availability of those types within the home ranges of eight radio-tagged Mexican Spotted Owls in northern Arizona. When all habitat types were considered, no owls used these types in proportion to availability. Use patterns differed among individuals and by activity type. All owls roosted primarily in virgin mixed-conifer and ponderosa pine (*Pinus ponderosa*) forests and less than expected in managed forests. Mature forests appear to be important to Spotted Owls in this region and different forest types may be used for different activities. Consequently, managers should retain virgin stands of both mixed-conifer and ponderosa pine forest where these owls occur, to provide both roosting and foraging habitat." (A)

Hamer, T.E.; Forsman, E.D.; Fuchs, A.D.; Waters, M.L. 1992. Hybridization between barred and spotted owls. Raptor Research Foundation 1992 annual meeting: Proceedings of a spotted owl symposium; 1992 November 11-15; Bellevue, WA.

"We present the first records of interspecific hydbridization between the Northern Barred Owl (*Strix varia varia*) and Northern Spotted Owls (*S. occidentalis caurina*). Two hybrid owls in Washington and two in Oregon were confirmed during 1989-92. One of the hybrids paired with a Barred Owl and produced young in 1990 and 1991. In addition, we confirmed the pairing of a female Barred Owl to a one-year-old male Spotted Owl, which produced at least one young in 1992. Hybrids were identified by their unique plumage, unusual vocalizations, and morphological measurements. All three adult hybrids had similar plumage characteristics and vocalizations. Body measurements of hybrids were intermediate between Barred and Spotted Owls, and sonograms of vocalizations displayed attributes of both species. Although genetic comparisons have not yet been conducted, we believe the three adult specimens we observed were all F1 crosses between Barred and Spotted Owls. Hybridization between these species and successful back-crossing by hybrids indicates that the designation of the Barred and Spotted Owl as a superspecies is appropriate." (A)

Hessburg, P.F.; Everett, R.L. 1992. Forest pathogens as catalysts of change in fire-restricted northern spotted owl landscapes. Wenatchee, WA: U.S. Department of Agriculture, Forest Service, Pacific Northwest Region, Forestry Sciences Laboratory; draft report. 66 p.

"Conclusions. Landscape-level analysis, planning, and management are needed to diminish the risk of catastrophic fire to spotted owl landscapes. This analysis and planning would strive to determine the amount of current risk, and the amount and distribution of stand-level fire risk that is manageable through time. Such analyses may well reveal that there is a greater probability of achieving the goal of maintaining viable owl populations in perpetuity when current owl population levels and current habitat abundance or quality are somewhat reduced. Future success in providing suitable habitat on a sustainable basis will likely be the result of interdisciplinary planning and active management of habitats as dynamic and movable locations within the forest, rather than the result of long term protection strategies." (A)

Irwin, L.L. March 1992. Relations among suitable habitat, fire management analysis zones, and demographic patterns of northern spotted owls on the east slope of the Cascade mountains, Washington. Corvallis, OR: NCASI. 11 p. Unpublished manuscript.

"Summary–. An updated analysis is reported for habitat conditions at 84 Spotted Owl sites where data on owl occupancy and reproduction are available." (A)

Irwin, L.L. 1992. Management activities on private timberlands and industry-supported research on northern spotted owls. Raptor Research Foundation 1992 annual meeting: Proceedings of a spotted owl symposium; 1992 November 11-15; Bellevue, WA.

"Private timberlands owners in the Pacific Northwest and northern California have developed various approaches to managing their lands relative to legal obligations and voluntary contributions for protecting the northern spotted owl as a Federally listed threatened species. Such activities depend upon the size and community of the private forests as well as the owner's objectives. Many private owners contract for annual surveys to locate owls, and some companies evaluate nest-site conditions and monitor reproduction success on their lands. Such activities may be used to schedule timber harvests to avoid locations with owls, or they may support development of habitat conservation plans or HCP's. For example, one company in northern California (Simpson) recently had and HCP approved by the Fish and Wildlife Service for operations on their lands. Another company maintains a computerized database of the status of all owls on their lands or on adjacent lands that may affect their operations. The same company is developing a GIS-based process for predicting other owl locations based upon conditions of known sites in managed forests. In many other cases, private companies survey their lands to determine if planned timber operations do not contain spotted owls. Several private companies support research on their lands to learn more about owl habitat requirements, and some have implemented case-history experiments with innovative forestry practices or special techniques (e.g. nest boxes) that may accommodate owls. In addition, a consortium of companies that purchase Federal timber support cooperative research on owl populations and habitat relationships. The goal of much of the industry supported research is to develop new technology that may support forest management alternatives that account for habitat needs of the owl while minimizing costs to wood production. Examples of topics that are being investigated in cooperation with Federal agencies will be presented." (A)

Irwin, L.L.; Martin, S.K.; Fleming, T.L.; Buchanan, J.B. March 1992. Demography of spotted owls in managed and unmanaged forests on the east slope of the Cascades Mountains, Washington. Corvallis, OR: NCASI; 1991 annual report. 34 p.

"We describe demographic information and habitat relations in 1990 and 1991 for Northern Spotted Owls (*Strix occidentalis caurina*) on the eastern slope of the Cascade mountains in Washington. Over the 2 years 125 Spotted Owl sites were examined for occupancy and reproduction by owl pairs. Field crews located 93 pairs, 55 of which produced young. Of the 125 sites, 92 were surveyed sufficiently to determine occupancy by owls in both 1990 and 1991. Of the 92 sites, 84 were occupied by at least 1 owl (91.3 percent), and 71 were occupied by pairs (77.2 percent) at least 1 of the 2 years. Forty-five sites contained pairs both years, 19 of which (27 percent of all pairs) produced young both years. In 1990, 32 (55.2 percent) of the 58 pairs produced and fledged 55 young (0.95 fledglings/pair), for a rate of 1.72 fledglings per reproductive pair. In 1991 44 (55 percent) of 80 pairs reproduced and fledged 71 young (0.89 fledglings/pair), for a rate of 1.61 fledglings per reproductive pair. Reproductive rates did not differ ($P<0.05$) between years or between managed forests and reserved locations (wilderness, National Parks, roadless area, etc.). Occupancy by a pair in one or both years was correlated with acreage of suitable habitat within 0.5-, 1.0-, 1.5-, and 2.1 miles of a nest- or site-center. Reproductive success was not correlated with acreage of suitable habitat. Partial-correlation analysis revealed that the number of young produced declined with increasing latitude and with increasing distance from the crest of the Cascades, after effects of suitable habitat were removed. Field observations indicated that reproduction was generally highest on the Naches District, which is located in the southern- and western most part of the study area. Since 1989 field crews have banded 112 Spotted Owls, including 51 in 1991." (A)

Johnson, D.H. 1992. Predators, competitors, and mobsters: interspecific interactions involving northern spotted owls. Raptor Research Foundation 1992 annual meeting: Proceedings of a spotted owl symposium; 1992 November 11-15; Bellevue, WA.

"Interactions, between spotted owls and other wildlife species can be placed into four main groups: prey, predators, competitors, and species which are involved in mobbing behaviors ("mobsters"). This presentation offers a review of the latter three groups and offers results of my recently completed study on spotted owls, great horned owls, and forest landscape patterns in the Central Oregon Cascades."

"Predators on spotted owls include the great horned owl, goshawk, red-tailed hawk, and common raven. Although cooper's hawks have been observed in unsuccessful predation attempts, it seems possible that juvenile owls may be taken. Spotted owl mortality caused by avian predation is significant: a query of researchers has indicated that 40 percent of 91 adult/subadult and 25 percent of 60 juvenile radio-marked spotted owl deaths were attributable to avian predation; an additional 25 percent of adult/subadult and 37 percent of juvenile owls died of undetermined causes; it seems likely that avian predation was involved in at least some of these deaths as well."

"The primary competitor with spotted owls is the barred owl. The barred owl outcompetes spotted owls in several different ways. For example, barred owls are slightly heavier in body mass than spotted owls, take a wider variety of prey, have smaller home ranges which they defend more rigorously, and are more diurnal in their activity patterns. Barred owls seldom "lose" in territorial interactions with spotted owls. Barred owls have continued to expand their range in the Pacific Northwest and now can be found in several hundred locations in Washington, some 260 locations in Oregon, and 17 locations in California."

"A wide range of species have been observed to mob spotted owls. Mobbing species may frequently make physical contact with spotted owls, ruffling the owl's feathers or, in some instances, knocking spotted owls from their perches. The following species have been observed to mob spotted owls: hermit thrush, Swainson's thrush, varied thrush, Cooper's hawk, black-capped and mountain chickadees, red-breasted nuthatch, rufous hummingbird, dark-eyed juncos, hermit warbler, golden-crowned kinglet, Steller's jay, gray jay, northern pygmy owl, and sharp-shinned hawk. The latter four species have more commonly been observed making physical contact with spotted owls."

"Great horned owls have been identified as the primary predator of spotted owls. As old-growth forests become fragmented through logging or natural processes, it is hypothesized that great horned owls become established and increase in numbers as this new niche is created. I conducted a nocturnal survey in 1989 and 1990 to locate great horned owls and spotted owls throughout the range of forest fragmentation levels in the Central Cascades of Oregon. Forest fragmentation levels ranged from landscapes (≥500 ha in size) containing intact stands of mature/old-growth forest (0 percent fragmentation) to landscapes containing younger stands with no mature/old-growth forest (100 percent fragmentation). Six survey visits were made to each of 469 calling stations located along 28 roadside survey routes. Relative abundance for great horned owls and spotted owls was 0.069 and 0.139 owls/road km, respectively. Thirteen habitat/landscape variables within 500-ha circular landscape plots surrounding great horned owl, spotted owl, and random points were assessed. Significant differences existed between great horned owl and spotted owl landscapes for six variables: great horned owl landscapes contained more shrub/forb and shelterwood, less mature/old-growth and mature/old growth interior habitat, had a higher linear edge-to-mature/old growth area ratio, and were higher in elevation than spotted owl landscapes. The greatest number of great horned owl responses were associated with landscapes containing 10-20 percent old forest. Great horned owl responses generally declined with increasing amounts of old forest, and few (11 percent) great horned owls were detected in landscapes containing ≥ 70 percent old forest. The majority (62 percent) of spotted owls were detected within landscapes containing ≥ 60 percent old forest. Spotted owl responses generally declined with declining amounts of old forest and few (7 percent) spotted owls were detected within landscapes containing $\leq$ 20 percent of the variation in habitat pattern. We suggest the percentage of area in owl habitat, an isolation index, and the CV of patch area are useful measures of owl habitat pattern in spotted owl home ranges. Our results support the use of circular areas on the order of 3,200 ha for assessment of northern spotted owl habitat on the Olympic Peninsula." (A)

Lint, J.R. 1992. Inventorying and monitoring programs for northern spotted owls. Raptor Research Foundation 1992 annual meeting: Proceedings of a spotted owl symposium; 1992 November 11-15; Bellevue, WA.

"The annual inventory and monitoring of northern spotted owls has become a tradition for many wildlife biologists working for Federal and state agencies, universities, private consultants and private timber companies in the Pacific Northwest. Current survey programs are founded on the efforts of biologists that began the search for owls over two decades ago. Pioneer work by Eric Forsman in Oregon and Gordon Gould in California was instrumental in developing and refining standard survey techniques essential to conducting an inventory."

"In the 1970s, the Forest Service and Bureau of Land Management took the inventory lead by surveying for spotted owl occurrence on lands they administered. This provided the first operational extension of the work of Forsman and Gould. Through the 1970s and early 1980s, agency surveys focused on locating territorial owls to provide basic information for planning timber sales and making land use planning decisions. Survey work for the 1980s decade turned to monitoring owl response to land use decisions and incremental inventory of lands not previously surveyed. During this time period, the use of offered prey called "mousing" and the implementation of banding added new dimensions to the inventory and monitoring program."

"The listing of the spotted owl as a Federal threatened species in 1990 accentuated the importance of ongoing work and set in motion intensive efforts by government and private interests to inventory proposed timber sale areas to ensure compliance with the Endangered Species Act. Through inventory and monitoring, knowledge has been gained on the distribution of owls, the relationship of occurrence to forest condition, dispersal movements and reproductive success. The programs, although productive, were not without shortcomings. Some local programs were keyed to finding owls, but lacked clear objectives and plans for data analysis. On a regional scale, poor coordination between agencies, lack of a central data storage and retrieval system and inconsistent formats for data recording were detractions. Fortunately these problems have been identified. The future affords the opportunity to learn form past experience and to establish a single, cooperative spotted owl inventory and monitoring program with common goals and objectives." (A)

McKelvey, K. June 1992. A spatially-explicit life-history simulator for the northern spotted owl. Arcata, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Experiment Station, Redwood Sciences Laboratory. 55 p.

"A spatial model was created to simulate the impact of forest management on populations of the northern spotted owl." (A)

McKelvey, K.; Noon, B.R.; Lamberson, R.H. 1992. [In press]. Conservation planning for species occupying fragmented landscapes: the case of the northern spotted owl. Arcata, CA: U.S Department of Agriculture, Forest Service, Pacific Southwest Experiment Station, Redwood Sciences Laboratory. 50 p.

> "In the case of the northern spotted owl, concerns over the reduction and fragmentation of habitat were translated into a specific plan for the subspecies conservation (Thomas et al. 1990). In this paper we report some of the models that were used to guide decisions and thinking about the size and geometry of the proposed reserve design. We would like to emphasize that we are reporting only a small fraction of the studies and analyses that have been pursued to help maintain spotted owl populations, and that our results represent the synthesis of a massive team effort." (A)

Meslow, E.C. 1992. Northern spotted owl management, 1972-1992. Proceedings of the 62nd annual meeting of the Cooper Ornithological Society symposium; 1992 June 22-28; Seattle, WA.

> "The top level administrators of the responsible Federal Agencies were made aware of the potential impact of the Northern Spotted Owl (*Strix occidentalis caurina*) on timber harvest in 1972. This paper traces the succession of spotted owl management plans/proposals that have evolved in the ensuing 20 years. Current direction continues to emphasize management of the spotted owl rather than the old-growth forests of the Pacific Northwest for which it is the surrogate." (A)

Meslow, E.C.; Bruce, C.R.; Marcot, B. 1992. History of conservation planning for the northern spotted owl. Raptor Research Foundation 1992 annual meeting: Proceedings of a spotted owl symposium; 1992 November 11-15; Bellevue, WA.

> "Conservation planning for the Northern Spotted Owl began in 1973 when the bird was given top priority by the newly formed Oregon Endangered Species Task Force. In 1977 the Task Force recommended maintaining 400 pairs on public lands in the state with 300 acres of old forest reserved per pair. Washington (1978) and California (1981) joined in conservation planning efforts. While the acreage reserved per owl pair increased with time, the operative paradigm remained focused on 1-3 pair management units until 1988. In 1989, the Interagency Spotted Owl Scientific Committee was jointly established by the directors of the four Federal wildlife/land managing agencies and charged with developing a scientifically credible Northern Spotted Owl management plan. The committee's product provided for a series of 20 pair conservation areas spaced to facilitate dispersal, with intervening "forest matrix" lands managed to provide habitat sufficient to support dispersal. The draft Northern Spotted Owl Recovery Plan utilizes the same basic construct." (A)

Meslow, E.C.; Forsman, E.D.; Swindle, K.A., [and others]. October 1991. The ecology of spotted owls on the Willamette National Forest: habitat use and demography. Pages 55-61 in: Wildlife habitat relationships in western Washington and Oregon. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Wildlife Ecology Team; annual report. 119 p.

"Study Objective(s): a. Elucidate the population biology of the spotted owl on a portion of the Willamette National Forest by banding adult and fledgling owls, and documenting age-specific reproductive parameters. b. Determine home ranges and habitat use by spotted owls, using radio-telemetry. c. Determine the diet and prey preferences of spotted owls by collecting and analyzing regurgitated pellets. d. Determine patterns of abundance of primary prey species using live-trapping and other techniques as appropriate (see companion report on prey ecology study). e. Relate owl foraging behavior and reproduction to prey abundance. f. Collaborate with other researchers in the Spotted Owl RD&A Program in synthesizing the results of the owl ecology studies across the Pacific Northwest." (A)

Meslow, E.C.; Forsman, E.D.; Thrailkill, J., [and others]. October 1991. Demographic characteristics of spotted owls on the Eugene BLM District, Central Coast Range, Oregon. Pages 62-68 in: Wildlife habitat relationships in western Washington and Oregon. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Wildlife Ecology Team; annual report. 119 p.

"Study objective(s): a. Satisfy Eugene Bureau of Land Management District spotted owl monitoring needs (Coast Range province). b. Elucidate the population ecology of the spotted owl on the Eugene Bureau of Land Management District (Coast Range province), to include population age structure and age specific birth, death, and reproductive rates. c. Determine total density of adult/subadult spotted owls within an intensive study area." (A)

Meslow, E.C.; Wagner, R.; Bennett, G., [and others]. October 1991. Spotted owls in managed forests: identification and evaluation of non old-growth cover types for use in habitat management on the Medford District of the Bureau of Land Management, Oregon. Pages 69-75 in: Wildlife habitat relationships in western Washington and Oregon. U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station, Wildlife Ecology Team; annual report. 119 p.

"Study Objective(s): a. Describe habitat use by spotted owls - especially the use of non old-growth cover types. b. Determine population parameters of spotted owls, including comparative density and annual rates for occupancy, turnover, and productivity. c. Identify and evaluate potential management options which utilize non old-growth cover types within spotted owl habitat management." (A)

Meyer, J.S.; Irwin, L.L.; Boyce, M.S. January 1992. Influence of habitat fragmentation on spotted owl site location, site occupancy, and reproductive status in western Oregon. Corvallis, OR: NCASI; progress report. 165 p.

"Our objectives were to (1) estimate several habitat indices, including measures of forest fragmentation, at known Spotted Owl sites; (2) test the null hypothesis of no difference between habitat indices at randomly-selected landscape locations; and (3) test the null hypothesis of zero correlation between habitat indices and occupancy or reproduction at Spotted Owl sites for which adequate occupancy surveys were conducted for 5 years from 1985 to 1989." (A)

Miller, G.; Forsman, E.D.; Johnson, D.H. 1992. Dispersal and survival of juvenile northern spotted owls. Raptor Research Foundation 1992 annual meeting: Proceedings of a spotted owl symposium; 1992 November 11-15; Bellevue, WA.

"With the Federal listing of the spotted owl as a threatened species, highlighted by the Interagency Scientific Committee's Conservation Strategy for the Northern Spotted Owl and the Spotted Owl Recovery Planning process, the importance of juvenile dispersal information has become much more apparent. Prior to 1982, information on the dispersal ecology of juvenile northern spotted owls was limited. Since that time, three general 'sources' of study can be identified that have addressed the dispersal topic. (1) In 1982, radio-telemetry studies, using back-pack transmitters, were initiated in Washington, Oregon and California to gather information on juvenile dispersal. Between 1982 and 1985, 6 juveniles in Washington, 32 in Oregon and 23 in California were followed during dispersal. A summary of first-year survival, distance dispersed, and habitat use is provided. (2) Between 1985 and 1987, intensive banding studies were initiated in Washington, Oregon and California, providing the opportunity to band several hundred juvenile spotted owls. A summary of dispersal distances and survival estimates obtained from the band return (resighting) data is also provided. (3) In 1991, a new radio-telemetry study, using tail-mounted transmitters, was initiated in Oregon and Washington to provide additional information on juvenile survival estimates. Preliminary results from that study for 1991 and 1992 are reported. A comparison of the three sources of information is discussed."

"An overview of how all the information on juvenile dispersal and survival has been incorporated into the Interagency Scientific Committee's Conservation Strategy for the Northern Spotted Owl and the Northern Spotted Owl Recovery Planning process is also discussed." (A)

Miller, G.S.; DeStefano, S. 1992a. Field and analysis methods for spotted owl demographic studies. Proceedings of the 62nd annual meeting of the Cooper Ornithological Society symposium; 1992 June 22-28; Seattle, WA.

"Spotted Owls were located on each study area using calling surveys (vocal imitations and playback) conducted both during the day and at night. Spotted owls were captured using a noose or snare pole and banded with USFWS lock-on bands and a colored plastic leg band. Reproductive status was determined by mousing the birds. Sites where spotted owls had been banded in previous years were resurveyed each year to confirm bands and band new birds. Capture history arrays of 1's and 0's were developed for all banded birds, where a 1 indicated that a marked bird was seen $\geq$1 times during the year and a 0 indicated that the individual was not observed for that year. Survival estimates and resighting probabilities were calculated using capture-recapture methodology. We used programs RELEASE and SURGE for data summarization, model selection and fit, and parameter estimation." (A)

Miller, G.S.; DeStefano, S.; Brown, M.T., [and others]. 1992b. Demography of spotted owls in the central Cascades, Oregon. Proceedings of the 62nd annual meeting of the Cooper Ornithological Society symposium; 1992 June 22-28; Seattle, WA.

> "Demographics of the northern spotted owl were studied in the central Cascades of western Oregon between 1987 and 1991. A total of 358 individual owls were banded over the 5-year period with yearly surveys conducted to re-sight marked birds. Re-sighting rates were high, especially for the adult age class. Mean fecundity for adult females was 0.30. Survival was higher for adults than juveniles and for adult males vs. adult females. The rate of change in territorial adult females/year was calculated, with lambda significantly less than 1. Population dynamics and the significance of the lambda calculation are discussed." (A)

Montgomery, C.A.; Brown, G.M.; Adams, D.M. 1992. The marginal cost of species preservation: the northern spotted owl. Missoula, MT: University of Montana, School of Forestry; draft. 35 p.

> "Because species survival is not certain, the decision to "save " a species is not an all-or-nothing choice but rather a marginal one. The appropriate unit for both benefit and cost functions is like the likelihood of survival and the appropriate question is how certain we want to be of species survival. The intensity of the species preservation debate is also fired by strong equity concerns. We illustrate these points for the case of the northern spotted owl by constructing a marginal cost curve for its survival and by disaggregating welfare loss by region and by market level." (A)

Reid, J.A.; Forsman, E.D.; Lint, J.B. 1992. Demography of spotted owls in west central Oregon. Proceedings of the 62nd annual meeting of the Cooper Ornithological Society symposium; 1992 June 22-28; Seattle, WA.

> "A capture-recapture study of northern spotted owls (*Strix occidentalis caurina*) began on the Roseburg District of the Bureau of Land Management in west-central Oregon in 1985. The study area is commercial forest land of alternating sections of Federal and private ownership. The sample of marked owls included 469 adult/subadults (207 females, 262 males) and 239 juveniles. Sex and age specific models indicated similar survival rates of males and females. The preferred model produced a survival estimate of 0.857 (s.e.= 0.021) for females and 0.846 (s.e. = 0.017) for males. Juvenile survival varied depending on the model used. The preferred model produced a juvenile survival estimate of 0.405 (s.e. = 0.136). There was no time effect on survival or recapture probabilities for either females or juveniles. The preferred model indicated a time dependence on survival rates for males. An average fecundity rate was 0.330 (s.e.= 0.039) for adult females and 0.094 (s.e. = 0.055) for subadult females. Mean lifespan for adults/subadults was 6.5 years contingent upon the individual reaching one year of age."
>
> "Estimated population growth rate (lambda) was 0.0964 (s.e.= 0.037). This indicates a declining population of resident owls. However, the estimate of lambda is not significantly different from 1 (p = 0.168). Future years of study will provide more precise estimates." (A)

Rinkevich, S.E. 1992. Distribution and habitat characteristics of Mexican spotted owls in Zion National Park, Utah. Raptor Research Foundation 1992 annual meeting: Proceedings of a spotted owl symposium; 1992 November 11-15; Bellevue, WA.

"Distribution, habitat characteristics, and food habits of the Mexican spotted owl (*Strix occidentalis lucida*) were investigated in Zion National Park. Two hundred and twenty-nine surveys were conducted in canyon and plateau habitat between May-August 1989 and April-August 1990. I located owls in nine different locations; each owl was associated with narrow canyons, "hanging" canyons, and cliff sites. The minimum estimated density in Zion National Park was 0.02 owls/km^2 in 1989 and 0.03/km^2 in 1990. Spotted owls were widely distributed and coincident with discontinuous habitat within the park."

"I used stepwise discriminant analysis to examine the habitat differences between (1) observed owl microsites and available microsites and (2) observed owl canyon habitat and available canyon habitat. Spotted owl microsites had higher humidity, more vegetation strata, narrower canyon widths, and higher percentage of ground litter than available microsites. Habitat within owl use canyons had higher humidity and higher total snag basal area than available canyon habitats. Owls may be selecting canyon habitat not only for the structural habitat features but also for the microclimate. The presence of canyons and cliffs may provide necessary refuge from high daytime temperatures that occurred in the study area. Mexican spotted owls do not appear to depend on extensive stands of old-growth forests as do northern spotted owls (*S. occidentalis caurina*) because this type of habitat is lacking in Zion Park. Seventy-one prey items were identified from 60 pellets collected from two owl territories. Mammals comprised 99.9 percent of estimated biomass and 80.3 percent of the total diet composition. Bushy-tailed woodrats (*Neotoma cinerea*) were the primary prey taken by owls. They comprised 67.3 percent of the estimated biomass and 40.3 percent by frequency of the diet. Further studies are needed to investigate the habitat requirements of spotted owls in the northern region of its range." (A)

Rowland, M.J. 1992. Northern spotted owl litigation review. Raptor Research Foundation 1992 annual meeting: Proceedings of a spotted owl symposium; 1992 November 11-15; Bellevue, WA.

"Principal court cases affecting the northern spotted owl will be reviewed. These cases include: Northern Spotted Owl v. Hodel: A suit against the US Fish and Wildlife Service for failure to list the spotted owl under the Endangered Species Act (ESA) and failure to designate critical habitat for the owl. The agency was ordered to reconsider its failure to list the owl, and the owl ultimately was listed. The court also ordered the agency to designate critical habitat."

"Seattle Audubon Society v. Robertson: A suit challenging the US Forest Service's spotted owl management plan for failure to comply with the National Forest Management Act (NFMA) and the National Environmental Policy Act (NEPA). The court ruled that the Forest Service's plan did not meet the requirements of either law, ordered the agency to prepare another plan, and enjoined further timber sales in spotted owl habitat until a legally adequate plan is in place."

"Bureau of Land Management v. US Fish and Wildlife Service: A petition by the Bureau of Land Management (BLM) for an exemption for 44 timber sales in Oregon from the requirements of the Endangered Species Act. The Endangered Species Committee granted an exemption for 13 of the sales, the first exemption ever granted under the Endangered Species Act after a full hearing."

"Portland Audubon Society v. Bureau of Land Management: A suit against the Bureau of Land Management for failure to follow National Environmental Policy Act requirements in managing the spotted owl. The court found that the BLM had violated National Environmental Policy Act and enjoined timber sales in spotted owl habitat pending the agency's compliance with National Environmental Policy Act." (A)

Steger, G.N.; Munton, T.E.; Verner, J. 1992. Preliminary results from a demographic study of spotted owls in Sequoia and Kings Canyon National Parks, 1990-1991. Proceedings of the National Park Service fourth conference on research in California's National Parks. San Francisco, CA: U.S. Department of the Interior, National Park Service; draft.

"In a study area of approximately 343 km^2 (132 mi^2) in Sequoia and Kings Canyon National Parks, 54 adult and subadult and 21 fledgling California spotted owls were located in 1990 (crude density = 0.157 owls per square kilometer). Comparable numbers in 1991 were 60 adults and subadults and one fledgling (crude density = 0.175 owls per square kilometer). Thirteen of 22 pairs in 1990 were found with young and one of 23 pairs was found with young in 1991. The reproductive rate (the proportion of pairs checked for reproduction that fledged young) was 0.88 in 1990 ad 0.08 in 1991; the combined turnover rate for 1990 and 1991 was 19.5 percent." (A)

Timber Association of California. California timberland wildlife habitat study. Redding, CA: Vestra Resources, Inc.; interim report. 51 p.

"The WHS uses state of the art capabilities in terms of data collection, computer generated mapping, and management prescription information to analyze the status of wildlife habitat in all of California's forests."

"At present this interim report covers the presumed range of the northern spotted owl." (A)

USDA Forest Service. September 1991. Spotted owl inventory and monitoring program. San Francisco, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Region; annual report. 24 p.

"This report summarizes Spotted Owl (*Strix occidentalis*) survey and inventory data collected during 1991 on U.S. National Forest Service lands in the Pacific Southwest Region of the Forest Service (hereafter Region 5). For the purposes of this report, the Region has been divided into three provinces: the Klamath Province in northern California, the Sierra-Nevada Province spanning the length of the Sierra-Nevada mountain range, and the Southern California Province. In Region 5, there are 18 National Forest units, and survey or inventory data were reported from each of the 18 units in 1991."

"In Region 5, the populations of the Northern Spotted Owl are found on the Klamath, Mendocino, Modoc, Shasta-Trinity, and Six Rivers National Forests, as well as the portion of the Lassen National Forest north of the Pit River." (A)

Wagner, F.F.; Meslow, E.C.; Bennett, G.M.; Small, S. 1992. Demography of spotted owls in southern Cascades and Siskiyou Mountains, Oregon. Proceedings of the 62nd annual meeting of the Cooper Ornithological Society symposium; 1992 June 22-28; Seattle, WA.

"We estimated the finite rate of population change for northern spotted owls in the southern Cascades and Siskiyou Mountains of Oregon for the period 1985 though 1991. Survival probabilities were estimated with cature-recapture methods by annually resighting uniquely color-banded spotted owls. We used programs RELEASE for data summary and goodness-of-fit tests and SURGE for model selection and fit. Fecundity was estimated annually according to a standardization field protocol. The finite rate of annual population change indicates that the population of resident females declined significantly over the observed time period." (A)

Young, K.E.; Franklin, A.B.; Ward, J.P. 1992. Infestation of northern spotted owls by Hippoboscid (Diptera) flies in northwestern California. 17 p.

"ABSTRACT - Hippoboscid flies were found on 62 (16.7 percent) of 382 northern spotted owls (*Strix occidentalis caurina*) captured between April and September, 1986 through 1990. Two species of hippoboscids were identified: *Icosta americana* and *Ornithomya anchineuria*. Male and female adult spotted owls had similiar prevalences and relative densities of hippoboscid flies. Juvenile owls had lower prevalences and relative densities than adults. There were no significant differences in mean intensity of hippoboscids on adult male, adult female and juvenile spotted owls. Relative densities of flies infesting adult owls were significantly greater during years of increased fall temperatures, decreased winter precipitation, and decreased summer temperatures." (A)

Zabel, C.; McKelvey, K.; Paton, P., [and others]. July 1992. Home range size and habitat use patterns of northern spotted owls in northwestern California and southwestern Oregon. [In preparation]. 40 p.

"<u>Abstract</u> - Home range sizes were estimated for northern spotted owls at 3 study sites in northwestern California and southwestern Oregon. We found significant positive correlations between the number of days an owl was radio tracked and home range size, indicating home ranges may shift or expand over time. Differences in home range sizes corresponded to differences in the primary prey of owls in different locations. We tested whether owls used habitat types within their home range in proportion to availability, and determined which habitat types were used more or less than expected. Patterns of selectivity were similiar to those found in earlier studies on spotted owls , but our results were weaker. We suggest that it is difficult to show selection for mature trees when most of the available habitat consists of mature trees. Our study areas were located where higher proportions of the landscape were mature forest compared to earlier studies. Use of suitable/unsuitable edges by owls was examined by comparing distance distributions of radio locations from the nearest edge to random locations. Where owls were preying predominantly on woodrats, they showed a preference use for edges. Where owls were preying predominantly on northern flying squirrels, they showed neither preference nor avoidance for edges. We tested the hypothesis that owls use suitable or unsuitable habitat exclusively within their home ranges and that the patterns of use we observed were due to telemetry error. Random points were displaced from either habitat type by distances equal to our estimated telemetry error. Distributions between displaced random points and owl locations differed significantly, indicating the patterns we observed could not be produced by our error distribution. Power of our Chi-square tests of habitat selection is presented, and factors that influence power are discussed." (A)

Zabel, C.J.; Noon, B. 1992. Demographic parameters of the northern spotted owl on the Coos Bay Bureau of Land Management District and Siskiyou National Forest, southwestern Oregon. Arcata, CA: U.S. Department of Agriculture, Forest Service, Pacific Southwest Region; draft annual report. 9 p.

Tables on survival and reproductive rates of populations of spotted owls on the Coos Bay BLM District and Siskiyou National Forest in Oregon. (C)

Appendix 4-C

Anderson and Burnham Report - Demographic Analysis of Northern Spotted Owl Populations

This report is reproduced here exactly as it appeared in Appendix C of the Draft Recovery Plan for the Northern Spotted Owl (USDI).

Appendix C

Demographic Analysis of Northern Spotted Owl Populations

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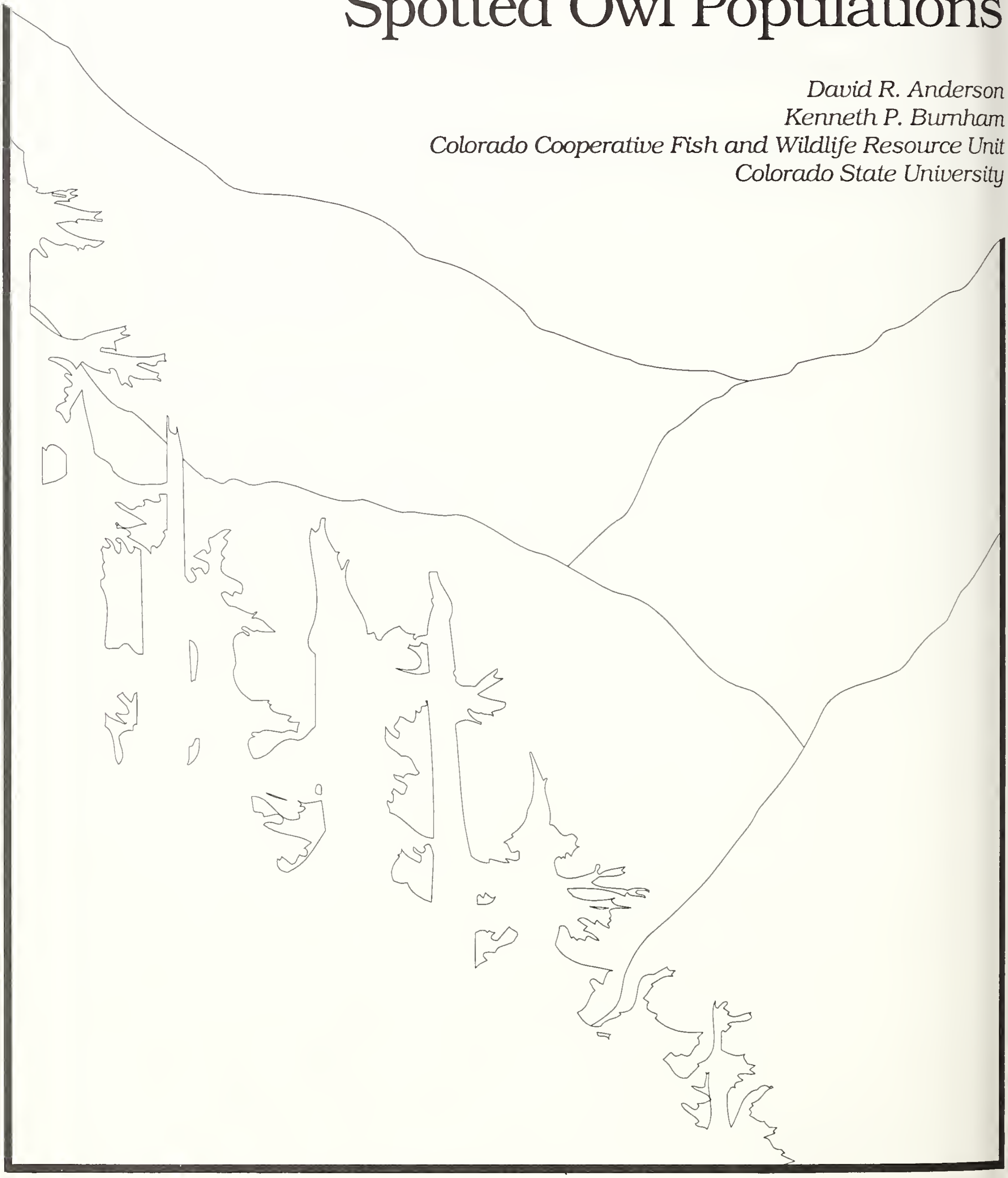

1. Introduction

The 1990 Status Review Northern Spotted Owl (USDI 1990) provided estimates of the rate of population change for populations of northern spotted owls in northern California (Willow Creek and surrounding regional study area) and southern Oregon (the Roseburg study area). The population of resident female owls in these areas was shown to be declining at a significant rate. By the fall of 1991, there were 2 additional years of capture-recapture data on these two populations, and three new areas (Medford in southern Oregon, H.J. Andrews near Corvallis, Oregon, and the Olympic Peninsula in northwestern Washington) had sufficient years of capture-recapture data to warrant an intensive analysis (Table C.1). More than 2,000 owls had been marked and the resighting probability for adult females was approximately 0.8 to 0.9 percent.

This appendix provides estimates of the rate of population change of resident, territorial females in these five large study areas. Analysis methods (e.g., model building, model selection, tests of model fit, parameter estimation, and inference procedures concerning the rate of population change) are those used in USDI (1990) with some extensions. The key references on methodology are Burnham and Anderson (In Press) and Lebreton et al. In Press). The analyses of data were done during September-October 1991, during two intensive workshops held in Fort Collins, Colorado. The analyses were completed by six biologists working on the northern spotted owl—two French scientists, two professors from Colorado State University with special expertise in the analysis of capture-recapture data, and two U.S. Fish and Wildlife Service employees from the Colorado Cooperative Fish and Wildlife Research Unit.

2. Results and Discussion

Two parameters are of critical interest; λ = finite (i.e., annual) rate of change in the size of the population of females, and $\hat{\phi}$ = annual probability of survival of adult females. Maximum likelihood estimates of these parameters are shown as $\hat{\lambda}$ and $\hat{\phi}$, respectively, along with estimates of their precision (i.e., $\hat{se}(\hat{\lambda})$ and $\hat{se}(\hat{\phi})$). If the number of resident females is "stationary," then $\lambda = 1$, while if the population is declining, then $\lambda < 1$. Thus, there is interest in testing the null hypothesis $\mathbf{H_o}$: $\lambda \leq 1$ against the alternative hypothesis $\mathbf{H_a}$: $\lambda < 1$. Proper estimation of λ answers the critical question, "Have the resident, territorial females replaced themselves?"

Table C.1. Summary information on the five demographic study areas.

Name of Study Area	Approximate Size	Years of Marking	Total Individuals Marked
Northwest California	4,000	1985-91	400
H.J. Andrews (western Oregon)	116	1987-91	358
Medford (southwestern Oregon)	4,050	1985-91	703
Roseburg (southwestern Oregon)	1,700	1985-91	589
Olympic Peninsula (northwestern Washington)	965	1987-91	302

Parameter Estimates for Individual Study Areas

The estimation of λ was based on the Leslie-Lefkovitch approach summarized in USDI (1990). Under this method, estimates of age-specific survival and fecundity are needed for the female component of the population. Model selection for the estimation of survival probabilities relied on the Akaike Information Criterion (AIC), however some use of likelihood ratio tests was made. Data from the five study areas supported only two age-classes for annual survival estimates (juvenile and all older classes = "adults"). Estimates of these parameters and measures of their precision are presented in Table C.2.

Estimates of age-specific fecundity of females also followed the procedures in USDI (1990), and these are summarized in Table C.3. with a measure of the precision of the estimates.

Estimates of λ, computed from the estimates in Tables C.2. and C.3., estimated precision, and test statistics related to the null hypothesis (above) appear in Table C.4. While there are several potential biases in these estimates, it is clear from Table C.4. that the population of resident, territorial females has declined in each of the five study areas. The simple average of the estimates was $\hat{\lambda} = 0.9022$ which indicates a rate of decline of approximately 10 percent per year during 1985-1991. Thus, the resident population was not replacing itself in any of the five large study areas. This is a critical finding. In each case, $\hat{\lambda}$ is significantly less than 1 (see test statistics and P-values in Table C.4.). No statistical inference is made concerning λ prior to these years of study or in the future. These estimates of λ represent a 5- or 6-year "snapshot" of the average annual change in the female component of these five populations.

The t-test is based on the empirical variance among the five independent estimates of λ, while the z-test is based on the theoretical standard error of $\hat{\lambda}$ (i.e., $\sqrt{\Sigma \operatorname{var}(\hat{\lambda}_i)} /5$). The t-test allows for significant variation in λ within the five study areas, however, a test for such variation was not significant (K^2=5.1409, 4 df, P=0.2731, (see Burnham et al. 1987:264-269). The estimated standard

Table C.2. Estimates of age-specific annual survival rates for female northern spotted owls.

Study Area	First Year		All Later Years	
	$\hat{\phi}_J$	$\hat{se}(\hat{\phi}_J)$	$\hat{\phi}_J$	$\hat{se}(\hat{\phi}_J)$
Northwest California	0.1946	0.0509	0.8507	0.0224
H.J. Andrews (western Oregon)	0.3112	0.1033	0.8365	0.0312
Medford (southwestern Oregon)	0.2002	0.0513	0.7854	0.0258
Roseburg (southwestern Oregon)[a]	0.2829	0.0366	0.8583	0.0131
Olympic Peninsula (northwestern Washington)[a]	0.0707	0.0282	0.8603	0.0264

[a] No sex-specific differences in adult survival were detectable, thus, the estimate of adult female survival includes adult males.

Table C.3. Estimates of age-specific fecundity (b) for female northern spotted owls (number of juvenile females/female of age x).

	Subadult 1 (12 mos.)		Subadult 2 (24 mos.)		Adult (36 mos.)	
Study Area	$(\hat{b}_1)$	$\hat{se}(\hat{b}_1)$	$(\hat{b}_2)$	$\hat{se}(\hat{b}_2)$	$(\hat{b})$	$\hat{se}(\hat{b})$
Northwest California	0.1154	0.0576	0.2286	0.0659	0.3576	0.0245
H.J. Andrews (western Oregon)	0.1430	0.0780	0.1430	0.0780	0.3270	0.0500
Medford (southwestern Oregon)	0.1110	0.0386	0.1110	0.0386	0.3233	0.4880
Roseburg (southwestern Oregon)[a]	0.0938	0.0547	0.0938	0.0547	0.3304	0.0385
Olympic Peninsula (northwestern Washington)[a]	0.1000	0.0667	0.1000	0.0667	0.3327	0.0784

[a] Year-specific differences in (b).
$\hat{b}$

error of the true $\hat{\lambda}$ across the five study areas $(\hat{\sigma}_\lambda)$ was 0.0267 (95 percent confidence interval is 0.0 to 0.1073). Both tests indicate a strong rejection of the null hypothesis, and one must conclude that these populations are declining.

Capture-recapture methods allow estimates, of the number of new entries into the population of resident, territorial females (standard Jolly-Seber estimates, see USDI(1990:35-36)). Estimates of this quantity, averaged over years, are

Table C.4. Estimates of the finite rate of annual population change (λ) for female northern spotted owls in five independent study areas throughout their range. Also shown are test statistics and P values for the test of the null hypothesis that $\lambda > 1$ vs. $\lambda < 1$.

Study Area	$\hat{\lambda}$	$\hat{se}(\hat{\lambda})$	t or z	P
Northwest California	0.9153	0.0433	-1.9561	0.0252
H.J. Andrews (western Oregon)	0.9276	0.0437	-1.6567	0.0488
Medford (southwestern Oregon)	0.8444	0.0304	-5.1184	0.0000
Roseburg (southwestern Oregon)	0.9405	0.0182	-3.2692	0.0005
Olympic Peninsula (northwestern Washington)	0.8828	0.0280	-4.1857	0.0000
Simple average and t-test	0.9021	0.0173	-5/7532	0.0024
Simple average and z-test	0.9021	0.0153	-6.4155	0.0000

provided in Table C.5. Study of the results of these analyses indicated that statistically significant immigration had occurred each year in all five study areas. The estimates of the number of new entries (B^) provide insight into how populations in each area have been augmented by immigration from outside the study areas. These findings are consistent with those in the 1990 Status Review (USDI).

b. Meta-analysis

The majority of the capture-recapture data comes from adult birds (i.e., nonjuveniles) and therefore a sophisticated attempt was made to model and understand these data for each of the five study areas. Models of capture-recapture data must properly treat two types of parameters; conditional survival probabilities (ϕ) and conditional recapture probabilities (p) and how these vary across study areas (g). Age was not a factor in this analysis as only adults were treated, and sex was not a factor as only females were of particular interest. For theoretical reasons, much of the analysis was done on logit(ϕ) and logit(p), where, in general, $\text{logit}(\theta) = \log_e(\theta/(1-\theta))$. The parameters R and p might vary by year (t), and models were derived to allow for this effect. Time (t) in years was considered in two ways. First, the notation t denoted any significant variability in ϕ or p over years. Second, T was used to denote a linear trend in time in either logit(ϕ) or logit(p). Thus, a model allowing survival probabilities to vary across areas (g) and recapture probabilities to vary across years was denoted as (ϕ_g, P_T).

More complex models allowed several effects to be considered in a likelihood framework. An asterisk (*) denoted independent factors (e.g., g*t indicated that year-dependent parameters were incorporated in a model separately for each study area). Models employing a logit-linear structure were denoted by a "+" (e.g., g+t would indicate a model whereby study area was indexed by dummy variables, and parameters across time would be parallel on a logit scale) (see Hosmer and Lemeshow 1989). In all models, a log-likelihood ($\log_e(L)$) was used as the basis for statistical inference and estimation of model parameters was based on Maximum Likelihood methods. The model selection method (AIC) was objective; neighboring models were explored using likelihood ratio tests.

Table C.5. Estimates of the average annual number of new entries (B) into the adult population and the estimated average population size ($\hat{N}$) of northern spotted owls.[a]

Study Area	$\hat{B}$	$\hat{se}(\hat{B})$	$\hat{N}$	$\hat{se}(\hat{N})$
Northwest California	14.76	0.84	49.71	2.46
H.J. Andrews (western Oregon)	15.57	1.48	60.06	4.15
Medford (southwestern Oregon)	54.97	3.26	91.80	7.87
Roseburg (southwestern Oregon)	36.69	2.21	99.68	7.57
Olympic Peninsula (northwestern Washington)	24.44	1.06	51.20	3.56

[a] The estimates of $\hat{B}$ and $\hat{N}$ and measures of precision were made using program JOLLY (see Pollock et al. 1990).

Using the conventions above, either ϕ or p could be modelled in eight ways, g*t, g+t, t g*T, g+T, T, g or the null case, denoted -. Combinations of these eight structures for ϕ and p lead to 64 models of the five data sets on adult females. Table C.6. presents the number of model parameters, $-2\cdot\log_e(L)$, and AIC for each of the models considered.

While the AIC-selected model was (ϕ_T, p_{g*T}), some neighboring models were tested to allow a deeper understanding of the data. These tests retain a very general model structure for the recapture probabilities. Three tests were of particular interest:

Test 1. $(\phi, p_{g*T}$ vs. (ϕ_t, p_{g*T}), $\chi^2 = 11.9666$, 5 df, P = 0.035.
Here, one concludes that there is significant year-specificity in adult female survival.

Test 2. (ϕ, p_{g*T}) vs. (ϕ_T, p_{g*T}), $\chi^2 = 4.930$, 1 df, P = 0.026.
Here, one concludes that there is a significant linear trend in logit(ϕ).

Test 3. (ϕ_T, p_{g*T}) vs. (ϕ_t, p_{g*T}), $\chi^2 = 7.036$, 4 df, P = 0.134.
Here, one concludes that there is no reason to use four additional parameters to let R vary by year, when a linear trend is satisfactory.

Finally, a Wald test (2-sided) of the significance of the slope in the relationship between logit(ϕ) vs. T is,

z = -2.287, P = 0.011. Thus, one concludes that the slope is significant.

This comprehensive analysis indicated a decreasing trend in annual adult female survival rate for the populations in the five study areas (Table C.7.). This finding is important because λ is critically influenced by the adult female survival (i.e., juvenile survival and fecundity are relatively less important in their influence on λ). Because the evidence strongly indicates that R decreased during the 1985-91 period, one must infer that λ also decreased over this period. That is, the rate of population decline was accelerating during the study period.

Biases in $\hat{\lambda}$

Estimates of juvenile survival have been contentious because estimates are biased low if some juveniles leave the study area, survive a full year, and never return to the study area. To the extent that these three events happen, juvenile survival is underestimated, and estimates of λ are too low (i.e., the true value of λ is probably larger than estimated).

Two approaches were employed to obtain more reasonable estimates of juvenile survival, ϕ_J. First, the maximum estimate of juvenile survival from the five study areas ($\phi_J = 0.311$, $\hat{se} = 0.103$) was used (cases 1 and 2 in Table C.8.). Second, data on juvenile survival from the best production year for the Medford and Roseburg areas were pooled to obtain a maximum estimate ($\phi_J = 0.3065$, $\hat{se} = 0.0764$) and this was used (cases 3 and 4, in Table C.8.). The Medford and Roseburg areas are large in size and adjacent to each other. Thus, the number of dispersing juveniles that survived and never returned is minimized in this approach. In each of the four cases, an attempt was made to use a realistic estimate of juvenile survival as one of the estimates affecting λ. Cases 1 and 3 allowed adult female survival to decline, while Cases 2 and 4 used an estimate of the average adult female survival from the pooled data. Table C.2. provides estimates of $\lambda = 1$. In each of the four cases, there was strong statistical evidence of a declining population.

Table C.6. Summary of statistics related to model selection, based on 64 models. For each model the three table entries are number of model parameters, -2·log$_e$(L), and AIC. The best model is indicated by the box.

Survival Rate ϕ	Recapture Rate, p: g*t	G+t	t	g*T	g+T	T	g	-
g*t	47	36	31	36	32	28	31	27
	1664.54	1681.92	1700.07	1674.01	1683.27	1701.75	1686.76	1705.23
	1758.54	1753.92	1762.07	1746.01	1747.27	1757.35	1748.76	1759.23
g+l	36	20	16	20	16	12	15	11
	1672.76	1694.44	1713.53	1689.23	1698.32	1715.82	1703.48	1719.62
	1744.76	1734.44	1745.53	1729.23	1730.32	1739.82	1733.48	1741.61
t	31	16	11	16	12	8	11	7
	1673.82	1702.36	1721.30	1691.92	1705.49	1722.69	1708.83	1725.85
	1735.82	1734.36	1743.30	1723.92	1729.49	1738.69	1730.83	1739.85
g*T	36	20	16	20	16	12	15	11
	1674.09	1696.88	1714.06	1690.32	1698.65	1717.14	1701.63	1720.15
	1746.09	1736.88	1746.06	1730.32	1730.65	1741.14	1731.63	1742.15
g+T	32	16	12	16	12	8	11	7
	1677.43	1705.04	1719.75	1696.17	1706.46	1723.24	1710.89	1726.14
	1741.43	1737.04	1743.75	1728.17	1730.46	1739.24	1732.89	1740.14
T	28	12	8	12	8	4	7	3
	1678.54	1711.22	1725.85	1698.96	1714.22	1730.82	1716.35	1732.83
	1734.54	1735.22	1741.85	1722.96	1730.22	1738.82	1730.35	1738.83
g	31	15	11	15	11	7	10	6
	1678.39	1708.71	1721.44	1701.81	1714.77	1729.76	1715.12	1729.90
	1740.39	1738.71	1743.44	1731.81	1736.77	1743.76	1735.12	1741.90
-	27	11	7	11	7	3	6	2
	1679.11	1712.14	1726.42	1703.89	1719.31	1735.57	1719.33	1735.60
	1733.11	1734.14	1750.42	1725.89	1733.31	1741.57	1731.33	1739.60

An additional perspective concerning this source of potential bias can be gained by examining the value for juvenile survival necessary to force $\lambda = 1$ (with the same adult survival and fecundity values). The large increases in estimated juvenile survival, shown here, seem unfounded.

Study	$\hat{\phi}_J \mid \lambda = 1$	% increase
Northwest California	0.49	151
H.J. Andrews	0.60	93
Medford	0.89	345
Roseburg	0.53	87
Olympic Peninsula	0.52	632
Average	0.61	190

In summary, even with optimistic assumptions about juvenile survival rates, the best information suggests that the population of resident, territorial owls has declined, on average, at an estimated rate of 7.5 percent each year during the 1985-91 period and that this rate of decline probably has accelerated in recent years.

Senescence is another potential problem; unaccounted for senescence leads to overestimation of λ. Likewise, it seems clear that fecundity is overestimated each year and this overestimation is more severe in years of poor production.

Table C.7. Estimates of average adult female survival (ϕ) during 1985-91 for the northern spotted owl, based on the best model out of 64 for the pooling of data across the five study areas.

Year	$\hat{\phi}$	$\hat{se}(\hat{\phi})$
1985-86	0.8880	0.0242
1986-87	0.8727	0.0202
1987-88	0.8556	0.0157
1988-89	0.8367	0.0124
1989-90	0.8158	0.0146
1990-91	0.7929	0.0231

Table C.8. Estimates of the finite rate of annual population change (λ) for the northern spotted owl obtained by pooling all the data across the five study areas. Cases (explained in the text) make differing assumptions about juvenile survival rates.

Case	Years	Female Survival Rate	$\hat{\phi}_J$	$\hat{\lambda}$	$\hat{se}(\hat{\lambda})$	z	P
1	1985-86	Declining	ϕ_{max1}[a]	0.9813	0.0373	-0.4879	0.3128
1	1990-91	Declining	ϕ_{max1}[a]	0.8857	0.0362	-3.1575	0.0008
2	1985-91	Constant	ϕ_{max1}	0.9259	0.0312	-2.3750	0.0088
3	1985-86	Declining	ϕ_{max2}[b]	0.9805	0.0322	-0.6056	0.2724
3	1990-91	Declining	ϕ_{max2}[b]	0.8844	0.0312	-3.7051	0.0001
4	1985-91	Constant	ϕ_{max2}	0.9246	0.0251	-3.0040	0.0013

[a] The survival rate of juveniles was used for the area with the highest survival rate.
[b] The year with the highest survival was used for the Medford and Roseburg areas, thus the emigration was lowest.

This source of bias in λ also tends to overestimate λ.

Sandland and Kirkwood (1981) noted that the recapture probabilities can be correlated and this leads to biases in the estimate of survival. This effect was tested, but no evidence of this effect was found. This effect is a minor problem when recapture probabilities are so high (i.e., 0.80-0.90).

3. Conclusions

Populations of resident, territorial females in all five large study areas have declined significantly, at an estimated average rate of 7.5 percent per year during the 1985-91 period. The parameter most important in λ is the annual survival rate of adult females and this parameter has decreased significantly during the 1985-91 period. Thus, the rate of population decline has probably accelerated.

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Chapter 5

Risk Analysis of Species in Old-Growth Forests of the Pacific Northwest: Viability Assessment and Mitigation Measures in National Forests

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Table of Contents

Appendices

List of Tables

List of Figures

CHAPTER 5

Risk Analysis of Species in Old-Growth Forests of the Pacific Northwest: Viability Assessment and Mitigation Measures in National Forests

INTRODUCTION

Court Order

This chapter addresses the portion of the United States District Court order to evaluate the effect of proposed management strategies for the northern spotted owl (*Strix occidentalis caurina*) in National Forests on viability of other species of plants and animals closely associated with old-growth forests. Specifically, the Scientific Analysis Team's tasks were: (1) to determine if the alternatives for management of northern spotted owl habitat as presented in the Forest Service's Final Environmental Impact Statement on Management for the Northern Spotted Owl in the National Forests (USDA 1992c)(hereafter referred to as the Final Environmental Impact Statement) would allow alterations of habitat that would result in the extirpation or extinction of any of the 32 vertebrate species associated with old-growth forest in National Forests within the range of the northern spotted owl, as identified in the Final Environmental Impact Statement and in the Judge's order; and (2) if analyses indicate low viability ratings for such other species as a result of the proposed actions, to propose appropriate mitigating options (Forest Service letters of direction dated July 30, 1992 and August 28, 1992; see Chapter 2, Appendix 2-A).

Framework for Assessment

Our evaluation of species associated with old-growth forests and their viability entailed three phases:

> Identification of species closely associated with old-growth forests and components of old-growth forests;
>
> Evaluation of the viability of each of these species, under each of the five alternatives in the Final Environmental Impact Statement, including estimating the likelihood of extirpation from planning areas (i.e., National Forests) within the range of the northern spotted owl; and
>
> Identification of mitigation options to ensure a high likelihood that each species would not be extirpated from planning areas within the range of the northern spotted owl as a result of Forest Service actions.

This process also entailed identifying scientific uncertainties and key unknowns that could influence the viability evaluations of old-growth forest species. Such unknowns included identifying species about which little or no scientific information on ecology, life history, and habitat relationships is available.

Risks to each species associated with old-growth forests in terms of extirpation and viability were judged by the alternatives in the Final Environmental Impact Statement. In estimating habitat associations and risks of extirpation, the Scientific Analysis Team was not expected to conduct a formal viability assessment for each forest species associated with old-growth forests. Rather, we were directed to use common sense and expert judgment and to explicitly display and discuss the process used for establishing viability ratings (Forest Service letter of direction dated August 28, 1992; see Chapter 2, Appendix 2-A; also see court order discussed in Chapter 1).

METHODS

Description of the Northern Spotted Owl Final Environmental Impact Statement

Viability of species closely associated with old-growth forests was evaluated under each of the five planning alternatives presented in the Final Environmental Impact Statement. These alternatives applied only to National Forests. They were:

- A - Spotted Owl Habitat Areas
- B - Interagency Scientific Committee's Conservation Strategy (Thomas et al. 1990)
- C - Interagency Scientific Committee's Conservation Strategy plus Fish and Wildlife Service's (USDI) critical habitat designated for the northern spotted owl
- D - Interagency Scientific Committee's Conservation Strategy plus all additional nesting, roosting, and foraging habitat for northern spotted owls
- E - The Multi-Resource Strategy

Standards and Guidelines of the Selected Alternative

The selected alternative in the Final Environmental Impact Statement was Alternative B–the Interagency Scientific Committee's Conservation Strategy. This strategy entails designation of Habitat Conservation Areas to encompass nesting, roosting, and foraging habitat for the northern spotted owl throughout its range in National Forests (see Chapter 3).

In addition, the forest "matrix" (lands between the Habitat Conservation Areas) are to be managed to provide for northern spotted owl dispersal habitat. Management guidelines for providing dispersal habitat are termed the "50-11-40 rule" (Thomas et al. 1990). This standard provides for each quarter-township outside of Habitat Conservation Areas in National Forests and other Federally administered public lands within the range of the northern spotted owl, at least 50 percent of the forested land base in forest stands averaging at least 11 inches diameter at breast height (dbh) and at least 40 percent canopy closure. Also, the Interagency Scientific Committee's Conservation Strategy calls for the retention of other land allocations that also provide for old-growth forest cover, as identified in each National Forest Land and Resource Management Plan.

Old-Growth Species Identified in the Final Environmental Impact Statement

The Final Environmental Impact Statement identified 32 species of terrestrial vertebrate wildlife (amphibians, reptiles, birds, and mammals) that are closely associated with late-successional or old-growth forests or components of old-growth forest (see Final Environmental Impact Statement, Volume 1, p. 3&4-136, Table 3&4-30, "Species Closely Associated With Late-Successional Forest"). Our analysis refined the basis for evaluating the degree of association of these species with late-successional and old-growth forests, and expanded the evaluation to include fungi, lichens, plants, invertebrates, and fish, in addition to all terrestrial vertebrates.

Why Evaluate All Species Groups?

We considered a wider range of plant and animal species than that presented in the Final Environmental Impact Statement for three primary reasons. First, selecting and implementing a spotted owl habitat management plan is best conducted from a base of full disclosure and knowledge of potential effects of that plan on all species. Second, assessing effects on a broad variety of species groups better meets agency direction to provide for, and evaluate impacts on, the full range of biological diversity. Third, such a comprehensive approach lays the groundwork for a more complete approach to ecosystem management. Identification of effects on, and mitigation options for, individual old-growth species is still but one step in ecosystem planning. We do not intend for this assessment to substitute for a complete ecosystem analysis; it is, however, a vital and major step toward such an analysis.

Furthermore, the Court identified that "Congress's mandate for multiple use, including both logging and wildlife preservation, can be fulfilled if the remaining old-growth habitat is left standing; it cannot be if the old growth in any National Forest is logged to the point where native vertebrate species cease to exist there" (Judge Dwyer's ruling of July 2, 1992). Our assessment was conducted to help the Forest Service determine steps necessary to safeguard the security of old-growth forest species occurring within the range of the northern spotted owl.

Selection of Old-Growth Species

The following procedure was used to identify species closely associated with old-growth forests. We compiled a "long list" of species that occur within late-successional forests (mature or old growth, as defined by Ruggiero et al. 1991, Brown 1985, USDI 1992a). This long list was narrowed to a "short list" of species closely associated with old-growth forests or with components of old-growth forests. Each species on this short list was then evaluated for viability under the Final Environmental Impact Statement alternatives, and subset lists of species with risk to viability were identified. Also, species were identified that are so poorly known scientifically that viability could not be judged. Mitigation options for the species with risk to viability were then identified. Specifically, each step in this process was conducted as follows.

"Long List" of Species That Use Mature and Old-Growth Forests - First, we identified all plant and animal species that might find optimal habitat within late-successional forests in National Forests within the range of the northern spotted owl. In this step, we reviewed available summaries of literature on species distribution by forest condition and age class (see literature cited in Appendix 5-A). We also accessed unpublished studies and data, existing Forest Service data bases (ecology data bases), and used professional knowledge to compile the long lists of plants. The technical and scientific literature contains many references on species occurring in late-successional forest (see citations in Appendix 5-A). We did not attempt to review every existing piece of primary literature; rather, we focused on the major syntheses of mature and old-growth species lists most often cited and used by resource managers and biologists (Appendix 5-A). Of particular importance in building the long lists were the recent publications of Ruggiero et al. (1991) and the Draft Recovery Plan for the Northern Spotted Owl (USDI 1992a).

We compiled a composite list of all species that were depicted in one or more of these references as using late-successional forests within the range of the northern spotted owl for at least one aspect of their life history. This resulted in a "long list" of plant and animal species found in late-successional forests (see Appendix 5-A). A long list of 7 anadromous fish species consisting of 214 stocks, and an additional 4 species of resident fish, were considered by the fish habitat experts on the Scientific Analysis Team. A stock is a locally adapted population that is, for the most part, reproductively isolated from other stocks (Ricker 1972). Individual stocks have been recognized for listing under the Endangered Species Act (National Marine Fisheries Service 1990). In this report, conservation mitigation options focused on the identified stocks.

"Short List" of Species Closely Associated With Old-Growth Forests - We then developed a set of criteria by which each species on the "long list" was further evaluated for its degree of association with old-growth forest ecosystems (Table 5-1). Not all species on the long list are **closely** associated with old-growth forests; some species also occur commonly in young-growth forests, or in other special habitat conditions. The criteria we developed helped identify those species that are associated with old-growth forest stages and old-growth forest components such as large snags and large down logs plus those species identified by state or Federal agencies as proposed or listed as threatened or endangered. The criteria helped us to produce a "short list" of species likely to be *closely associated* with old-growth forests or components of old-growth forests (see Appendices 5-B, 6-C, 6-D; also, Appendix 5-A shows how the criteria were applied to each species of terrestrial vertebrate on the long list).

Components of old-growth forests considered in this evaluation included large diameter snags, large diameter and very old live trees, large amounts and sizes of down wood, and deep litter and duff layers on the forest floor. We explored species' use of old-growth forest components because these are elements of forest ecosystems that possibly could be provided outside old-growth forests per se by use of innovative silviculture. These old-growth forest elements are key to the dispersal and distribution of some species across the general forest landscape.

Table 5-1 Criteria for Developing the List of Species Closely Associated With Old-Growth Forests or Components of Old-Growth Forests ("Short List"), From the List of Species That at Least Occur Within Old Growth ("Long List").

Criteria

A species is included in the short list of species closely associated with old-growth forests or components if it meets at least one of the following 4 criteria:

Criterion 1:	- The species is statistically significantly more abundant (based on field study or collective professional judgment of the Scientific Analysis Team) in old-growth forest than in pole or mature forest, in any part of its range.
Criterion 2:	- The species shows association with old-growth forest (may reach highest abundance there, but not necessarily statistically so) and the species requires habitat components that are contributed by old-growth forest (based on field study or collective professional judgment of the Scientific Analysis Team).
Criterion 3:	- The species is associated with 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 old-growth forest, and the species is listed as a Federal (Fish and Wildlife Service) threatened and endangered, and Scientific Analysis Team suspects that it is associated with old-growth forest.

Specific Factors

Following are specific factors extracted from the above list of criteria. These factors were identified for each terrestrial vertebrate species (amphibians, reptiles, birds, and mammals) on the long list (see Appendix 5-A; a similar procedure was used for plant species and fish stocks, not shown in the appendices).

Factor A-	- Field data: species is significantly more abundant in old-growth forest than in younger forest based on field data.
Factor B-	- Scientific Analysis Team judgment: species is significantly more abundant in old-growth forest than in younger forest based on collective professional judgment of the Scientific Analysis Team.
Factor C-	- Association with old-growth forest: species is associated with old-growth forest (may reach highest abundance there, but not necessarily statistically so).
Factor D-	- Associated with old-growth forest elements: species is associated with habitat elements that are contributed by old-growth forest (based on field study or collective professional judgment of the Scientific Analysis Team).
Factor E-	- Federal Fish and Wildlife Service threatened and endangered: species is on Federal (Fish and Wildlife Service) list of threatened or endangered species.
Factor F-	- Federal Fish and Wildlife Service Candidate: species is on Federal Fish and Wildlife Service Candidate Species List.
Factor G-	- Forest Service Sensitive Species: species is on Forest Service Region 5 or 6 Sensitive Species List.
Factor H-	- State list: species is on state list (threatened and endangered, sensitive, special concern) in Washington, Oregon, or California.
Factor I-	- Inadequate field data: unaware of adequate field data by which to measure (quantify) strength of association with old-growth forest.

Table 5-1 (continued) Criteria for Developing the List of Species Closely Associated With Old-Growth Forests or Components of Old-Growth Forests ("Short List"), From the List of Species That at Least Occur Within Old Growth ("Long List").

Rule Set for Determining "Short List"

Relating factors to criteria - a species qualifies as a "short list" species under a given criterion if it strictly meets the following factor conditions:

Meets Criterion 1 if meets: Factor A or B.
Meets Criterion 2 if meets: Factors C and D.
Meets Criterion 3 if meets: (Factor A or C) and (E or F or G or H).
Meets Criterion 4 if meets: Factors E and I and (A or B or C or D).

Assessment of Viability Effects

Population viability analysis can be a complex series of quantitative evaluations. It can involve field data on demography and trend of populations, calculations of loss of genetic variation, and simulation models projecting habitat conditions, population responses, dynamics of metapopulations (interacting populations), and complicating, cumulative effects of other biological and nonbiological factors. Our evaluation of potential viability of old-growth species is not a quantitative population viability analysis. We lack data and specific models of habitats and populations by which to quantify likelihoods of extirpation and continued existence. Our emphasis was qualitative and focused on amount and distribution of habitat provided under planning alternatives. Given more time, we could have considered additional primary literature on some species. However, there are few basic scientific studies on life history and ecological requirements of most species examined.

Based on our collective professional judgement and that of the expert review panels (see below), we qualitatively considered potential future effects of natural catastrophes and disturbances on species viability. However, because of lack of time and available models, we did not quantify and predict specific aspects of ecosystem process and function, such as by analyzing the type, frequency, and potential effects of disturbance events (i.e., fires, windstorms, outbreaks of forest pathogens, and natural succession). Thus, the viability evaluations presented should be interpreted as qualitative assessments of potential, longer-term effects of implementing habitat management plans for northern spotted owls, rather than as quantitative, statistical analyses of species' demographics and population trends. Likewise, our viability evaluations are not precise quantifications of extinction likelihoods. We fully expect that results of viability assessments for some species will change with availability of more precise data and quantitative models of populations or their environments.

Ecological Characteristics of Species - The following information was used in evaluating potential viability effects. Life history, ecological characteristics and legal listing status were compiled for each species on the short list.

In addition, range maps of the geographic distribution of each species on the short list of terrestrial vertebrates were obtained and entered into a Geographic Information System. The extent of each species' range within that of the northern spotted owl was superimposed onto maps of reserved areas (such as congressionally designated Wilderness) and designated areas managed primarily for spotted owl habitat under each of the five planning alternatives in the Final Environmental Impact Statement. This analysis helped determine the general extent of the distributional range of each species on the short list that would be protected by (1) designated and reserved spotted owl habitat, and (2) forests outside of designated areas classified as unsuitable for timber harvest.

Effects of Land and Resource Management Plans on Old-Growth Distribution Over Time - Also used in the evaluation was information on distribution and abundance of northern spotted owl habitat and old-growth forest cover under each of the five Final Environmental Impact Statement alternatives and as influenced by individual Land and Resource Management Plans from each National Forest. We used information from National Forests in Washington and Oregon on distribution of old growth as assessed with the previous inventory contracted with Pacific Meridian Resources (PMR). We also used the current land management allocations (full timber production, partial timber production, and no timber production allocations) from individual Land and Resource Management Plans from National Forests in Washington and Oregon as affecting the PMR old-growth categories (large old growth, small old growth, and other conifer) in each National Forest. Such data, along with maps of PMR old growth throughout the region and maps of each National Forest's Land and Resource Management Plan, helped us discern the potential amount and arrangement of old-growth forest cover at present and over time that would be provided by individual forest plans in concert with that provided under each planning alternative presented in the Final Environmental Impact Statement.

Fish Experts' Evaluations - Viability of habitat for the anadromous salmonid stocks was evaluated by two members of the Scientific Analysis Team (Reeves and Sedell). Mitigation options for these stocks were developed in coordination with the Forest Service's Pacific Salmon Workgroup and Field Team (also known as "PacFish," USDA 1992a).

Expert Panel Evaluations - We convened a set of five expert panels to evaluate viability of the "short list" old-growth species. The panels evaluated risk of extirpation for each species by planning alternative from the Final Environmental Impact Statement. Each panel was made up of seven to eight recognized experts on (1) fungi, lichen, and nonvascular plants, (2) vascular plants, (3) amphibians and reptiles, (4) birds, and (5) mammals (Appendix 5-E).

In the course of their viability evaluations, the panels considered information on life history and ecological characteristics of each species (including information in Appendix 5-D), range maps of each vertebrate species, and the expected influence of each of the five planning alternatives on spotted owl habitat and old-growth forest cover over time. Each panel also considered each species in various portions of its range, and evaluated viability in each area separately, if the species was distributed in a disjunct (noncontiguous) pattern and would incur different risks to viability in each area.

As a result of the panel deliberations, short lists used at the start of the assessment process were modified for nonvascular plants, vascular plants, amphibians, and mammals. Modifications reflected the panels' additions of species, or distinct populations in the species' ranges, to the lists. The viability ranking system used by the panelists is presented in Table 5-2. Hereafter, species considered throughout their range and species evaluated by the panels in a portion of their range will be referred to collectively as "species or ranges." (The numbers in these modified short lists are shown in Table 5-3.)

Table 5-2 Five-Class Viability Ranking Scale Used to Assess the Likelihood That Populations of Each Old-Growth Associated Species Would Stabilize or Increase Over Time. The Timeframe Considered Here is Approximately 50 Years (a Period Over Which we Assume that Most Old-Growth Forest Outside No-Yield Forest Allocations Would be Harvested).

HIGH – There is a high likelihood that the population(s) of the species would stabilize in National Forests within the range of the northern spotted owl. This provides *broad* latitude for natural catastrophes and uncertainties in knowledge. The likelihood of widespread or complete extirpation is low.

MEDIUM HIGH – There is a moderately high likelihood, somewhat better than 50/50, that the populations of the species would stabilize in National Forests within the range of the northern spotted owl. This provides *limited* latitude for natural catastrophes and uncertainties in knowledge. There is less than a 50/50 likelihood of widespread or complete extirpation.

MEDIUM - There is a roughly 50/50 likelihood that the population would stabilize, and a similar likelihood of widespread or complete extirpation in National Forests within the range of the northern spotted owl. This provides *extremely limited* latitude for natural catastrophes and uncertainties in knowledge.

MEDIUM LOW - There is less than a 50/50 likelihood that the population would stabilize, and a greater than 50/50 likelihood of widespread or complete extirpation in National Forests within the range of the northern spotted owl. There is *no* latitude for natural catastrophes and uncertainties in knowledge.

LOW - It is highly unlikely that the species' populations would stabilize, and there is high likelihood of widespread or complete extirpation in National Forests within the range of the northern spotted owl. There is *no* latitude for natural catastrophes and uncertainties in knowledge.

Identification of Species With Viability at Risk - Three broad categories of species at risk of extirpation were defined by summarizing the viability rankings (shown in Table 5-2): low risk, medium risk, and high risk. We defined extirpation as the local extinction of a species from one or more National Forests within the range of the northern spotted owl, as a direct (but possibly delayed) effect of specific forest management activities. Thus, extirpation means the elimination of a species from a National Forest although it might continue to exist elsewhere. Exceptions to this may be local endemic species, such as stocks of anadromous salmonids, which are either entirely or largely restricted to areas managed by Forest Service.

For anadromous fish stocks, we used the risk of extinction ratings of Nehlsen et al. (1991). Stocks were identified as having a moderate or high risk of extinction or to be in need of special management considerations beyond those currently implemented in National Forest Land and Resource Management Plans. Criteria for these ratings were population size and trend.

Species with low risk of extirpation are those that were ranked by the panelists as "high" or "medium high" viability (Table 5-2) over an approximately 50-year period under at least one alternative. We felt that species in this category were likely to meet the population viability criteria presented in the regulations (36 CFR 219.19) implementing the National Forest Management Act; these species were not considered to be at risk.

Species with medium risk of extirpation are those that were generally ranked by the panelists as less than "medium high" viability (Table 5-2) over an approximately 50-year period under at least one alternative. We felt that such a risk category failed to meet the population viability criteria presented in the regulations implementing the National Forest Management Act.

A 50-year time period was chosen as representing a median duration over which adverse effects on viability as well as any significant modification of old-growth forest habitats, particularly timber harvesting, would occur.

Species with high risk of extirpation are those that were generally ranked by the panelists as less than "medium" viability (Table 5-2) over an approximately 50-year period under at least one alternative. High risk species are strictly a subset of the list of medium risk species above. High risk species are of even greater concern than are medium risk species because of their higher likelihood of extirpation within one or more planning area (National Forest) over the next 50 years.

The panel of experts provided professional advice for use in our evaluation; the Scientific Analysis Team, however, made the final interpretations on viability. Overall, both levels of risks to viability were identified for all species groups except for invertebrates and fish stocks. Ecological associations and geographic distributions of invertebrates are very poorly known; therefore, viability of each invertebrate species could not be evaluated under each alternative at the present time.

Assessment of the probability of the proposed measures for maintaining and restoring habitat for anadromous salmonid fish stocks considered at risk (Nehlsen et al. 1991) was done for all 112 stocks as a unit rather than for individual stocks. Habitat degradation, which includes loss of or a decrease in the quality of freshwater habitat, has contributed to the decline of each stock (Nehlsen et al. 1991). Habitat requirements of the various species comprising the stocks vary considerably (Bjornn and Reiser 1991, Groot and Margolis 1991); however, and responses to changes in habitat conditions resulting from land management activities may also vary (Reeves et al., in press). Although habitat requirements may vary, all species are dependent on the same suite of ecological processes and elements that structure and maintain habitat. We therefore assumed that the proposed mitigation actions were sufficiently robust to address the processes and elements that influence fish habitat and would result in the creation and maintenance of a range of conditions conducive to supporting all species and stocks collectively. Thus, we did not analyze each stock separately.

All aspects of the development of species lists were conducted in close coordination with the Northern Spotted Owl Recovery Team (USDI). Our assessments began with those conducted by the Northern Spotted Owl Recovery Team, particularly by Anthony et al. (1992).

Viability Evaluation Methods - The following specific methods were used to evaluate viability of each species group.

a. Nonvascular Plants - An assessment of fungi, lichen, and nonvascular plants (bryophytes, including clubmosses, mosses, and liverworts) was led by Robin Lesher, a Forest Service botanist, under the guidance and oversight of the Scientific Analysis Team. (For purposes of clarity and brevity in this report, fungi, lichen, and bryophytes will be referred to collectively as nonvascular plants, although this is not strictly correct terminology.) Because much of the expert knowledge of these species resided with academic experts in the Pacific Northwest, contracting for and review by experts from outside the Forest Service was a major component of this assessment. These "outside" experts and reviewers identified species closely associated with old-growth conditions and compiled known data on distribution and ecology of each species. Forest Service botanists also worked with the expert panel to evaluate potential risks to viability under each Final Environmental Impact Statement alternative and to identify mitigation options to help ensure high viability.

Collectively, fungi, lichen, and nonvascular plants were included in the assessment because they are vital elements of forest ecosystems. They play central roles in nutrient cycling and uptake by conifers and other tree species of commercial value, provide reservoirs of water, participate in decay and decomposition of organic matter and replenishment of soil fertility, and other ecological functions. Their ecological roles, distribution, abundance, and environmental relationships deserve greater study under ecosystem approaches to forest management.

As an example, some species of fungi (mychorrizae) are essential symbionts for assisting coniferous trees in nitrogen absorption. Their abundance, distribution, and sensitivity to changes in old-growth forest conditions directly influence forest health. Also, the ecology of dispersal agents for mychorrizae, such as northern flying squirrels, also play important roles in maintaining forest health. Lichens are used elsewhere as indicators of air quality. Likewise, many species of nonvascular plants are sensitive to changes in old-growth microclimates and habitat conditions and would likely serve as useful biological indicators of changes in forest ecosystem health.

b. Vascular Plants - Vascular plants were assessed with the help of a Forest Service core team of plant experts under the guidance and oversight of Joan Ziegltrum (a Forest Service ecologist) and the Scientific Analysis Team. Species lists and ecological characteristics of the species were compiled from existing literature, unpublished data from the Forest Service old-growth research program, ecology data bases from the Forest Service's Pacific Northwest and Pacific Southwest Regions, and information on threatened, endangered and sensitive plants from the Forest Service, Washington Natural Heritage Program, Oregon Natural Heritage Program, California Department of Fish and Game Natural Diversity Data Base, and California Native Plant Society (also see references cited in Appendix 5-B).

The core team of plant experts sought analysis and evaluation help from Forest Service botanists and ecologists, and from state and academic experts outside the Forest Service. The core team also worked with the expert panel on plants to evaluate potential risks to viability and to identify mitigation options.

c. Invertebrates - As a starting point in evaluating effects on invertebrates associated with old growth, we relied on earlier reports provided by the Northern Spotted Owl Recovery Team. The previous reports were authored by Frest and Johannes (1991) and Lattin and Moldenke (1992) and were used for the appendix on other species and ecosystems in the Draft Northern Spotted Owl Recovery Plan (see Anthony et al. 1992). These reports were reviewed under new contracts conducted for us as follows.

The report on mollusks by Frest and Johannes (1991) was reviewed by Ingrith Deyrup-Olsen, Professor Emeritus of Zoology at the University of Washington, Seattle, and an expert in the field (see Appendix 5-E for all reviewers' affiliations). The review focused on evaluating the content and conclusions of the previous report (letter to Scientific Analysis Team from Deyrup-Olsen dated November 6, 1992).

The report on arthropods by Lattin and Moldenke (1992) was reviewed under contract with The Xerces Society in Portland, Oregon, a society established for the study and conservation of invertebrates. The contract resulted in a second report, authored by David M. Olson (1992), Division of Environmental Studies, University of California, Davis. Olson reviewed the content and conclusions of the previous work and included a qualitative evaluation of how the five Final Environmental Impact Statement alternatives collectively might affect arthropods.

Because of a lack of information, invertebrates were not evaluated for viability under each of the planning alternatives. However, the contract reports consistently underscored the following themes: (1) invertebrates are little studied and little understood in the Pacific Northwest; (2) many species play crucial and diverse ecological roles in late-successional forest ecosystems, including decomposers of organic material for replenishment of soils, pollinators of flowering plants, and prey for a wide variety of other invertebrates and vertebrates; and (3) many arthropods can serve as biological indicators of forest health (Lattin and Moldenke 1992, Asquith et al. 1990, Olson 1992).

d. <u>Fish</u> - Evaluation of the effects of the various alternatives on habitat of at-risk stocks of anadromous salmonids in National Forests within the range of the northern spotted owl was derived from ongoing evaluations of anadromous fish (USDA 1992a). The assessment for these stocks was based on habitat conditions and not populations. Refer to Appendix 5-K for justification for assessing the effects on habitat.

Each alternative in the Final Environmental Impact Statement was evaluated in terms of: (1) the probability of maintaining or restoring riparian zones and their ecological functions and processes; (2) presence and components of a watershed restoration program; and (3) the fraction of the landscape covered by spotted owl reserves, particularly that contained within key watersheds (Johnson et al. 1991). All Final Environmental Impact Statement alternatives lacked riparian management standards and a watershed restoration component. Therefore, we assumed that riparian zone management standards and guidelines for Land and Resource Management Plans would apply. Emphasis was on the fraction of key watersheds contained within spotted owl reserves.

Key watersheds had previously been identified as part of an evaluation of alternatives for the management of late-successional forests by Johnson et al. (1991). These were watersheds that either currently contained good quality habitat or were in poor condition but had a strong potential to be restored. These were identified with the assistance of fish biologists from National Forests within the range of the northern spotted owl. Key watersheds identified in Johnson et al. (1991) in California were modified slightly after evaluation by the Forest Service's Pacific Southwest Region Fish and Watershed Work Group, which did so as part of an assignment to develop a strategy for managing fish habitat and riparian ecosystems for the Six Rivers, Mendocino, Klamath, and Shasta-Trinity National Forests. Some watersheds originally identified were removed and others added. Key watersheds in California that were evaluated in this exercise included these changes.

e. Terrestrial Vertebrates - We evaluated amphibians, reptiles, birds, and mammals by review of selected literature on species' orientations to late-successional and old-growth forests to identify long and short lists. We also worked with the expert panels on amphibians and reptiles, birds, and mammals to evaluate potential viability concerns under each Final Environmental Impact Statement alternative and mitigation options to help ensure high viability.

We also sought technical advice on viability of, and mitigation options for, marbled murrelets from several experts on the species including Eric Cummins and Thomas Hamer (Washington Department of Wildlife), Kim Nelson (Oregon Cooperative Wildlife Research Unit, Oregon State University), and C. John Ralph (Pacific Southwest Forest and Range Experiment Station, Forest Service).

Identification of Unknowns and Species of Undetermined Status - For each species group above, we also identified the species for which scientific information is inadequate or lacking by which to judge viability effects and mitigation options needed to help ensure high viability over time.

Identification of Mitigation Options

The expert panels helped to identify mitigation options for habitat conditions conducive to providing for high viability, for all medium-risk species (that is, those species that ranked less than "medium high" in viability). Mitigation options included general qualitative and, where available, quantitative management standards that would provide needed habitat conditions, such as provision of components of old-growth forests outside Habitat Conservation Areas for northern spotted owls.

In identifying mitigation options (standards and guidelines for management of vital habitat components), we relied on the advice of the expert panels on plants and terrestrial vertebrates, the content of the contract reports on invertebrates, results of the Pacific Salmon Workgroup, and additional supplementary information on fish, northern goshawks, marbled murrelets, American marten, lynx, and other species.

To combine mitigation options among all medium-risk species under Alternative B, we used the following incremental process (hereafter referred to as steps, although they should be applied as a collective set and not necessarily in a step-wise fashion). In each step, the habitat needs of additional old-growth species were provided in a cumulative fashion. To ensure the needs of all species, the mitigation guidelines resulting from all steps would need to be adopted.

The general procedure we used to develop the mitigation steps follows. We first identified old growth protected by existing National Forest Land and Resource Management Plans. Next, we included the Interagency Scientific Committee's Conservation Strategy for the northern spotted owl in National Forests, as analyzed in the Final Environmental Impact Statement. One variant of the Interagency Scientific Committee's Conservation Strategy that we included here as an optional mitigation step is the modification to Habitat Conservation Areas as presented in Chapter 3 of this report. Next, we considered the additional needs for species with existing or impending Federal threatened or endangered species status; these were also additional old-growth species with the broadest scope of habitat requirements or distributional ranges, and with current viability concerns. These species included anadromous at-risk fish stocks and marbled murrelet. We then added other old-growth species of more local concern and with narrower ecological or distributional ranges. Finally, we added any additional species that occur in the upland forest matrix that were not already included in the above lists. The overall result of implementing the mitigation activities identified in all steps combined is likely to be security from extirpation for all species of late-successional and old-growth forests in National Forests within the range of the northern spotted owl, for which scientific information was adequate. However, the degree of security from extirpation risk for species on which there was inadequate information is still unknown and cannot be judged.

Mitigation Step 1 - Standards and Guidelines From Existing Land and Resource Management Plans of National Forests Within the Range of the Northern Spotted Owl. This step entailed simply accepting the standards and guidelines in existing National Forest Land and Resource Management Plans. The viability needs of some of the "short list" species closely associated with old-growth forests or old-growth forest conditions would be provided by these standards and guidelines for forest management. This step entailed identifying which species would and would not be provided for under existing standards. We assumed for this assessment that existing management direction corresponded to Final Environmental Impact Statement Alternative A.

Mitigation Step 2a - Standards and Guidelines for Habitat Conservation Areas Under Alternative B. We identified the standards and guidelines for habitat management under Alternative B (the Interagency Scientific Committee's Conservation Strategy) in the Final Environmental Impact Statement. This established the extent and locations of Habitat Conservation Areas and management guidelines for provision of dispersal habitat in the forest matrix between Habitat Conservation Areas, according to guidelines from the Interagency Scientific Committee's Conservation Strategy. In this step, we identified the species that would and would not be provided for by the combination of the standards and guidelines from National Forest Land and Resource Management Plans and from Alternative B of the Final Environmental Impact Statement.

Mitigation Step 2b - Recommended Additions to Habitat Conservation Areas in National Forests. We identified additions to Habitat Conservation Areas within National Forests that may be needed as mitigation options for reduced spotted owl viability associated with preferred alternatives of Bureau of Land Management's Draft Resource Management Plans (see Chapter 3).

Mitigation Step 3 - Standards and Guidelines for Riparian Habitat Conservation Areas
We then applied standards and guidelines designed for protecting habitat for the 112 fish stocks at risk. This step provided a substantial increase in the distribution and extent of existing and potential old-growth forest cover for a wide variety of species. We listed the resident fish and non-fish species likely to be also benefited by mitigation options for anadromous fish and riparian habitat.

Mitigation Step 4 - Standards and Guidelines for Marbled Murrelet
We developed standards and guidelines for protecting nesting habitat for the marbled murrelet. This accounted for additional forest areas conserved within proximity to marine environments. We then identified other species likely benefited by the combination of guidelines for the Riparian Habitat Conservation Areas and for protection of nesting habitat for the marbled murrelet.

Mitigation Step 5 - Standards and Guidelines for Rare and Locally Endemic Species
We then identified rare and locally endemic species requiring inventory for locating specific occurrences, for the purpose of conserving habitat conditions at those individual sites.

Mitigation Step 6 - Additional Standards and Guidelines for Other Species in the Upland Forest Matrix. Finally, we identified any other species not included in the first five steps that would require additional standards and guidelines for conserving old-growth forests and components of old-growth forests in the upland forest matrix outside of conservation areas described in Mitigation Steps 1 through 5.

We did not quantitatively analyze the demography, population size and trend, genetics, or disturbance dynamics of populations and their environments. Rather, we addressed only the components of habitats directly or indirectly affected by management activities in National Forests. Managing such components is a necessary, but not always sufficient, set of conditions to ensure viability of each species throughout its range, even only in National Forests. For example, restoring viability to many fish stocks at risk would also entail addressing problems outside National Forests, including effects of hydroelectric structures, harvesting, and hatchery practices. Likewise, changes in regional climate and air quality would likely affect the distribution of species of lichen and other nonvascular plants in inland valley environments outside National Forests, thereby increasing, over time, the species' reliance on old-growth forest habitats in National Forests over time. These are significant factors to consider in a viability assessment. As new information becomes available, a reevaluation of our recommendations may well be warranted if future viability analyses incorporate these factors.

Also, management of late-successional forests and northern spotted owl habitat on other lands, such as those administered by the Bureau of Land Management in southwest Oregon, can influence the distribution and abundance of many old-growth wildlife species in National Forests. Overall, we did not quantify such potential off-site effects, but we did consider their qualitative influences on National Forest biota and accounted for them in many of our evaluations.

We also addressed the habitat requirements of some species whose geographic range overlaps that of the northern spotted owl only along fringes of their ranges. Some of these species were rated as having medium to high risk to viability. However, management of their habitats outside the range of the northern spotted owl would have a major influence on maintaining their long-term viability. This report does not address those additional needs because our charge was to identify extirpation risks and mitigation options for helping to ensure viability of species and habitats within the northern spotted owl's range.

We also identified mitigation options in coordination with Forest Service Pacific Northwest and Pacific Southwest Regions, drawing on management standards and guidelines in preparation but not yet in effect. This was particularly useful for identifying habitat needs of marbled murrelets, northern goshawks, and American martens, and for coordinating with ongoing management efforts to provide these needs.

RESULTS

Identification of Old-Growth Species

We evaluated over a thousand plant and animal species for their association with old-growth forests of the Pacific Northwest within the range of the northern spotted owl (this was the "long list" of species; see Appendix 5-A for long list of terrestrial vertebrates). These species included nearly 700 species of plants and fungi, 214 stocks of at-risk anadromous salmonids, 4 species of resident fish, and 224 terrestrial (non-fish) vertebrates (Figure 5-1). In addition, our contractors considered hundreds of invertebrate species. Of these totals, 312 plants, 149 invertebrates, 112 stocks of anadromous salmonids, 4 species of resident fish, and 90 terrestrial vertebrates were found to be closely associated with old-growth forest conditions ("short list" species). We had concerns for viability under each alternative in the Final Environmental Impact Statement for a smaller subset of species, as described below. We also had concerns about the viability of all 112 fish stocks identified for our project by our fish habitat experts, and all 149 species of invertebrates identified by our contractors and in the previous assessments.

Assessments by Species Groups

Nonvascular Plants - A total of 42 species of fungi (mostly mushrooms) and 148 species of lichens and nonvascular plants (liverworts and mosses) were evaluated for viability status under each of the five alternatives in the Final Environmental Impact Statement (Appendix 5-H). Little is known about many of the fungi, lichen, and nonvascular plants. Scientific, ecological information was lacking for 39 species. As a result, viability could only be rated with great uncertainty, if at all (Appendix 5-J). However, viability assessments could be made for many other species for which more information was available. The number of species assigned medium risk to viability ranged from 19 under Alternative D to 147 under Alternative E. The number of species with a high risk to viability ranged from 4 under Alternatives B, C, and D, to 82 under Alternative E.

Under Alternative B – the selected alternative in the Final Environmental Impact Statement (the Interagency Scientific Committee's Conservation Strategy) – 38 species or ranges were at medium risk (Appendix 5-H). The 38 species or ranges included 18 fungi, 2 lichens, 6 liverworts, and 12 mosses. The 4 species with high risk to viability under Alternative B included 1 species of fungus and 3 mosses.

Vascular Plants - A total of 122 species or ranges of vascular plants were evaluated for viability effects (Appendix 5-H). Vascular plants include a wide variety of life forms, some of which are economically important to the Pacific Northwest. Species of vascular plants assessed in this report included saprophytes (plants that live off of decaying vegetable matter), root parasites, orchids, grape ferns, heaths, shrub heaths, coniferous trees, ferns, grasses, and other herbaceous forms. As with all other species groups evaluated in this report, some of the vascular plant species have quite narrow geographic distributions ("local endemics") or occur only in very specific conditions of forest structure and soil (such as the serpentine barren species of Klamath Mountains in southwestern Oregon and northwestern California).

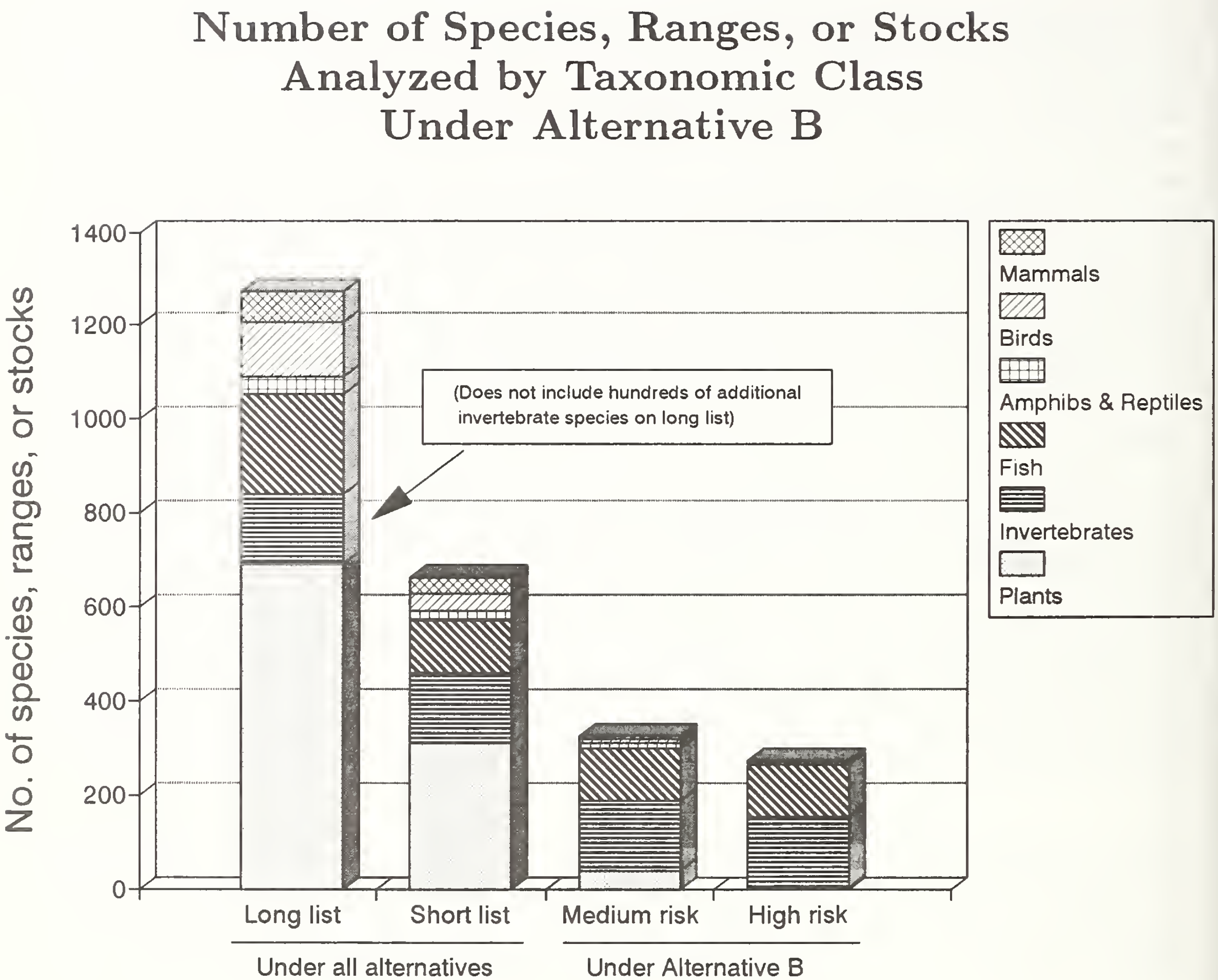

Figure 5-1 Number of Species, Ranges, or Stocks Analyzed by Taxonomic Class Under Alternative B of the Final Environmental Impact Statement.

Under each of the five alternatives described in the Final Environmental Impact Statement, the number of species or ranges with medium risk to viability ranged from none under Alternative B to 5 under Alternative E. One species, Pacific yew, is at high risk, but only under Alternative E. Sufficient scientific information to justify rating viability by alternative was lacking for 10 species.

Under Alternative B, none of the vascular plant species was determined to have either medium or high risk. However, two vascular plants (both are orchids) were rated as being at medium risk to viability under Alternatives C and D. This is because the species require ground fire disturbance that the panel on vascular plants felt might be more rare and less extensive under Alternatives C and D than under Alternative B.

Invertebrates - A total of 149 species of invertebrates, including 58 mollusks and 91 arthropods (Appendix 5-F), were identified as closely associated with old-growth forests or old-growth forest conditions. Out of a regional list of more than 7,000 species (Olson 1992), we could find reliable data on distribution for only a few hundred species closely associated with old growth.

Olson (1992) concluded that none of the proposals for spotted owl conservation areas on Federal lands would be adequate to capture the full invertebrate diversity that currently exists across the landscape. In particular, in the coming century, if the only remaining tracts of old-growth forest are located within the Habitat Conservation Areas and Critical Habitat Areas designated in Alternatives B and C in the Final Environmental Impact Statement, "then there is a very high probability that many invertebrate species extinctions will occur in areas not covered by protected lands, particularly in the coastal forests of Oregon and northern California, the Klamath Province, and the Olympic Peninsula that are known for a high degree of [species] diversity" (Olson 1992:9-10). Although Olson may have underestimated the extensive coverage of Habitat Conservation Areas under Alternatives B and C in the Oregon Coast Range and Olympic Peninsula Provinces, local distributions of some invertebrate species might still range outside the Habitat Conservation Areas. Populations of the less vagile species remaining within Habitat Conservation Areas would likely become isolated into smaller populations unless connected with corridors of forest cover, as might be provided by some of the mitigation options discussed below.

We identified 79 invertebrate species as closely associated with both old-growth forests and riparian habitats (see Appendix 5-F). Many of these species would likely benefit from increased riparian habitat protection, as discussed below under Mitigation Step 3.

Fish - We evaluated 112 stocks of anadromous salmonids representing 7 species found in National Forests (Appendix 5-C). Numbers of stocks of fish are based on current knowledge, and are likely to change. These stocks have been identified by Nehlsen et al. (1991) as being at risk of extirpation. Additionally, we considered 4 other fish species recognized by Williams et al. (1989) as being in various stages of population decline (Appendix 5-C). These 4 species included bull trout which are currently being considered by the Fish and Wildlife Service for threatened status. Like the anadromous salmonids, habitat loss and degradation have also contributed to the decline of these 4 species. Habitat loss and degradation are responsible, at least in part, for the decline in habitat and populations of each stock.

None of the five alternatives described in the Final Environmental Impact Statement provided a high probability of maintaining or restoring fish habitat for the 112 anadromous salmonid stocks (Appendix 5-G). The Final Environmental Impact Statement alternatives did not specify any riparian management zone standards; nor were Habitat Conservation Areas delineated based on riparian zones or watersheds. Standards and guidelines for protecting riparian management areas vary substantially in quality among National Forests. Most plans lack goals that establish a "vision" for management and use of anadromous fish resources. Few plans include objectives for anadromous fish management that are: time-specific, measurable, comprehensive, and established on a drainage or other biologically significant basis. In general, planning documents fail to address indirect and/or cumulative effects, or they address them only in a cursory manner. Rarely do plans provide documentation of a formal, standardized cumulative effects process that was applied on a drainage specific basis. Few plans specifically consider anadromous fish needs in delineating management areas. Overall, such standards and guidelines were rated as fair because of the relatively small width of forest buffers protected from cutting along fish bearing streams, generally <200 feet, the absence or small size of riparian management areas along intermittent streams, and the amount of activity allowed within riparian management areas.

Additionally, among the five alternatives evaluated in the Final Environmental Impact Statement, a relatively small fraction (generally <25 percent) of the key watersheds were contained within designated areas managed primarily for northern spotted owl habitat, although this fraction varied by Final Environmental Impact Statement alternative and physiographic province. This coincides with the Draft Recovery Plan for the Northern Spotted Owl (USDI 1992a) estimate that <20 percent of the approximately 12,000 miles of streams with fish stocks considered at risk were within their Designated Conservation Areas. We estimated that more than 50 percent of the area of key watersheds in National Forests overlapped the designated areas managed primarily for spotted owl habitat (i.e., Habitat Conservation Areas; all remaining nesting, roosting, and foraging habitat) under Alternative D. However, Alternative D rated only a medium probability of maintaining and restoring fish habitat because of the riparian management standards and guidelines and the absence of a watershed restoration program in the National Forests. Other alternatives in the Final Environmental Impact Statement rated lower than Alternative D because of the lower percentage of coincidence of key watersheds and other streams inside areas protected from timber harvest.

Amphibians - A total of 21 species or ranges of amphibians were evaluated for viability effects. Some of the salamander species are locally endemic within small geographic ranges in the Pacific Northwest. The number of amphibian species or ranges judged to be at medium risk to viability ranged from 8 under Alternative D to 20 under Alternatives A and E. Of these, the number judged to be at high risk ranged from 6 under Alternative D to 18 under Alternative E. Scientific information was judged sufficient to assess viability effects of all amphibian species.

Under Alternative B, 11 species or ranges (including 10 salamanders and the tailed frog) were determined to be at medium risk and 7 at high risk. Van Dyke's salamander was considered in two parts of its overall range, and was rated as being at high risk of extirpation in both parts, under Alternative B. Most of the 11 at-risk species or ranges have narrow geographic distributions and occur in localized riparian, headwater, or talus (loose rock) habitats.

Reptiles - A total of 10 species of reptiles (turtles, lizards, and snakes) were initially evaluated in the "long list" for their association with old growth (Appendix 5-A). None of these species was considered to be closely associated with old-growth forest conditions (Appendix 5-A). Thus, no further viability assessments were conducted on reptiles. However, some reptile species, such as the sharp-tailed snake and northern alligator lizard, are associated with components of old-growth forests, including large down logs and forest litter cover. Such species would be secondarily benefited by provision of such forest elements under any of the planning alternatives and provision for riparian habitat protection.

Birds - A total of 38 species or ranges of birds were evaluated for viability effects. The birds included various species of owls and other birds of prey, marbled murrelet, song birds, and others.

Under each of the five alternatives described in the Final Environmental Impact Statement, the number of species determined to be at medium risk to viability ranged from 6 under Alternative D to 17 under Alternatives A and E. Of these, the number of species determined to be at high risk ranged from 1 under Alternatives B, C, and D, to 6 under Alternative E. Information was sufficient to allow us to assess viability for all bird species.

Under Alternative B of the Final Environmental Impact Statement, 9 species were rated as being at medium risk and 1 of these species, marbled murrelet, at high risk. The species at medium risk included several species at the edge of their ranges (such as black-backed woodpecker and pygmy nuthatch) or that use riparian and aquatic habitats (such as bufflehead and harlequin duck). Other birds at medium risk that were distributed more broadly within the range of the northern spotted owl and more associated with spotted owl habitat included the northern goshawk, flammulated owl, and great gray owl.

Mammals - A total of 35 species or ranges of mammals were evaluated for their viability. These species included furbearers (including fisher, American marten, lynx, and others), bats, rodents, and other species groups.

Under each of the five alternatives described in the Final Environmental Impact Statement, the number of species or ranges judged to have medium risk to their viability ranged from 6 under Alternative D to 12 under Alternatives A and E. Of these, the number of species or ranges judged to be at high risk ranged from 1 under Alternative D, to 9 under Alternative E. Information was inadequate for ranking viability for 10 other species.

Under Alternative B of the Final Environmental Impact Statement, 8 species or ranges were rated as being at medium risk to viability and 5 of these as being at high risk. The American marten was ranked as being at medium risk in one portion of its range and at high risk in two other portions. The fisher was determined to be at medium risk in one portion of its range and at high risk in another portion. Both species of red tree vole (prey species of the northern spotted owl) rated as being at high risk. The ranges of the lynx and the northern spotted owl are both extensive but only overlap along a narrow fringe area. The lynx was rated as being at medium risk. Most of the bats could not be rated because of lack of information.

Summary of Species at Medium and High Risk - Appendix 5-H presents an overall list of species of all taxonomic classes judged to be at medium or high risk to viability under at least one of the five alternatives described in the Final Environmental Impact Statement. The number of species or ranges (excluding invertebrates and fish) determined to have medium risk to their viability totaled as low as 41 under Alternative D in the Final Environmental Impact Statement and as high as 201 under Alternative E in the Final Environmental Impact Statement. Alternative E in the Final Environmental Impact Statement had the greatest number of species or ranges estimated to have medium risk, in part because it does not provide for old growth in Habitat Conservation Areas for the spotted owl in the Olympic Peninsula or in the northern Oregon Coast Range. Alternative E also provides for substantially less amounts of old growth protected in other locations in the Pacific Northwest. Alternative A in the Final Environmental Impact Statement also had high numbers of species or ranges determined to have risks to viability because its reserves for spotted owls (Spotted Owl Habitat Areas) provided for substantially smaller old-forest conservation areas than do Alternatives B, C, and D in the Final Environmental Impact Statement. Alternatives B, C, and D in the Final Environmental Impact Statement progressively provide for greater numbers of species or ranges. Under Alternative B in the Final Environmental Impact Statement, 67 total species or ranges (excluding invertebrates and fish) were ranked medium risk and 17 of these were ranked high risk. With inclusion of invertebrates and fish, these tallies were 328 and 278, respectively.

The 32 Old-Growth Species Listed in the Final Environmental Impact Statement

Thirty-two species associated with late-successional forests were listed in the Final Environmental Impact Statement. All 32 were included in the short list of species closely associated with old growth. Under Alternative B of the Final Environmental Impact Statement, 25 of the 32 species were not considered to be at risk in terms of viability. Three species are at medium risk to viability, and 3 species were considered at high risk. In addition, the Scientific Analysis Team considered one species from the list of 32 species – the Olympic Salamander – as a (newly defined) complex of four species, one of which was deemed to be at medium risk and three of which were deemed to be at high risk. Another species – red tree vole – is considered here as a (newly defined) complex of two species, both of which were deemed to be at high risk of extirpation. And one species, fisher, was considered to be at medium risk in one portion of its range and at high risk in the other (Appendix 5-I).

Mitigation Options for Species With Medium or High Risk to Viability Under Alternative B

Mitigation options were considered for the set of 328 species or ranges (38 fungi and nonvascular plants, 0 vascular plants, 58 mollusks, 91 arthropods, 112 fish stocks, 12 amphibians, 0 reptiles, 9 birds, and 8 mammals; see Table 5-3) considered to be at medium or high risk to viability under Alternative B of the Final Environmental Impact Statement (also see below for lists of species accommodated under each step in the mitigation process). Mitigation options developed for the 112 stocks of anadromous salmonids also provide protection to viability for the 4 additional species of resident fish.

We assumed that habitat conditions for species closely associated with old growth would be maintained under the following mitigation options. If the protected areas called for are manipulated in a way that diminishes old-growth habitat conditions, our assumption would no longer be valid.

The step-down mitigation procedure resulted in identifying the following sets of species requiring management standards and guidelines beyond those in Alternative B as described in the Final Environmental Impact Statement. These steps are cumulative in effect. Each set of species considered in a step assumes implementation of mitigation activities in all previous steps.

Mitigation Step 1 - <u>Standards and Guidelines From Existing Land and Resource Management Plans of National Forests Within the Range of the Northern Spotted Owl</u>. Standards and guidelines influencing the management of old-growth forests and components of old-growth forests are described in the individual Land and Resource Management Plans for National Forests within the range of the northern spotted owl. They are not repeated here. Species associated with old-growth forests or old-growth forest components within the range of the northern spotted owl that would be provided for by application of the Land and Resource Management Plan standards and guidelines include all of the "short list" old-growth associated species that were not identified as being either at medium or high risk under Alternative A (current management direction). (Complete lists of all species evaluated are available from the authors upon request.)

Mitigation Step 2a - Standards and Guidelines for Habitat Management Under Alternative B. This step entailed reviewing the standards and guidelines for management of habitat for northern spotted owls under the selected alternative (Alternative B) in the Final Environmental Impact Statement. Habitat needs for the northern spotted owl are provided by this alternative, assuming that the Interagency Scientific Committee's guidelines are followed on all Federal lands. In addition, other old-growth species provided for by application of Alternative B of the Final Environmental Impact Statement that are not included in the first mitigation step above, are those species that were identified as being either at medium or high risk under Alternative A (current condition) but not under Alternative B. Implementation of Alternative B would reduce the number of species with risk of extirpation by 120 species (Table 5-3).

Mitigation Step 2b - Recommended Additions to Habitat Conservation Areas in National Forests. This optional step entailed reviewing the additions to the Habitat Conservation Areas in National Forests if necessary under the assumption that USDI Bureau of Land Management would not follow the Interagency Scientific Committee's Strategy (Chapter 3). Without adjustment of Habitat Conservation Areas in National Forests, viability of the northern spotted owl is rated as low under their current plans (the "Bureau of Land Management/Oregon Department of Fish and Wildlife Agreement Areas"), and medium under preferred alternatives in the Bureau of Land Management's Draft Resource Management Plans. With the addition of approximately 418,000 acres to Habitat Conservation Areas in National Forests, the spotted owl's viability would be rated as high (Chapter 3). The addition to Habitat Conservation Areas of 418,000 acres would contribute to maintaining the viability of a number of additional species. However, these additional acres were not designed to provide mitigation for species other than the spotted owl. In addition, the designation of these acres was only one of several outcomes, depending on the plan actually adopted by the Bureau of Land Management. For this reason, we did not tie the viability assessment of any other species to this acreage.

Table 5-3 Number of Species or Ranges and Fish Stocks Identified as Potential Viability Concerns That are Protected by the Cumulative Mitigation Steps Discussed in the Text.

Mitigation Step:	1.	2a. or 2b.[1]	3.	4.	5.	6.		Unknowns	
Species groups	National Forest planning standards and guidelines	Alternative B FEIS[2] standards and guidelines	Species benefited by Riparian Habitat Conservation Areas	Species benefited by marbled murrelet protection	Mitigation for rare and locally endemic species	Additional mitigation for upland forest matrix species	TOTAL (All 6 mitigation steps)	Unknown but likely protected by mitigation measures	Degree of protection generally unknown
Nonvascular Plants (190)[5]	18	95	5	19	14	0	151	20	19
Vascular Plants (122)	108	4	0	0	0	0	112	2	8
Invertebrates (149)		(Not rated by alternative)						0	149
Fish[3] (112)	0	0	112	0	0	0	112	0	0
Amphibians (21)	1	8	7	1	3	1	21	0	0
Reptiles[4] (0)	0	0	0	0	0	0	0	0	0
Birds (38)	20	9	2	2	0	5	38	0	0
Mammals (35)	13	4	5	2	0	1	25	1	9
TOTAL (667)	160	120	131	24	17	7	459	23	185
Cumulative Guidelines that apply	1	1-2	1-3	1-4	1-5	1-6	1-6	1-6	1-6
Cumulative spp. totals	160	280	411	435	452	459	459	482	667

Table 5-3 (continued)

[1]This column reflects either the original standards and guidelines in Alternative B of the Final Environmental Impact Statement or those standards and guidelines supplemented by mitigations for actions on lands administered by the Bureau of Land Management (see Chapter 3).
[2]FEIS = Final Environmental Impact Statement.
[3]Mitigations developed for 112 stocks of anadromous salmonids also provide for 4 additional species of resident fish.
[4]No reptile species was identified on the short list of species closely associated with old-growth forests, and thus none was identified as extirpation risk.
[5] Values in parentheses are the total number of species or ranges and fish stocks identified by each expert panel as closely associated with old-growth forests or conditions ("short list" species) in National Forests within the range of the northern spotted owl.

Mitigation Step 3 - Standards and Guidelines for Riparian Habitat Conservation Areas

a. Riparian Habitat Conservation Area Designation

The size and management of Riparian Habitat Conservation Areas vary depending on stream type and aquatic ecosystem type as outlined in Table 5-4. Riparian Habitat Conservation Area widths for streams are horizontal distances and are measured **on each side** from the edge of the active stream channel. Active channels consist of all portions of the stream channel carrying water at bankfull flows. They include side-channels and backwaters, which may not carry water during seasonal low flows. Riparian Habitat Conservation Area dimensions for lakes, ponds, springs, seeps, meadows, and small wetlands are measured from the outer edge of the seasonally saturated soils. In the case of reservoirs, distances are measured from the maximum pool elevation. See Appendix 5-K for further criteria on establishing Riparian Habitat Conservation Area dimensions.

Table 5-4 lists interim minimum Riparian Habitat Conservation Area widths that will be in place until a watershed analysis is completed (as explained in Appendix 5-K). In general, a watershed analysis consists of a systematic examination of Riparian Habitat Conservation Areas to characterize watershed history, processes, and landforms and conditions. Boundaries of Riparian Habitat Conservation Areas may be altered after completion of the watershed analysis if warranted by the information resulting from that analysis. The result is the identification of parts of the landscape that influence the creation and maintenance of habitat for fish and other riparian species. Particular attention should be given to terrestrial or semi-aquatic organisms (e.g., molluscs, amphibians) that are associated with the microclimates of non-fish bearing and intermittent streams. Habitat associations of many of these organisms are not completely understood at this time.

Table 5-4 Interim Boundaries of Riparian Habitat Conservation Areas (RHCAs) Delineated Along Different Water Bodies and Area of the Watershed.

Water Bodies	Interim Boundaries of RHCAs
Fish bearing streams	edge of active channel to: - top of inner gorge, or - outer edges of 100-year floodplain, or - outer edges of riparian vegetation, or - a distance equal to height of two site-potential trees on each side of stream, or - 300 feet horizontal distance on each side of stream, whichever is greatest
Perennial, non-fish bearing streams	edge of active channel to: - top of inner gorge, or - outer edges of 100-year floodplain, or - outer edges of riparian vegetation, or - a distance equal to height of one site-potential tree on each side of stream, or - 150 feet horizontal distance on each side of stream, whichever is greatest
Ponds, reservoirs, and wetlands >1 acre	edge of water body to: - outer edge of riparian vegetation, or - extent of seasonally saturated soil, or - extent of moderately or highly unstable areas, or - a distance equal to height of one site-potential tree, or - 150 feet horizontal distance for ponds and wetlands >1 acre, - 150 feet from edge of maximum pool elevation of reservoirs, whichever is greatest
Lakes	edge of water body to: - outer edge of riparian vegetation, or - extent of seasonally saturated soil, or - extent of moderately or highly unstable areas, or - a distance equal to height of two site-potential trees, or - 300 feet horizontal distance, whichever is greatest
Seasonally flowing or intermittent streams, wetlands <1 acre, landslides and landslide-prone areas	edge of stream channel or wetland to: - top of inner gorge, or - outer edges of riparian vegetation, or - extent of landslides and landslide-prone areas, or - a distance equal to height of one site-potential tree on each side of stream, or - 100 feet horizontal distance on each side of stream, whichever is greatest

Within the Riparian Habitat Conservation Areas, timber management and other land management activities are essentially prohibited unless the watershed analysis indicates such activity is necessary to accelerate meeting desired ecological conditions. Specific standards and guidelines (Appendix 5-K) were developed to guide land management activities within Riparian Habitat Conservation Areas.

b. Other Species Benefited by Riparian Habitat Conservation Areas

The following species whose viability is considered to be at risk under Alternative B are likely to have their viability assured after application of the mitigation options for riparian habitat protection.

(1) Nonvascular plants:

(a) *Usnea longissima* (Lichen) This species is found in both hardwoods and softwoods in riparian fog belts. This species requires forests on broad riparian areas and should be maintained by protecting riparian habitats, especially by controlling upstream timber harvesting. These needs are likely met by the Riparian Habitat Conservation Area guidelines.

(b) *Metzgeria conjugata* (Liverwort) This species occurs in fog areas of coastal forests especially along streams. Its needs are likely met by the Riparian Habitat Conservation Area guidelines.

(c) *Dicranella palustra* (Moss) This species occurs in 1st-order streams in coniferous forest and is sensitive to siltation. This species is endemic to the west coast and needs riparian forests. Mitigation options include protection of stream buffers of at least 100 feet width on each side of the stream, protection of non-anadromous streams, and upstream protection from logging and road building. Mitigation options also include preventing 1st-order streams from siltation and piling of logging debris, and maintaining a component of coarse woody debris for substrate needs. All of these mitigation activities are included in the Riparian Habitat Conservation Area guidelines.

(d) *Hygrohypnum bestii* (Moss) This species is included in the species group with *Dicranella palustra*, above, with the same conditions and mitigation options.

(e) *Mythicomyces corneipes* (Fungus) This mushroom occurs in low elevation moist humus soils with mosses and old-growth conifer stands throughout the range of the northern spotted owl from sea level to 4,000 feet elevation. Mitigation measures include maintaining moist conifer forest habitats. These needs are likely met by the Riparian Habitat Conservation Area guidelines.

(2) Amphibians:

(a) Van Dyke's Salamander (Coastal, Olympic Peninsula, and Cascades populations) - This species is associated primarily with seeps and streamside talus, although it also occurs in association with moist soil on shaded north-facing slopes. Van Dyke's salamander is very rare and occurs in small, isolated populations. Seeps and headwater streams are key habitats throughout the species' range. The combination of National Forest Land and Resource Management Plans, Alternative B of the Final Environmental Impact Statement, and Riparian Habitat Conservation Area guidelines, particularly buffered habitats along headwater streams, will provide needed protection for this species. We foresee no critical needs for further protection.

(b) Olympic Salamander complex -

Olympic torrent salamander (*Rhyacotriton olympicus*) - Olympic Peninsula
Columbia torrent salamander (*R. kezeri*) - Coastal Oregon (northern) and Washington (southern)
Cascade torrent salamander (*R. cascadae*) - Cascades of Oregon and Washington
Southern torrent salamander (*R. variegatus*) - Coastal Oregon (southern) and California (northern)

All species in this complex (formerly Olympic Salamander, *Rhyacotriton olympicus*) occur in association with small, cold (46° to 54° F in summer) streams, especially in mossy gravel or splash zones of rocky, tumbling brooks. They are sensitive to increased temperature and sedimentation. Therefore, the primary mitigation measure for this group is protection of small streams, including headwaters, through buffers on each side of designated sites.

(c) Tailed Frog - Tailed frogs, like Olympic salamanders, occur in small, cold streams and are very sensitive to temperature. The primary mitigation measure for this species is protection of headwater streams through buffers designated on each side of the streams. Buffers provided under the Riparian Habitat Conservation Areas guidelines will maintain cool temperatures and will reduce sedimentation. Such buffers should provide adequate mitigation for this species.

(3) Birds:

(a) Bufflehead - Buffleheads nest in tree cavities in riparian zones at low elevation. They are associated with ponds, lakes, streams, and rivers. Protection of forest cover along streams, as in the Riparian Habitat Conservation Areas, will likely lead to long-term maintenance of nesting and foraging habitat.

(b) Harlequin Duck - Harlequin ducks are primarily associated with high elevation mountain streams. They are sensitive to human disturbance and water quality. Riparian Habitat Conservation Areas, in conjunction with large areas protected in congressionally designated Wilderness and Habitat Conservation Areas, will likely provide high quality water and undisturbed nesting sites. Road closures may be important in some locations to reduce disturbance; in such cases, road closure plans must be developed and implemented as part of the watershed analysis for the Riparian Habitat Conservation Areas (see Appendix 5-K).

(c) Northern Goshawk - Riparian Habitat Conservation areas will benefit goshawks, but will not fully provide for viability. Benefits from Riparian Habitat Conservation Areas will be most significant on the Olympic Peninsula and the Cascades of Oregon and Washington. Additional measures for goshawks are discussed below, and full mitigation measures are discussed in Mitigation Step 4. We recommend completion and implementation of the Forest Service's Pacific Northwest Region management direction and inventory protocol for northern goshawk currently in preparation (USDA 1992b). The purpose of the direction is to protect known active nest sites until the Forest Service, working with other agencies, can determine the species' actual habitat requirements (letter dated October 1, 1992, from Forest Service, Pacific Northwest Regional Directors of Fish, Wildlife, and Botany, and Timber Management, to Forest Supervisors).

(4) Mammals:

(a) American Marten (Oregon Cascades) - American martens use riparian areas for foraging and for selection of resting sites in large standing trees or in piles of woody debris. Riparian buffers will protect potential habitat in riparian zones and will contribute to long-term provision of snags and logs. In conjunction with Alternative B, riparian habitat protection will be particularly important in the Coast Range and Cascades of Oregon. Mitigation options for American marten in other parts of its range in the Pacific Northwest is further discussed under Mitigation Steps 4 and 6, below.

(b) Fisher (populations in California and southern Oregon, and northern Oregon and Washington) - Fishers use a wider range of habitats than those used by American martens and are able to forage in early-successional forest with dense overhead cover, as in brushy cutover or burned forest. However, they are sensitive to forest fragmentation when patches of forest are isolated by extensive open areas. Large snags (>20 inches dbh) are important as maternal den sites. The Riparian Habitat Conservation Areas will likely provide cover and large snags in the forest matrix between Habitat Conservation Areas and will thus substantially enhance the distribution of fisher habitat. Other considerations for mitigation options for fisher are discussed under Mitigation Step 6, below.

(c) Red Tree Voles (*Arborimus longicaudus* and *A. pomo*) - Distributions of both species of red tree vole are poorly known. Studies are needed to better understand their relative abundance in different forest types and to delineate their geographic distribution, although such studies are not essential components of this mitigation step. Both species of red tree vole are thought to have very limited dispersal capability. Thus, fragmentation of forest canopy habitat in the forest matrix (outside old-growth protection areas such as Habitat Conservation Areas) could be a concern under Alternative B, especially in the Oregon Coast Range. However, buffers along steams in the Riparian Habitat Conservation Areas should alleviate much of this potential concern by providing connectivity between many of the Habitat Conservation Areas and other reserves. Maintenance of forest corridors of stands averaging at least 11 inches dbh and at least 40 percent canopy closure as required by the 50-11-40 standard for spotted owl dispersal habitat in the Final Environmental Impact Statement Alternative B, between Riparian Habitat Conservation Areas and across ridgetops, may further facilitate dispersal between watersheds. Although forest stands averaging 11 inches dbh and 40 percent canopy closure likely do not provide optimal breeding habitat, we believe that such stands would provide at least some dispersal habitat linking watersheds.

Mitigation Step 4 - Standards and Guidelines for Marbled Murrelet

a. Standards and Guidelines for Marbled Murrelet

The marbled murrelet is listed by the Fish and Wildlife Service as a threatened species. These proposed standards and guidelines for management of marbled murrelets and their habitat are intended to be interim in nature and are based on the Scientific Analysis Team's professional judgment, which in turn was based on consultation with experts on the species and the very limited published information available.

We anticipate that ongoing planning efforts for conservation of the marbled murrelet (such as those in preparation by the Fish and Wildlife Service's Recovery Team, and the Forest Service's Marbled Murrelet Conservation Assessment Team) will produce management plans for marbled murrelets and their habitat that will supersede these interim standards. Our intent is to preserve options for management of marbled murrelet habitat until these plans are in place.

(1) Habitat:

(a) Identify all suitable habitat, regardless of occupancy by marbled murrelets, within 35 miles of marine environments in California and Oregon south of State Highway 42 and within 50 miles of a marine environment in the remainder of Oregon and Washington. This zone represents a geographical area influenced by marine air masses and likely encompasses nearly all, if not all, of the suitable marbled murrelet habitat. Nesting habitat, used here interchangeably with the term suitable habitat, is of primary concern and is defined as old-growth conifer forest stands, or mature forest stands with individual trees >32 inches dbh. Stand size is not an issue in this definition; stand size criteria should not be used to eliminate stands from consideration. The definition for suitable habitat is broad and for some National Forests habitat remains unmapped. It is, therefore, essential to complete the following tasks:

- The above definition of suitable habitat must be refined for each National Forest within the range of the marbled murrelet in cooperation with the U.S. Fish and Wildlife Service and the respective state wildlife agencies as necessary to fit specific habitat types used by murrelets across the range of the species.

- Each National Forest within the range of the marbled murrelet shall map suitable marbled murrelet habitat on that Forest.

(b) Stop all ongoing projects under contracts or other legally binding agreements that may affect suitable murrelet habitat. This cessation of activity shall continue until completion of consultation between the Forest Service and the Fish and Wildlife Service on proposed projects that may affect this species, as required under Section 7 of the Endangered Species Act. Projects shall then be modified as indicated by that consultation. Such consultation may result in cancellation of some projects.

(c) In the case of all other other ongoing or proposed projects or activities without contracts or other legally binding agreements, do not remove or modify the tree canopy in suitable habitat. Ongoing or proposed activities may proceed when a conservation strategy or recovery plan is implemented, and provided that the activities are consistent with the conservation strategy or recovery plan.

(d) Identify and delineate habitat recruitment stands (younger forest stands deemed likely to develop into suitable murrelet habitat) within 35 miles of the coast in California and Oregon south of State Highway 42 and within 50 miles of a marine environment in the remainder of Oregon and Washington. No timber cutting shall take place in such habitat recruitment stands so long as these interim standards and guidelines are in effect.

There appears to be consensus among experts on the marbled murrelet that protection of all currently suitable marbled murrelet habitat alone would be insufficient as a long-term management strategy. A conservation strategy for marbled murrelet that does not provide for recruitment of nesting habitat will not ensure that nesting habitat and conditions conducive for successful reproduction (those habitat components that are in National Forests and contribute to viability) will be provided.

It seems logical to assume that nesting habitat may limit marbled murrelet populations. Therefore, it is prudent for the interim to ensure that forest stands that will develop into nesting habitat are retained in sufficient amounts and appropriate locations. The exact amount of recruitment habitat necessary for a long-term conservation strategy or recovery plan is not known, so precise standards for selection of replacement habitat are not now available. Although new insights from ongoing studies and planning team efforts will likely result in modification, we believe that the following standards and guidelines, if adopted, will ensure that adequate amounts of forest stands which are available to develop into nesting habitat are protected until a recovery plan is adopted.

The intent of the standards and guidelines for delineating stands as recruitment habitat is to prevent further fragmentation of forests adjacent to present nesting habitat for marbled murrelets, buffer suitable habitat from edge effects, and preserve options to allow such stands to grow into nesting habitat. We concluded that it is neither possible nor prudent, given the present state of knowledge, to provide standards and guidelines that address site specific variation in arrangements and quality of younger stands. We expect there will be places on the landscape where the standards and guidelines for delineating recruitment habitat cannot be applied exactly as outlined. Where that situation exists, we expect that selection of recruitment habitat will be made in a manner that best meets the intent of the guidelines as stated above. Selection of all recruitment habitat shall be made with interagency participation and cooperation.

Identification and Definition of Habitat Recruitment Stands:

1. Amounts of habitat recruitment stands equivalent to 50 percent of the total amount of existing suitable habitat outside Category 1 and 2 Habitat Conservation Areas (as described in the Interagency Scientific Committee's Conservation Strategy) and congressionally designated Wilderness will be delineated outside Category 1 and 2 Habitat Conservation Areas and such Wilderness. For example, if in a National Forest 60,000 acres of the existing suitable habitat for marbled murrelets occur outside Wilderness and Category 1 and 2 Habitat Conservation Areas, then 30,000 acres of habitat recruitment stands will be delineated outside Category 1 and 2 Habitat Conservation Areas and Wilderness. All younger forest stands inside Category 1 and 2 Habitat Conservation Areas and Wilderness within the range of the marbled murrelet are already protected and have the potential to develop into nesting habitat. Habitat recruitment stands should be as contiguous as possible and (where the stands exist) 100 acres or more in size. Recruitment stands should be well distributed and adjacent to many nesting stands rather than concentrated around a few stands.

2. First priority for delineation of habitat recruitment stands shall be given to stands adjacent to suitable habitat with known occupancy by marbled murrelets.

3. After first considering the priority for delineation of habitat recruitment stands adjacent to occupied sites, priority for selection of habitat recruitment stands shall be given to those watersheds where an analysis indicates that suitable habitat for marbled murrelets comprises less than 30 percent of the watershed. The Fish and Wildlife Service in the Status Review for marbled murrelets indicated that marbled murrelets were found more often when the percent of old-growth/mature forests makes up over 30 percent of the landscape (Hamer and Cummins 1992). Our objective here is to preserve options for planning teams to incorporate key stands into a recovery plan or conservation strategy that will likely improve the future quantity, distribution, and quality of nesting habitat for marbled murrelets.

4. Priority for selection of habitat recruitment stands among various-aged stands shall be given to old-growth or mature coniferous stands that will likely develop murrelet habitat characteristics in the shortest time period. If such stands are not available in an area where marbled murrelet occupancy has been determined, the next oldest and/or largest stands shall be selected. Stands where the average dbh is smaller than 16 inches shall not be selected as recruitment stands.

5. Habitat recruitment stands should be selected considering their potential for buffering adjacent suitable habitat. This is especially significant where such stands are adjacent to occupied sites. In such cases recruitment stands should be selected to minimize danger of windthrow and edge effects to the existing nesting habitat.

6. For stands of suitable habitat known to be occupied by marbled murrelets and for which it is not possible to delineate recruitment habitat that buffers the stand, either because stands meeting the above standards for recruitment habitat did not exist or acreage amounts for delineation (that is, the 50 percent guideline discussed in paragraph 1 above) have been met, it will be necessary to delineate additional buffers. Such buffers shall consist of stands where the average dbh is at least 10 inches. For occupied stands of suitable habitat greater than 100 acres in size, the buffer should be at least 300 feet wide. Where the occupied stands of suitable habitat is less than 100 acres, the buffer shall be at least 600 feet wide. Inasmuch as possible, buffers should completely surround the suitable habitat. Modification of the buffers shall be avoided until a recovery plan or a conservation strategy for marbled murrelets is implemented.

(2) Surveys:

(a) Within suitable habitat and within 35 miles of the coast in California and Oregon south of State Highway 42 and within 50 miles of a marine environment in the rest of Oregon and in Washington, all surveys conducted for marbled murrelets shall follow current protocol for intensive surveys adopted by the Pacific Seabird Group (Ralph and Nelson 1992). Under that protocol a minimum of two years of survey should be conducted to confirm absence of marbled murrelets. Protocols should be reviewed and updated annually by an interagency body.

(b) Conduct transect surveys in California and Oregon, south of State Highway 42, beyond 35 miles from marine environments. This area is included in the descriptions of the range of marbled murrelets but is an area where marbled murrelet sightings have not been documented. There was disagreement between experts contacted as to whether marbled murrelets occur within this area. Transect surveys should be conducted in forest stands with the same structural attributes as those stands that meet the definition of suitable marbled murrelet habitat closer to marine environments. These transect surveys are needed to ascertain the actual range and distribution of marbled murrelet habitat. If marbled murrelets are detected beyond 35 miles from the coast in southern Oregon and northern California, the intensive surveys following the current protocol as described in paragraph 1 above shall be conducted. This would expand the area over which intensive surveys are to be conducted. If murrelets are not detected it may be appropriate to redefine the range.

(3) Seasonal Restrictions:

Activities that may not affect suitable habitat but have the potential to disturb nesting activity of marbled murrelets should be implemented based on the following:

(a) Management activities within a 1/4-mile radius of known occupied sites should be restricted from April 1 to September 15 if, after a review of the specific activity and the landscape by a qualified wildlife biologist, the activity is determined to have the potential to disturb marbled murrelet nesting activity. Potentially-disturbing activities include, but are not limited to, activities resulting from issuance of permits for road rights-of-way, felling in forest stands not suitable for nesting by marbled murrelets, road construction or reconstruction, blasting, yarding, operation of heavy equipment, and mining operations.

(b) Within the zone 35 miles from marine environments in California and Oregon, south of Oregon State Highway 42, and within 50 miles of marine environments in the rest of Oregon and Washington, restrict potentially disturbing management activities (as described above) within 1/4 mile of suitable habitat unless absence of marbled murrelets has been determined through protocol surveys.

(4) Adaptive Management:

(a) These guidelines should be reviewed by an interagency body annually or more frequently if warranted for adaptive management considerations.

(b) New research information concerning effects of disturbance on marbled murrelet nesting behavior, suitable stand size for murrelet management areas, and survey protocol should be incorporated into these guidelines as they become available.

b. <u>Other Species Benefited by Standards and Guidelines for Marbled Murrelet</u>

The following species whose viability is at risk under Alternative B of the Final Environmental Impact Statement are likely to be protected if they occur within areas protected under the guidelines for Riparian Habitat Conservation Areas or marbled murrelets. It seems likely that much of the distribution of these species is included in such protected areas.

(1) Nonvascular Plants:

(a) *Teloschistes flavicans* (Lichen) Only one site is known for this species, at Cape Lookout, Oregon, adjacent to land managed by the Forest Service. It occurs in the coastal fog belt in large, old, coastal Sitka spruce forest. It may occur in National Forests but surveys are needed.

(b) *Herbertus sakuraii* (Liverwort) This species is extremely rare, occurring only on Saddle Mountain, Coast Range, Oregon. Fog drip environment is significant. This species occurs in coastal Sitka spruce fog belt. There is a need to survey for the species on Mt. Hebo, Onion Mt., and Sugarloaf Mt., Coast Range, Oregon, and to protect habitats from ground disturbance if found. Other liverwort species associated with the same habitats and ranges as *H. sakuraii*, and likely to be equally benefited by mitigation options for marbled murrelet, include *Iwiatsukella leucotricha*, *Radula brunnea*, *Tritomaria quinquedentata*, and *Apometzgeria pubescens*.

(c) *Bartramiopsis lescurii* (Moss) This species occurs in low to mid elevations on the west slopes of the Olympic Mountains on wet organic soils. It is extremely rare. There is a need to protect from ground disturbance known sites and additional sites as found. As an interim measure, mitigation options for marbled murrelet will help protect known sites for this species.

(d) *Pleuroziopsis ruthenica* (Moss) This species is included in the species group with *Bartramiopsis lescurii* above, with the same conditions and benefits from mitigation options for marbled murrelet.

(e) *Collybia racemosa* (Fungus) This mushroom is rare, known to occur in six sites in the Quinault Research Natural Area in Washington in well established old-growth forest. It is perhaps more common in coastal old-growth forests, but needs surveys, studies, and inventories. In the interim, mitigation measures for marbled murrelet will help protect known sites for this species.

(f) *Albatrellus caeryliopus* (Fungus) This mushroom occurs mostly at lower elevations in the Olympic Peninsula, Cortez Island, and Mt. Hood National Forest. Other mushroom species sharing similar habitats and ranges that would also benefit from mitigation options for marbled murrelet are *Catathelasma ventricosa* (widely distributed), *Cortinarius boulderensis*, *Cortinarius cyanites*, *Cortinarius olympianus*, *Cortinarius rainierensis* (only known site is Barlow Pass and Mount Rainier), *Cortinarius tabularis* (occurs on spruce trees in Quinault Research Natural Area, Washington), *Cortinarius valgus* (occurs on spruce trees in Quinault Research Natural Area, Washington), *Cortinarius variipes*, and *Gomphus kauffmannii*. Although not required as a standard, additional surveys for all of these species would better define their distribution and the need for any additional protection. However, in the interim, mitigation measures for marbled murrelet will help protect known sites for this species.

(2) Amphibians:

Clouded Salamander - This species requires large (>20 inches in diameter) down logs of mid-decay classes (decay classes 2-4 preferred) with sloughing bark. The species is well distributed within its range, which closely coincides with that of the northern spotted owl in California and Oregon (clouded salamanders do not occur in Washington). Late-successional forest protected for marbled murrelets, Riparian Habitat Conservation Areas, Alternative B as described in the Final Environmental Impact Statement (or its modification as presented in Chapter 3), and existing Land and Resource Management Plan standards and guidelines for management of down logs will likely provide sufficient habitat to assure well distributed viable populations of this species in National Forests within the range of the northern spotted owl.

(3) Birds:

Northern Goshawk - Although some protection for northern goshawk habitat is afforded by the Riparian Habitat Conservation Areas discussed above, additional protection is needed to help ensure viability within the range of the northern spotted owl. Under the interim marbled murrelet standards and guidelines, nearly all of the mature or old-growth forest in the Olympic National Forest that is otherwise unprotected outside of Habitat Conservation Areas under Alternative B of the Final Environmental Impact Statement will be protected. Therefore, nearly all potential nesting habitat in the Olympic National Forest will be protected from timber harvest. The Olympic Peninsula is an area of particular concern because northern goshawks are believed to be relatively isolated there, they occur in low numbers, and their habitat requirements have not been well documented. Experts strongly suspect that old-growth forests are vital for nesting. Protection of habitat under the combination of Alternative B of the Final Environmental Impact Statement, Riparian Habitat Conservation Areas, and marbled murrelet guidelines provides broad latitude for natural catastrophes and uncertainties in knowledge.

In addition, the bird expert panel recommended the following mitigation measures: save mistletoe trees, especially on the east slope of the Cascades, protect nest stands of pairs located outside of Habitat Conservation Areas, and conduct further research on the distribution and ecology of the species throughout its range. The following forest management activities would help conserve suitable habitat conditions for the species: retain the upper forest canopy at known or suspected nest sites; retain down wood and logs for prey, principally squirrel species; and manage stands for understory removal and canopy retention. We believe that such conditions would be provided under Mitigation Steps 1 through 4.

(4) Mammals:

American Marten (populations in Olympic Peninsula and Oregon Coast Range) - As with northern goshawk, protection for American marten is afforded by the Riparian Habitat Conservation Areas discussed above. However, additional protection is needed for American marten habitat to help ensure viability within the range of the northern spotted owl. Interim guidelines for marbled murrelets on the Olympic Peninsula will also provide substantial benefit to protection of American marten habitat on the Olympic Peninsula, especially in combination with Alternative B of the Final Environmental Impact Statement, and watershed protection. Murrelet guidelines plus Riparian Habitat Conservation Areas will also contribute to American marten viability within the range of murrelets on the Oregon Coast Range and coastal northern California.

c. <u>Adoption of Recovery Plan for Marbled Murrelet</u>

Once a final recovery plan for marbled murrelets is adopted, the new standards and guidelines must be evaluated to determine whether the set of other species protected by the interim standards and guidelines will still be adequately protected. If an area of habitat is removed from protection, the area should be surveyed for the species listed in this section prior to undertaking any site-disturbing activity and, if necessary, site-specific management prescriptions should be prepared to meet the habitat requirements of these species.

Mitigation Step 5 - Standards and Guidelines for Rare and Locally Endemic Species.

As with the set of species listed in the above category, the following rare and locally endemic species are likely to be assured viability if they occur within Habitat Conservation Areas conserved by Alternative B of the Final Environmental Impact Statement, Riparian Habitat Conservation Areas, or areas covered under the marbled murrelet guidelines. However, there might be occupied locations outside these conservation areas that will be important to protect as well. We therefore recommend that protocols for surveys be developed that will ensure a high likelihood of locating these occupied sites. Prior to ground disturbing activities, surveys using the protocol must be conducted within the known or suspected ranges and within the habitat types or vegetation communities occupied by the species. When located, the occupied sites need to be protected as indicated below.

(1) Nonvascular Plants:

(a) *Ptilidium californicum* (Liverwort) This species is rare and has a very limited distribution in old white fir forests with fallen trees. It occurs on trunks of trees at about 5000 feet elevation. Mitigation options include finding locations and maintaining stands of overmature white fir at about 5000 feet elevation for inoculum and dispersal along corridors; and studying specific distribution patterns. Protect known occupied locations if distribution patterns are disjunct and highly localized, by deferring timber harvest and avoiding removal of fallen trees and logs.

(b) *Ulota megalospora* (Moss) This species occurs in northern California and southwest Oregon. It is best developed (locally abundant) in very old stands of tanoak, Douglas-fir, and other conifer species further north, but is generally scarce throughout its range. The species is poorly known ecologically. Mitigation activities include conducting basic ecological studies, and surveying for presence, particularly in Oregon. Protect known occupied sites if distribution patterns are disjunct and highly localized. Defer timber harvest or other activities which would not maintain desired habitat characteristics and population levels.

(c) *Brotherella roellii* (Moss) This very rare species is endemic to the Washington Cascades north of Snoqualmie Pass. It occupies rotting logs in low to mid elevation old-growth stands having dense shade, closed canopies, and high humidity. Mitigation options include locating specific populations and protection of large decay class 3, 4, and 5 logs and >70 percent canopy closure. Defer management activities conflicting with maintaining suitable habitat characteristics and known population levels.

(d) *Buxbaumia piperi*, *B. viridis*, *Rhizomnium nudum*, *Schistostega pennata*, and *Tetraphis geniculata* (Mosses) Most of these species are fairly rare (the exception is *B. piperi*). They occur on rotten logs and some organic soil, and are shade-dependent, occurring in old-growth forests. *S. pennata* occurs only in mature western red-cedar forests in the Olympic National Forest and in Washington Cascades. Mitigation activities include surveying to determine presence and distribution; and, where located, maintaining decay class 3, 4, and 5 logs and >70 percent closed-canopy forest habitats for shade. Shelterwood and thinning prescriptions for timber harvest will cause their demise, as logs dry out.

(e) *Aleuria rhenana* (Fungus) This mushroom is widely distributed but rare and little known throughout its range, known from one collection from Mt. Rainier National Park. It is a conifer litter decomposer. Mitigation activities include conducting ecological studies and surveys to determine localities. Protect known populations if surveys continue to indicate that the population is rare. Defer ground disturbing activities.

(f) *Otidea leporina*, *O. onotica*, and *O. smithii* (Fungi) These mushrooms occur in conifer duff, and are widespread in distribution but uncommon. They are dependent on older age forests. Specific mitigation options include protecting older forests from ground disturbance where the species are located.

(g) *Polyozellus multiplex* (Fungus) Ecologically, this mushroom was considered by the nonvascular expert panel in the same species group as *Albatrellus caeryliopus* and others, listed above under species aided by marbled murrelet mitigation measures. However, *P. multiplex* occurs in higher elevation of the Cascades in silver fir and mixed conifer (and is thus outside the range of marbled murrelet mitigations). It can be locally abundant and is a mychorrizal species important to forest health. Like its group associates, it is a good indicator of old-growth forests. Mitigation activities for this species include conducting surveys to define its distribution, and studies to assess its habitat requirements.

(h) *Sarcosoma mexicana* (Fungus) This mushroom occurs in deep conifer litter layers in older forests. It is uncommon to rare and is found in the Oregon and Washington Coast Range into British Columbia. Mitigation activities include surveying for locations and protecting deep litter layers of older forests where found. Defer prescribed burning of understory or other activities which would not retain a deep litter layer.

For all of the plants listed in this mitigation step, and for those listed in the next step, we recommend that Regional ecologists or botanists should: (1) maintain a spatially explicit data base of all known sites in National Forests, and (2) develop species or area management plans, to be implemented under the guidance of the regional botany programs.

(2) Invertebrates:

Although lack of information prevented us from analyzing mitigation needs for specific invertebrate species, Olson (1992) underscored the need for surveys for species that are rare or locally endemic. Within the range of the northern spotted owl, invertebrates are noted for their high frequency of endemism (species found nowhere else) and restricted ranges. Centers of invertebrate biodiversity include, in particular, the Olympic Peninsula and its south coast, the southern Oregon Cascades, the Klamath physiographic province, several isolated volcanic peaks including Mt. Hood and the Three Sisters in the Oregon Cascades, and the coastal forests of Oregon and California. In addition, some species are poor dispersers or rely on special habitats including decaying wood or aquatic environments.

Frest and Johannes (1991) identified endemic species complexes of terrestrial molluscs (bivalves and snails) in the west coast states, particularly limited to the areas from the Cascades crest to the coast. As summarized by Anthony et al. (1992:348-349),

> "Within the owl's range, there are three distinct land snail provinces. The Oregon province extends from coastal British Columbia just into extreme northern California; the Washington province extends east from the Cascades crest; and the California province is coastal northern California."
>
> "There are sizable endemic species clusters in the land snail genera *Monadenia, Trilobopsis, Megomphix, Haplotrema, Vespericola* and *Hemphillia*. Physical factors limiting their distribution include geologic history, substrate (some are restricted to limestone, for example, the candidate *Monadenia troglodytes*, endemic to the Siskiyou Mountains and the area around Mt. Shasta), moisture requirements, and cover. In general, land snails in this region require relatively undisturbed cover. Most thrive in lowland forests and the areas around springs. Many species seem to be associated specifically with lowland old-growth forests, and most are extremely limited in distribution. The malone jumping slug, *Hemphillia malonei*, occurs only on the slopes of Mt. Hood. The genus *Megomphix* is known only from sites in the Puget Sound region and in the Willapa Hills, of southwest Washington. In recent years, only one site has been found to support *Megomphix hemphilli*."

Frest and Johannes (1991) also identified complexes of endemic freshwater molluscs, although the aquatic complexes are not part of our current analysis.

Anthony et al. (1992:355-356) also discussed the occurrence and distribution of arthropods in old-growth forests of the Pacific Northwest:

> "First, many species are flightless, which means that their dispersal capabilities are limited. Second, the flightless condition is believed to reflect habitat stability and permanence over a long time period. Some old forest associates have highly disjunct distributions and are found only in undisturbed forests. They share similar distribution patterns on the west side of the Cascade Mountains from British Columbia south to southern Oregon and northern California (i.e., they are endemic to the Pacific Northwest). Many of the species native to this region have not been described or named, and the number of known species probably represents less than half of the estimated species (J. Lattin, Oregon State University, pers. comm.)."

Mitigation guidelines for Riparian Habitat Conservation Areas and marbled murrelets would aid in conserving species in biodiversity centers and other areas, as "Habitat Conservation Areas established for owls probably will not capture the full extent of invertebrate species richness. The protection of suitable owl habitat in intervening areas as proposed in Alternative D of the Final Environmental Impact Statement will help preserve more species distributed over the landscape, but the effectiveness of this provision will be dependent upon the number, size, and isolation of the selected habitat fragments" (Olson 1992:4-5).

Olson (1992) also noted that small fragments of primary forest might serve as reserves for populations of old-growth invertebrates. "In regions with a high proportion of species with restricted ranges, such as the Olympic Peninsula, the coastal forests of Washington, Oregon, and California, and the Klamath Province, increased emphasis on preserving small fragments of [old-growth forest] habitat may be warranted" (Olson 1992:15). Such fragments would be provided under a combination of the Riparian Habitat Conservation Areas and marbled murrelet guidelines. Elsewhere, some species of invertebrates can be provided for by retaining canopy coverage, providing log and slash piles, and maintaining a moist forest floor environment.

Understanding the true effectiveness of conserving the invertebrate fauna with mitigation measures proposed in our report awaits further surveys, inventories, and studies. Olson (1992:12) proposed using a survey protocol for rapidly identifying biologically unique areas, and in taking advantage of "natural experiments" to investigate the relationships of invertebrate populations to different growth stages and variously fragmented forest patches and landscapes. He presented an excellent research agenda for such studies (too lengthy to repeat here), which included testing and use of invertebrate species as environmental indicators. This agenda should be pursued.

(3) Amphibians:

(a) Larch Mountain Salamander - Because of the narrow distribution of this species, mostly within the Columbia River Gorge, primary emphasis should be to survey and protect all known sites. Sites must be identified based on fall surveys conducted using a standardized protocol. Known sites are included within boundaries of conservation areas and under these guidelines, are not to be disturbed. Surveys are needed at additional sites in the forest matrix along the Columbia River Gorge. Key habitat is mossy talus protected by overstory canopy. Avoiding any ground-disturbing activity that would disrupt the talus layer where this species occurs is the primary means of protection. Once sites are identified, maintain 40 percent canopy closure of trees within the site and within a buffer of at least the height of one site-potential tree or 100 feet horizontal distance, whichever is greater, surrounding the site. Larger buffer widths are appropriate upslope from protected sites on steep slopes. Partial harvest may be possible if canopy closure can be retained; in such cases logging must be conducted using helicopters or high-lead cable systems to avoid disturbance of the talus layer.

(b) Siskiyou Mountain Salamander - This species occurs within an extremely narrow range on the Rogue River, Siskiyou, and Klamath National Forests. Its range does not fall within any Habitat Conservation Areas in Oregon. Additional surveys conducted using a standardized protocol must be undertaken to delineate range and identify subpopulations. All populations must be protected by delineating an occupied site and avoiding disturbance of talus throughout the site, especially on moist, north-facing slopes, particularly in Oregon where Habitat Conservation Areas do not incorporate species' range. Because this species seems to require cool, moist conditions, a buffer of at least the height of one site-potential tree or 100 feet horizontal distance, whichever is greater, surrounding the site, must be retained around the outer periphery of known sites. Overstory trees must not be removed within the boundary of this buffer.

(c) Shasta Salamander - This species is very narrowly distributed, occurring only in localized populations on the Shasta-Trinity National Forest. Only a small part of its range is included within a Habitat Conservation Area under Alternative B. It occurs in association with limestone outcrops, protected by an overstory canopy. All known and future localities must be delineated and protected from timber harvest, mining, quarry activity, and road building within the delineated site, and a buffer of at least the height of one site-potential tree or 100 feet horizontal distance, whichever is greater, should surround the outcrop. Additional surveys, conducted using a standardized protocol, must be undertaken to identify and delineate all occupied sites within the species' potential range.

Mitigation Step 6 - Additional Standards and Guidelines for Other Species in the Upland Forest Matrix.

As with the above sets of species under Mitigation Step 5, the following species whose viability is considered to be at risk under Alternative B of the Final Environmental Impact Statement are likely to be assured viability if they occur within Habitat Conservation Areas of Alternative B of the Final Environmental Impact Statement, Riparian Habitat Conservation Areas, or areas covered under the marbled murrelet guidelines. However, if they are located outside of such areas, additional mitigation measures would be needed to avoid increasing risk to viability. These measures are discussed, by species, below.

(1) Amphibians:

Del Norte Salamander - This species occurs in talus slopes protected by overstory canopy that maintains cool, moist conditions on the ground. The species is a slope-valley inhabitant, and sometimes occurs in high numbers near riparian areas. Riparian Habitat Conservation Areas, in combination with Habitat Conservation Areas and other reserves, will offer some protection to the species but significant numbers also occur in upland areas. Additional mitigation options in this upland matrix include identifying locations (talus areas inhabited by the species) by using a standardized survey protocol, then protecting the location from ground-disturbing activities. Designate a buffer of at least the height of one site-potential tree or 100 feet horizontal distance, whichever is greater, surrounding the location. Within the site and its surrounding buffer, maintain 40 percent canopy closure and avoid any activities that would directly disrupt the surface talus layer. Partial harvest within the buffer may be possible if 40 percent canopy closure can be maintained; in such cases, tree harvest must be conducted using helicopters or high lead cable systems to avoid compaction or other disturbance of talus.

(2) Birds:

(a) White-headed Woodpecker, Black-backed Woodpecker, Pygmy Nuthatch, and Flammulated Owl - These species will not be sufficiently aided by application of mitigation measures for riparian habitat protection or for marbled murrelets alone. They all occur on the periphery of the range of the northern spotted owl on the east slope of the Cascade Range in Washington or Oregon. Additionally, white-headed woodpecker and flammulated owl occur in the Klamath Province in northwestern California and southwestern Oregon. The viability of all four species within the range of the northern spotted owl was rated as a medium risk on National Forests, although they each are much more widely distributed elsewhere.

Apply the following mitigation guidelines to ensure that the distribution and numbers of all four species do not severely decline on National Forests within the range of the northern spotted owl. These guidelines apply to the forest matrix outside designated habitat for the northern spotted owl and Riparian Habitat Conservation Areas. Maintain adequate numbers of large snags and green tree replacements for future snags within the four species' ranges in appropriate forest types. Where feasible, green tree replacements for future snags can be left in groups to reduce blowdown. Specifically, we recommend that no snags over 20 inches dbh be marked for cutting. We recognize, however, that safety considerations may prevent always retaining all snags. Use of standardized definitions of hazard trees is required. For the longer term, provide for sufficient numbers of green trees to provide for the full (100 percent) population potential of each species.

As depicted by Neitro et al. (1985), the 100 percent population potential for white-headed woodpeckers is 0.60 conifer snags (ponderosa pine or Douglas-fir) per acre in forest habitats; these snags must be at least 15 inches dbh (or largest available if 15 inch dbh snags are not available) and in soft decay stages (see Neitro et al. 1985 for specifics), and must be provided in stands of ponderosa pine and mixed pine-Douglas-fir. The 100 percent population potential for black-backed woodpeckers is 0.12 conifer snags per acre in forest habitats; these snags must be at least 17 inches dbh (or largest available if 17 inch dbh snags are not available) and in hard decay stages, and must be provided in stands of mixed conifer and lodgepole pine in higher elevations of the Cascade Range. Provision of snags for other cavity-nesting species, including primary cavity-nesters, must be added to the requirements for these two woodpecker species. Site-specific analyses, and application of a snag recruitment model (specifically, the Forest Service's Snag Recruitment Simulator) taking into account tree species, diameters, falling rates, and decay rates, will be required to determine appropriate tree and snag species mixes and densities. If snag requirements cannot be met, then harvest must not take place.

As identified by the expert panel, black-backed woodpeckers also require beetle-infested trees for foraging; some such trees should be provided in appropriate habitat, and sanitation harvest of all such trees would be detrimental to the species. More information is needed on habitat use, seasonal occurrence, and use of forest age classes and burns, for the black-backed woodpecker.

Pygmy nuthatches use habitats very similar to those of white-headed woodpecker. Pygmy nuthatches require large trees, typically ponderosa pine within the range of the northern spotted owl, for roosting. Provision of snags for white-headed woodpeckers is assumed to provide for the needs of pygmy nuthatch, as no species-specific guidelines for the species have been developed. Additional information on ecology of pygmy nuthatch within the range of the northern spotted owl is needed to develop more precise guidelines.

Flammulated owls are secondary cavity-nesters and use cavities, in snags and live trees, created by woodpeckers or, less often, that occur naturally. We assume that standards and guidelines for snags and green tree replacements for woodpeckers and other primary cavity-nesting species, as provided by existing National Forest Land and Resource Management Plans and for the woodpeckers in this species group, would provide for flammulated owls.

(b) Great Gray Owl - Within the range of the northern spotted owl, the great gray owl is most common in lodgepole pine forests adjacent to meadows. However, it is also found in other coniferous forest types. In some locations, such as on the Willamette National Forest west of the Cascades Crest, at least some shelterwood harvesting seems to be beneficial for the species by opening up otherwise closed canopy cover for foraging. In doing so, consequences to species such as northern goshawk and American marten must be evaluated. Specific mitigation measures for great gray owl, within the range of the northern spotted owl, include the following: provide a no-harvest buffer of 300 feet around meadows and natural openings and establish 1/4-mile protection zones around known nest sites. Within one year, develop and implement a standardized protocol for surveys; survey for nest locations using the protocol. Protect all future discovered nest sites as previously described.

(3) Mammals:

(a) American Marten and Fisher - The level of habitat conservation provided by the combination of Alternative B of the Final Environmental Impact Statement, Riparian Habitat Conservation Areas, and marbled murrelet mitigation guidelines are generally sufficient so that additional standards and guidelines are not required to prevent the extirpation of American martens and fishers within the range of the northern spotted owl. However, we do recommend two additional actions for specific areas to help ensure future viability of these species.

First, the National Forests in California must finalize and implement their draft habitat capability model for fisher and American Marten. Implementation of this model would likely reduce information that will further reduce risks to viability in those National Forests. Forests in Oregon and Washington must retain existing management requirement areas for American marten for the same reason. However, adequacy of these practices must be reevaluated through the ongoing conservation assessment process or through special review. Monitoring and adaptive management are especially important for these species.

Second, populations of fishers are extremely low in northern Oregon and Washington. Harvest of American martens is permitted in these states, and accidental take of fishers cannot be avoided using kill-trap methods. To reduce risk of further loss of fishers, we recommend closure of all National Forests (within the overlapping ranges of American marten, fisher, and northern spotted owls) to kill-trapping of American martens until the rate of accidental take of fishers is determined to be insignificant. We recommend formation of an interagency group comprised of state furbearer biologists and Forest Service wildlife biologists to undertake this evaluation for both states.

(b) Lynx - Lynx are rare within the range of the northern spotted owl, occurring primarily in the Okanogan area of Washington. The lynx is currently listed by the Fish and Wildlife Service as a Category 2 candidate (a species for which additional information is needed to propose listing as threatened or endangered). A petition was filed to list the lynx as endangered within the northern Cascades of Washington, based on small population size, population isolation, and lack of adequate prey base (snowshoe hare). However, the Fish and Wildlife Service ruled that available information does not warrant listing the lynx in Washington (USDI 1992b).

Three primary habitat components for lynx are (1) foraging habitat (15-35 year old lodgepole pine) to support snowshoe hare and provide hunting cover, (2) denning sites (patches of >200-year old spruce and fir, generally <5 acres), and (3) dispersal/travel cover (variable in vegetation composition and structure). The major limiting factor is abundance of snowshoe hare, which in turn is limited by availability of winter habitat (primarily early-successional lodgepole pine with trees at least 6 feet tall). Past excessive trapping of lynx and incidental mortality of lynx from hunting of other species have depressed populations and may have been detrimental to local lynx populations in Washington (Washington Department of Wildlife 1991). Roads provide access to hunters and trappers and thus road density may be related to lynx mortality.

Alternative B as described in the Final Environmental Impact Statement, as well as existing higher elevation reserves, will provide denning habitat within protected forest stands in juxtaposition with early successional vegetation in the forest matrix. Connectivity between many of the denning patches will be provided by the network of buffers along streams under the Riparian Habitat Conservation Areas.

In addition, we propose development of site-specific timber harvest, roading, and fire management plans in known lynx range. These plans should be developed in consultation with state wildlife agencies and should address: (1) minimizing road construction, closing unused roads, and maintaining roads to the minimum standard possible; (2) using prescribed fire to maintain forage for snowshoe hare in juxtaposition with hunting cover; (3) designating areas as closed to kill trapping of any furbearer to avoid incidental lynx mortality to maintain population refugia for lynx in key areas; (4) planning for kill trapping closure on a wider basis if data indicate a declining lynx population as a result of incidental trapping mortality; and (5) developing and implementing a credible survey and monitoring strategy to determine the distribution of lynx throughout its potential range.

Species for Which Information is Most Limited

The amount and quality of information available for old-growth associated species varies significantly from species to species. More information would be useful in developing conservation measures for all these species, including northern spotted owls which are probably the best studied. For this analysis, we have chosen to place the species in three broad categories based on the amount of information available. The first category includes the 459 species for which specific mitigation was described (Table 5-3). The second group includes species for which information was poor, but which are likely to be significantly protected by the mitigation measures due to overlap between their ranges or habitat requirements and the old-growth areas identified in the mitigation steps. The third group includes species for which information is most limited. No conclusion can be drawn about the protection of this third category of species.

In these last two groups, we identified 59 species of nonvascular plants, vascular plants, and terrestrial vertebrates. These are species which the expert panelists identified as lacking scientific studies and whose viability could not be ranked according to general life history attributes and distribution because of the lack of basic information. All 59 species, however, are thought to be closely associated with old-growth forests or components of old-growth forests.

An additional 149 species of invertebrates (58 molluscs and 91 arthropods) were identified from the contract reviews as closely associated with old-growth forests or old-growth forest conditions within the range of the northern spotted owl, or whose specific habitat conditions or future viability could be directly influenced by spotted owl habitat planning. Data were lacking for all 149 invertebrate species so that individual viability assessments under each of the five alternatives in the Final Environmental Impact Statement were not possible. All 149 species – and likely other invertebrate species not included in the contract evaluations – require further study for more specific analysis of potential viability effects.

Thus, in this report, we identified a total of 208 species (59 fungi, lichens, plants, and terrestrial vertebrates; and 149 invertebrates) for which information is most limited. Only 10 species of this total are vertebrates, all of which are mammals. Nine of the mammals are species of bats.

The conservation of old-growth forests under Mitigation Steps 1 through 6 listed previously might provide some of these 208 species with some degree of protection. Some overlap between each of their distributional ranges with those of the old-growth areas may exist. To examine the likelihood of protection, we identified a set of seven ecological conditions which reflected general distribution or life history patterns suggesting some (unknown) degree of protection from Mitigation Steps 1 through 6. The seven ecological categories of conditions were:

1. Species which may be at least locally common to abundant;

2. Species that are rare to uncommon but are widespread;

3. Species that are locally endemic;

4. Species closely associated with the general types of old-growth forests and conditions afforded by the mitigation steps;

5. Species that are specialized to specific substrates (surfaces) or edaphic conditions (soil and ground conditions), especially those afforded by the mitigation steps;

6. Species occurring in high elevation forests, within the overall range of the northern spotted owl but generally in higher elevation forest types than those used by the northern spotted owl for nesting, roosting, or foraging; and

7. Species whose geographic range overlaps that of the northern spotted owl only along a fringe of the owl's range.

We assumed that habitat conditions for species identified in ecological categories 1 through 5 might be protected by the combination of Mitigation Steps 1 through 6. Species in categories 6 and 7 generally occur outside the ecological or distributional range of the northern spotted owl; and whereas their viability is still of direct concern in this evaluation, their persistence is much more influenced by factors other than those addressed in the spotted owl habitat management guidelines.

According to the results of this evaluation, 23 of the 59 plant and vertebrate species met at least one of the first five ecological conditions, leaving 36 of these species for which effects were truly unknown. The 36 species included 19 nonvascular plants, 8 vascular plants, and 9 mammals (Appendix 5-J).

Effects are also unknown for all 149 invertebrates. Appropriate study should identify the important role of each invertebrate species in old-growth ecosystem processes, and would help identify which set of species could serve as indicators of various aspects of the health of old-growth forests (Olson 1992).

There may be species that we did not identify in our evaluation or to whom we assigned a low risk, that, as more data accumulate, would show close association with late-successional and old-growth forests and that might put such species at viability risk. This is likely the case with at least some species of invertebrates and nonvascular plants. On the other hand, with further scientific study, inventory, and monitoring, some of the species identified in this report as potentially having their viability at risk might turn out to be at less risk than initially suggested. At this time it is impossible to determine without further study which, if any, species would fall into either of these categories. Surveys, research, monitoring, and an adaptive management approach would all be necessary to gather and account for such new information over time.

DISCUSSION AND CONCLUSIONS

Ensuring Effectiveness of the Mitigation Measures

We believe that the combination of (1) forest management standards and guidelines, (2) the spotted owl habitat guidelines in Alternative B of the Final Environmental Impact Statement, or their modifications to account for increased risk from Bureau of Land Management management (see Chapter 3), (3) Riparian Habitat Conservation Areas, (4) habitat protection for marbled murrelet, (5) mitigation measures for rare and locally endemic species, and (6) mitigation measures for other species in the upland forest matrix, would collectively provide for a high likelihood of continued existence of well distributed fish habitat and plant and wildlife populations plus northern spotted owls on National Forests. Although it is not possible to predict effects on most invertebrate species, future security of this group is likely to be greatly enhanced under this scheme.

We also strongly urge the application of regional oversight and guidance to ensure consistent interpretation and application of these guidelines and mitigation measures across all pertinent National Forests. An example is the need for development and application of standardized inventory and survey protocols for some species; such protocols should be written by a technical group at the regional or inter-regional level.

Uncertainties of Information and Viability Projections

Ensuring long-term population viability means taking preemptive action to prevent currently secure species from becoming viability risks; identifying species currently at risk; instituting appropriate conservation strategies; and gathering new scientific information on species and ecological conditions where such information is lacking. We believe that these steps collectively constitute a necessary part of any scheme of ecosystem management.

Applying mitigation measures presented herein would provide preemptive actions to help prevent currently secure species from having their viability placed at risk in the future. The list of secure species are those on the short lists (Appendices 5-B, 5-D) that do not appear as viability concerns (Appendix 5-H). However, better inventories are still needed on vegetation conditions that can be used to project the extent, distribution, and trend of habitat for species that are secure and for those whose viability is at risk. Such inventories would also help determine the occurrence of scarce or declining ecological communities and special habitats, which our report addresses only indirectly. Similarly, we could not quantify the locations and frequency of catastrophic events, nor could we map specific locations of future management activities. Both of these factors added uncertainty in our attempt to project the distribution and abundance of habitat over time. We did, however, construct our mitigation steps to attain a high probability of providing for the viability of the species we addressed. This entailed qualitatively accounting for catastrophic events.

Uncertainties associated with identifying viability risk species and mitigation options include the degree to which factors are currently a threat, and the pace at which such threats can be offset by restoring habitat conditions. For many species, such quantitative analyses are not possible without further knowledge of specific habitat associations of species, demography of populations, and dynamics of habitat changes, including changes from anthropogenic (human-induced) and ecological (such as succession, fire regimes, etc.) factors. Uncertainties in projecting future viability were recognized by the Scientific Analysis Team and by the expert panels, who depicted uncertainties as ranges of potential future viability effects.

Uncertainties associated with species lacking adequate scientific information underscore the need for basic life history and ecology studies, and inventories for presence and habitat associations. Studies and inventories are needed on a variety of plant, invertebrate, and some vertebrate species. Such basic data will allow agencies to move toward more credible, ecologically-based management that will sustain biological diversity and production of commodity renewable resources.

In particular, increasing scientific knowledge on invertebrates can help develop monitoring and adaptive management activities for management of old-growth forest ecosystems. For example, Olson, (1992: 27-28) noted that, "forest invertebrate assemblages can serve as excellent tools for adaptive management programs. The effect of harvesting schedules and management practices on local ecosystem vigor can be assessed rapidly, and appropriate changes can be made in a timely fashion. Invertebrates are also useful for long-term monitoring of ecosystem viability on both a local and regional scale." Olson presented a list of 14 potential invertebrate indicator taxa and species for monitoring old-growth forests ecosystems, from H.J. Andrews Experimental Forest on the west slope of the northern Oregon Cascades. An example from this list is the millipede *Harpaphe haydeniana* (Diplopoda: Xestodesmidae), a widespread species vital for nutrient cycling in the soil because it is a dominant decomposer of coniferous litter (also see Lattin and Moldenke 1992). Other potential invertebrate indicators presented by Olson (1992: 47-48) include species of camel crickets, sowbugs, weevils, true bugs, ground beetles, wood-boring beetles, cursorial spiders, mites, ants, and earthworms. This is an obviously rich and untapped area worthy of further study.

Toward Ecosystem Management

We emphasize the need to treat our viability evaluations and proposed mitigation measures as preliminary management hypotheses. All species that we identified as associated with old growth, and particularly those that we identified as having medium or high risk of extirpation, require further basic research, monitoring of habitat amount and distribution, and, in some cases, monitoring of specific population distribution, size, and trend.

This project is but an initial step in a larger process for supporting ecosystem management, planning, and evaluation. There is still a great deal of basic work to do to support ecologically-based land stewardship. There are no quick fixes given the complexities of natural environmental systems.

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Appendix 5-A

Terrestrial Vertebrates Associated With Late-Successional and Old-Growth Forests in National Forests Within the Range of the Northern Spotted Owl ("Long List")

Table of Contents

Appendix 5-A
Terrestrial Vertebrates ("Long List")

Key

This list consists of species of amphibians, reptiles, birds, and mammals that constitute the "long list". The objective was to include all old-growth/mature associated species within the range of the northern spotted owl. A species was put on the list if any of the references indicated use of mature or old-growth (late-successional) forest habitat or features (down logs or large snags). The species on this list may not be dependent or closely associated with mature or old-growth forests or their components but may merely be reported to use one of these habitats.

Nine references were used to identify species for this long list (listed here in order of appearance in the table):

RP = USDI (1992)
UF = Ruggiero et al. (1991)
SVO = Marshall (1992)
LSO = Marcot et al. (in prep.)
PS = Rodrick and Milner (1991)
KP = Foster (1992) and Macfarlane et al. (1991)
OFW = Marshall (1991)
WOW = Brown (1985)
CWH = California Department of Fish and Game (see description below)

To clarify how the selection of species was done, the following about the references should be noted:

Species from Brown (1985; coded as WOW) were included if they were denoted as a primary or secondary user of large sawtimber or old-growth forest age classes in evergreen hardwood, conifer hardwood, mixed coniferous, temperate, high temperate, subalpine park or lodgepole pine forests. The latter three types were included because they are considered dispersal habitat for the spotted owl.

Species from California Department of Fish and Game's Habitat Relationship System (1989 version; coded as CWH) were sorted for those species associated with mixed conifer or Douglas-fir forest types, medium or large tree forest age classes, and moderate (40-59 percent) or dense (60-100 percent) crown closure classes.

Species from Ruggiero et al. (1991:456-462; coded as UF) were included if they were denoted as present (P), associated (+), or closely associated (*) with the mature or old-growth age classes.

Species from the Draft Recovery Plan for the Northern Spotted Owl (USDI 1992:341,343,346; coded as RP) were included as listed in their Table D.1 (birds), Table D.2 (mammals), or Table D.3 (amphibians and reptiles).

Appendix 5-A
Terrestrial Vertebrates ("Long List")

Key (continued)

For the remaining references, the narratives for each species were reviewed. If association with late-successional forest habitats or features were indicated, the species were included on the list.

Other codes used in the column headings:

USFWS = USDI Fish and Wildlife Service
WA = Washington
OR = Oregon
CA = California
OG = old-growth forest
Endemic = degree of endemism in the Pacific Northwest; Loc = locally endemic, Broa = broadly distributed throughout the Pacific Northwest within the range of the northern spotted owl
Columns labeled A through I = see text, Table 5-1, for factors for identifying species closely associated with old-growth forests
Columns labeled 1 through 4 = see text, Table 5-1, for criteria for identifying species closely associated with old-growth forests
Conclusion = indicated if a species is included in the "short list" of species closely associated with old-growth forests

Appendix 5-A
Terrestrial Vertebrates ("Long List") - Amphibians

Species	References									Information from USFWS Draft Recovery Plan (Anthony et al.)									
										USFWS listing	State listing			OG assoc.			Endemic		OG assoc.
Species	RP	UF	SVO	LSO	PS	KP	OFW	WO	CWH	status	WA	OR	CA	WA	OR	CA	Loc	Broa	Reference
Amphibians																			
Oregon Slender salamander	x	x	x	x			x	x				SC			+		X		Ruggiero et al. 1991
Larch Mt. salamander	x		x		x		x	x		C2	C	SC			*		X		Beatty et al. 1991
Siskiyou Mt. salamander	x		x				x	x	x	C2		SC	T				X		Beatty et al. 1991
Del Norte salamander	x	x	x	x			x	x	x	C2		SC	SC			*	X		Ruggiero et al. 1991
Van Dyke's salamander	x				x			x		C3	C			+			X		Beatty 1991 pers. comm.
Mount Lyell salamander									x										
Dunn's salamander	x	x		x	x			x			C				+	?	X		Ruggiero et al. 1991
Western red-backed salamander	x	x						x									X		Ruggiero et al. 1991
Black salamander	x	x	x					x	x			SC						X	Ruggiero et al. 1991
California slender salamander		x	x	x				x											
Clouded salamander	x	x	x	x			x		x			SC			+	+	X		Ruggiero et al. 1991
Arboreal salamander									x										
Ensatina	x	x		x				x								+			Ruggiero et al. 1991
Pacific giant salamander	x	x		x				x	x					+	+	*		X	Raphael 1988
Cope's giant salamander	x	x	x	x			x							+	?		X		Ruggiero et al. 1991
Olympic salamander	x	x	x	x			x	x	x		SC	SC	SC	+	*	*		X	Ruggiero et al. 1991
Northwestern salamander	x	x		x				x	x					*	+	?	X		Ruggiero et al. 1991
Shasta salamander	x								x	C2			T				X		Beatty et al. 1991
Red-bellied newt									x										
Roughskin newt		x		x				x	x					*					Ruggiero et al. 1991
Pacific treefrog		x						x	x										
Tailed frog	x	x	x	x			x	x	x		SC	SC	SC	+	+	*		X	Ruggiero et al. 1991
Cascades frog	x		x					x		C2		SC	SC				X		Beatty et al. 1991
Red-legged frog	x	x	x							C2		SC	SC			?		X	Ruggiero et al. 1991
Western spotted frog	x		x		x					C2	C	SC							Beatty et al. 1991
Foothill yellow-legged frog	x	x	x							C2		SC	SC		?			X	Ruggiero et al. 1991
Western Toad	x								x										Beatty 1991 pers. comm.
Northern leopard frog																			

Appendix 5-A
Terrestrial Vertebrates ("Long List") - Amphibians (continued)

	More abundant in OG forest				Species lists				
	field data	SAT judgment	Assoc w/ OG forest	Requires OG elements	Federal USFWS T&E	Federal USFWS Candidat	USFS sensitive species	State list	Inadeq. field data
Species	A	B	C	D	E	F	G	H	I
Amphibians									
Oregon Slender salamander			x	x				x	
Larch Mt. salamander	x					x	R6	x	
Siskiyou Mt. salamander			x	x		x	R6	x	
Del Norte salamander	x		x	x		x	R6	x	
Van Dyke's salamander			x	x		x		x	
Mount Lyell salamander									
Dunn's salamander			x	x				x	
Western red-backed salamander									
Black salamander		x						x	
California slender salamander			x	x					
Clouded salamander			x	x				x	
Arboreal salamander				x					x
Ensatina			x						
Pacific giant salamander	x	x?	x						
Cope's giant salamander		x?	x				R6		x
Olympic salamander	x							x	
Northwestern salamander	x								
Shasta salamander		x?				x		x	x?
Red-bellied newt									
Roughskin newt	x		x						
Pacific treefrog									
Tailed frog	x							x	
Cascades frog						x		x	
Red-legged frog						x	R6	x	
Western spotted frog						x		x	
Foothill yellow-legged frog						x		x	
Western Toad									
Northern leopard frog									

Appendix 5-A
Terrestrial Vertebrates ("Long List") - Amphibians (continued)

Species	Criteria for assigning species to old-growth associated list				Conclusion: On old-growth associated list? *	Comments
	1	2	3	4		
Amphibians						
Oregon Slender salamander		x			YES	uses down logs
Larch Mt. salamander	x		x		YES	also protected in forest plans
Siskiyou Mt. salamander		x			YES	threatened in Calif.
Del Norte salamander	x	x	x		YES	
Van Dyke's salamander		x			YES	uses down logs
Mount Lyell salamander					no	
Dunn's salamander		x			YES	not known if late seral required
Western red-backed salamander					no	
Black salamander	x				YES	
California slender salamander		x			YES	
Clouded salamander		x			YES	
Arboreal salamander					no	widespread; & wide variety of habitat conditions
Ensatina					no	ubiq.; uses small down wood
Pacific giant salamander	x				YES	Gomez 1992, Raphael 1988
Cope's giant salamander	x				YES	assumes similar ecology as w/ Pac. Giant Sal.
Olympic salamander	x		x		YES	
Northwestern salamander	x				YES	
Shasta salamander	x				YES	
Red-bellied newt					no	
Roughskin newt	x				YES	
Pacific treefrog					no	
Tailed frog	x		x		YES	
Cascades frog					no	
Red-legged frog					no	
Western spotted frog					no	
Foothill yellow-legged frog					no	
Western Toad					no	
Northern leopard frog					no	

* "old-growth associated list" = "short list" (see Appendix 5-D)

Appendix 5-A
Terrestrial Vertebrates ("Long List") - Reptiles

Species	References									Information from USFWS Draft Recovery Plan (Anthony et al.)									
										USFWS listing status	State listing			OG assoc.			Endemic		OG assoc.
	RP	UF	SVO	LSO	PS	KP	OFW	WO	CWH		WA	OR	CA	WA	OR	CA	Loc	Broa	Reference
Reptiles																			
Western pond turtle	x		x	x						C2	T	SC	SC					X	Beatty et al. 1991
Sharp-tailed snake	x		x									SC						X	Beatty et al. 1991
Rubber boa								x											
Gopher snake									x										
Western aquatic garter snake									x										
Western terrestrial garter snake									x										
Common garter snake									x										
Western rattlesnake									x										
Northern alligator lizard		x							x										
Western fence lizard									x										

Species	More abundant in OG forest		Assoc w/ OG forest	Requires OG elements	Species lists				Inadeq. field data
	field data	SAT judgment			Federal USFWS T&E	Federal USFWS Candidat	USFS sensitive species	State list	
	A	B	C	D	E	F	G	H	I
Reptiles									
Western pond turtle						x	R6	x	
Sharp-tailed snake				x				x	
Rubber boa									
Gopher snake									
Western aquatic garter snake									
Western terrestrial garter snake									
Common garter snake									
Western rattlesnake									
Northern alligator lizard									
Western fence lizard									

Appendix 5-A
Terrestrial Vertebrates ("Long List") - Reptiles (continued)

Species	Criteria for assigning species to old-growth associated list				Conclusion: On old-growth associated list? *	Comments
	1	2	3	4		
Reptiles						
Western pond turtle					no	
Sharp-tailed snake					no	
Rubber boa					no	
Gopher snake					no	
Western aquatic garter snake					no	
Western terrestrial garter snake					no	
Common garter snake					no	
Western rattlesnake					no	
Northern alligator lizard					no	
Western fence lizard					no	

* "old-growth associated list" = "short list" (see Appendix 5-D)

Appendix 5-A
Terrestrial Vertebrates ("Long List") - Birds Part 1

Species	References									Information from USFWS Draft Recovery Plan (Anthony et al.) USFWS listing status	State listing			OG assoc.			Endemic		OG assoc. Reference
	RP	UF	SVO	LSO	PS	KP	OFW	WO	CWH		WA	OR	CA	WA	OR	CA	Loc	Broa	
BIRDS																			
Marbled murrelet	x	x	x	x	x	x	x		x	T	C	S(C	E		*	*			Ruggiero et al. 1991
Great blue heron								x	x										
Barrow's goldeneye			x		x		x	x											
Bufflehead			x		x		x	x											
Wood duck					x			x											
Hooded merganser					x			x											
Common merganser								x											
Harlequin duck	x		x		x					C2									
Blue grouse			x	x	x			x	x					+	+	?			Ruggiero et al. 1991
Spruce grouse								x											
Ruffed grouse		x		x				x	x					+	P	?			Ruggiero et al. 1991
Mountain quail		x							x	C2				?	P	P			Ruggiero et al. 1991
California quail									x										
Merriam's turkey					x														
Wild turkey								x	x										
Mourning dove								x	x										
Band-tailed pigeon		x						x	x					P	P	?			Ruggiero et al. 1991
Northern goshawk	x		x	x	x	x	x	x	x	C2	C	S(C	SC	+	+	+			Hayward et al. 1990
Sharp-shinned hawk								x	x										
Cooper's hawk								x	x										
Red-tailed hawk								x	x										
Golden eagle								x	x										
American kestrel									x										
Merlin																			
Peregrine falcon									x	E	E	E	?						
Prairie falcon									x										
Bald eagle	x			x	x	x		x	x	T	T	T	E	*	*	*			Anthony et al. 1982
Osprey					x				x										
Turkey vulture								x	x										
Barred owl		x						x						P	?	?			Ruggiero et al. 1991
Northern pygmy-owl	x	x	x				x	x	x					P	+	?			Ruggiero et al. 1991

Appendix 5-A
Terrestrial Vertebrates ("Long List") - Birds Part 1 (continued)

	More abundant in OG forest				Species lists				
	field data	SAT judgment	Assoc w/ OG forest	Requires OG elements	Federal USFWS T&E	Federal USFWS Candidat	USFS sensitive species	State list	Inadeq. field data
Species	A	B	C	D	E	F	G	H	I
BIRDS									
Marbled murrelet	x		x	x	x		R6	x	x
Great blue heron									
Barrow's goldeneye			x	x					
Bufflehead			x	x					
Wood duck			x	x					
Hooded merganser			x	x					
Common merganser			x	x					
Harlequin duck			x	x		x	R6		
Blue grouse								x	
Spruce grouse									
Ruffed grouse								x	
Mountain quail						x			
California quail									
Merriam's turkey									
Wild turkey									
Mourning dove									
Band-tailed pigeon									
Northern goshawk		x				x		x	
Sharp-shinned hawk									
Cooper's hawk									
Red-tailed hawk									
Golden eagle									
American kestrel									
Merlin									
Peregrine falcon					x		R6	x	
Prairie falcon									
Bald eagle	x	x			x		R6	x	x
Osprey				x					
Turkey vulture									
Barred owl			x	x					
Northern pygmy-owl			x	x?					

Appendix 5-A
Terrestrial Vertebrates ("Long List") - Birds Part 1 (continued)

Species	Criteria for assigning species to old-growth associated list 1	2	3	4	Conclusion: On old-growth associated list? *	Comments
BIRDS						
Marbled murrelet	x	x	x	x	YES	recently listed as Threatened
Great blue heron					no	
Barrow's goldeneye		x			YES	riparian management for snags
Bufflehead		x			YES	riparian management for snags
Wood duck		x			YES	riparian management for snags
Hooded merganser		x			YES	riparian management for snags
Common merganser		x			YES	riparian management for snags
Harlequin duck		x			YES	riparian management for snags
Blue grouse					no	
Spruce grouse					no	
Ruffed grouse					no	
Mountain quail					no	
California quail					no	
Merriam's turkey					no	
Wild turkey					no	
Mourning dove					no	
Band-tailed pigeon					no	
Northern goshawk	x				YES	Reynolds references; OG associated on Olymp. Pen.
Sharp-shinned hawk					no	
Cooper's hawk					no	
Red-tailed hawk					no	
Golden eagle					no	
American kestrel					no	
Merlin					no	
Peregrine falcon					no	
Prairie falcon					no	
Bald eagle	x		x	x	YES	
Osprey					no	snags, esp. along lakes, rivers
Turkey vulture					no	
Barred owl		x			YES	Brown lists elements incl. snags
Northern pygmy-owl		x			YES	check factor D?; Brown lists snags

* "old-growth associated list" = "short list" (see Appendix 5-D)

Appendix 5-A
Terrestrial Vertebrates ("Long List") - Birds Part 2

	References									Information from USFWS Draft Recovery Plan (Anthony et al.)									
										USFWS listing	State listing			OG assoc.			Endemic		OG assoc.
Species	RP	UF	SVO	LSO	PS	KP	OFW	WO	CWH	status	WA	OR	CA	WA	OR	CA	Loc	Broa	Reference
Northern spotted owl	x	x		x	x	x	x	x	x	T	T	T	?	*	*	*			Ruggiero et al. 1991
Flammulated owl	x		x	x	x		x		x										
Great gray owl	x		x			x	x		x										
Western screech owl									x										
Great horned owl								x	x										
Long-eared owl								x	x										
Northern saw-whet owl								x	x										
Common nighthawk									x										
Whip-poor-will									x										
Allen's hummingbird		x		x											+	+			Ruggiero et al. 1991
Calliope hummingbird								x											
Rufous hummingbird		x		x				x	x		C			P	+			X	Ruggiero et al. 1991
White-throated swift									x										
Vaux's swift	x	x		x	x	x	x	x	x		C			*	*	?			Ruggiero et al. 1991
Black swift									x										
Tree swallow								x											
Violet-green swallow								x	x										
Belted kingfisher								x			C	S(C		+	+	+			Ruggiero et al. 1991
Pileated woodpecker	x	x	x	x	x		x	x	x										
Downy woodpecker		x							x					?	P	?			Ruggiero et al. 1991
Hairy woodpecker		x		x				x	x		C	S(C		+	*	*		X	Bull 1990
White-headed woodpecker	x		x		x		x	x	x		M	S(C		+	+				Goggans et al. 1987
Black-backed woodpecker	x		x		x		x	x											
Acorn woodpecker			x				x												
Lewis woodpecker		x		x			x	x	x										
Three-toed woodpecker		x					x												
Nuttall's woodpecker									x										
Common raven		x		x				x	x					P	+	P			Ruggiero et al. 1991
Gray jay		x		x				x	x					+	P	P			Ruggiero et al. 1991
Steller's jay		x		x				x	x					P	+	P			Ruggiero et al. 1991
Clark's nutcracker (1)								x	x										
Red-breasted sapsucker	x	x		x				x	x										
Williamson's sapsucker			x				x	x	x										

Appendix 5-A
Terrestrial Vertebrates ("Long List") - Birds Part 2 (continued)

	More abundant in OG forest				Species lists				
	field data	SAT judgment	Assoc w/ OG forest	Requires OG elements	Federal USFWS T&E	Federal USFWS Candidat	USFS sensitive species	State list	Inadeq. field data
Species	A	B	C	D	E	F	G	H	I
Northern spotted owl	x				x		R6	x	
Flammulated owl			x	x					
Great gray owl			x	x					
Western screech owl									
Great horned owl									
Long-eared owl									
Northern saw-whet owl									
Common nighthawk									
Whip-poor-will									
Allen's hummingbird									
Calliope hummingbird									
Rufous hummingbird								x	
White-throated swift									
Vaux's swift	x			x				x	
Black swift									
Tree swallow				x					
Violet-green swallow									
Belted kingfisher								x	
Pileated woodpecker			x	x					
Downy woodpecker				x					
Hairy woodpecker	x			x				x	
White-headed woodpecker			x	x				x	
Black-backed woodpecker			x	x					
Acorn woodpecker				x					
Lewis woodpecker				x					
Three-toed woodpecker			x	x					
Nuttail's woodpecker				x					
Common raven									
Gray jay									
Steller's jay									
Clark's nutcracker (1)									
Red-breasted sapsucker		x		x					
Williamson's sapsucker			x	x					

Appendix 5-A
Terrestrial Vertebrates ("Long List") - Birds Part 2 (continued)

Species	Criteria for assigning species to old-growth associated list				Conclusion: On old-growth associated list? *	Comments
	1	2	3	4		
Northern spotted owl	x		x		YES	
Flammulated owl		x			YES	occurs in NSO range only in nw CA? Goggans 1986
Great gray owl		x			YES	E. Bull references
Western screech owl					no	
Great horned owl					no	
Long-eared owl					no	
Northern saw-whet owl					no	
Common nighthawk					no	
Whip-poor-will					no	
Allen's hummingbird					no	
Calliope hummingbird					no	
Rufous hummingbird					no	
White-throated swift					no	
Vaux's swift	x		x		YES	closely assoc. w/ OG; WA candidate
Black swift					no	
Tree swallow					no	
Violet-green swallow					no	
Belted kingfisher					no	
Pileated woodpecker		x			YES	
Downy woodpecker					no	uses small snags
Hairy woodpecker	x		x		YES	closely assoc. w/ OG in no. CA (Raphael 1988)
White-headed woodpecker		x			YES	uses large snags; Bull reference
Black-backed woodpecker		x			YES	uses large snags; Goggans et al. 1987
Acorn woodpecker					no	assoc. w/ oak woodlands, hardwood components
Lewis woodpecker					no	
Three-toed woodpecker		x			YES	Brown lists as using snags; Goggans et al. 1987
Nuttail's woodpecker					no	
Common raven					no	
Gray jay					no	
Steller's jay					no	
Clark's nutcracker (1)					no	
Red-breasted sapsucker	x				YES	
Williamson's sapsucker		x			YES	

* "old-growth associated list" = "short list" (see Appendix 5-D)

Appendix 5-A
Terrestrial Vertebrates ("Long List") - Birds Part 3

	References									Information from USFWS Draft Recovery Plan (Anthony et al.)									
										USFWS listing	State listing			OG assoc.			Endemic		OG assoc.
Species	RP	UF	SVO	LSO	PS	KP	OFW	WO	CWH	status	WA	OR	CA	WA	OR	CA	Loc	Broa	Reference
Northern flicker		x		x				x	x					P	+	P			Ruggiero et al. 1991
Dusky/Hammond's flycatcher		x		x					x						+				Ruggiero et al. 1991
Western flycatcher	x	x		x				x	x					P	*	*			Ruggiero et al. 1991
Olive-sided flycatcher		x		x				x	x									X	
Hammond's flycatcher	x	x						x	x					P	P	*			(see comments)
Willow flycatcher	x			x		x													
Western wood-peewee		x						x	x					P	P	P			Ruggiero et al. 1991
Black-capped chickadee		x						x						?	P			X	Ruggiero et al. 1991
Chestnut-backed chickadee	x	x		x				x	x					+	+	+			Ruggiero et al. 1991
Mountain chickadee								x	x										
Brown creeper	x	x		x				x	x					+	*	*			Ruggiero et al. 1991
Red-breasted nuthatch	x	x		x				x	x					+	?	?			Ruggiero et al. 1991
White breasted nuthatch		x						x	x					?	P	?			Ruggiero et al. 1991
Pygmy nuthatch			x				x	x	x					+	+	+			Ruggiero et al. 1991
Winter wren	x	x		x				x	x					+	+	+			Ruggiero et al. 1991
House wren		x												?	P	?			Ruggiero et al. 1991
Western bluebird									x										
Mountain bluebird																			
Golden-crowned kinglet		x						x	x					P	P	P			Ruggiero et al. 1991
Ruby-crowned kinglet		x						x	x					?	P	?			Ruggiero et al. 1991
American robin		x		x					x					P	+	+			Ruggiero et al. 1991
Hermit thrush	x	x		x				x	x					P	P	+			Rugg. et al. 91, Raphael 1985
Swainson's thrush		x		x				x	x					+	P	?			Rugg. et al. 91
Townsend's solitaire		x						x	x		C	S(C		+	+	+			Goggans 1986
Varied thrush		x		x				x	x				E	+	+	P			Ruggiero et al. 1991
Wrentit		x		x										P	P	+			Ruggiero et al. 1991
Cedar waxwing									x										
Brewer's blackbird									x										
Hermit/Townsend's warbler		x						x						P	P				Ruggiero et al. 1991
MacGillivray's warbler		x												P	P	?			Ruggiero et al. 1991
Black-throated gray warbler		x						x	x					P	P	P			Ruggiero et al. 1991
Nashville warbler		x							x					?	P	P			Ruggiero et al. 1991
Hermit warbler		(x)						(x)	x					?	P	+			Ruggiero et al. 1991

Appendix 5-A
Terrestrial Vertebrates ("Long List") - Birds Part 3 (continued)

	More abundant in OG forest				Species lists				
	field data	SAT judgment	Assoc w/ OG forest	Requires OG elements	Federal USFWS T&E	Federal USFWS Candidat	USFS sensitive species	State list	Inadeq. field data
Species	A	B	C	D	E	F	G	H	I
Northern flicker			x	x					
Dusky/Hammond's flycatcher									
Western flycatcher	x								
Olive-sided flycatcher									
Hammond's flycatcher	x								
Willow flycatcher									
Western wood-peewee									
Black-capped chickadee									
Chestnut-backed chickadee		x							
Mountain chickadee									
Brown creeper	x			x					
Red-breasted nuthatch			x	x					
White breasted nuthatch			x	x					
Pygmy nuthatch			x	x					
Winter wren		x							
House wren									
Western bluebird									
Mountain bluebird									
Golden-crowned kinglet		x							
Ruby-crowned kinglet									
American robin									
Hermit thrush		x							
Swainson's thrush									
Townsend's solitaire								x	
Varied thrush		x						x	
Wrentit									
Cedar waxwing									
Brewer's blackbird									
Hermit/Townsend's warbler		x							
MacGillivray's warbler									
Black-throated gray warbler									
Nashville warbler									
Hermit warbler									

Appendix 5-A
Terrestrial Vertebrates ("Long List") - Birds Part 3 (continued)

Species	Criteria for assigning species to old-growth associated list 1	2	3	4	Conclusion: On old-growth associated list? *	Comments
Northern flicker		x			YES	assoc. w/ open forests, but uses lg snags
Dusky/Hammond's flycatcher					no	
Western flycatcher	x				YES	assoc. w/ OG in no. Cal. (Raphael 1988)
Olive-sided flycatcher					no	
Hammond's flycatcher	x				YES	Ruggiero et al. 1991; Sakai & Noon 1991 (CA)
Willow flycatcher					no	
Western wood-peewee					no	
Black-capped chickadee					no	
Chestnut-backed chickadee	x				YES	assoc. w/ OG in no. Cal. (Raphael 1988)
Mountain chickadee					no	
Brown creeper	x				YES	assoc. w/ OG in no. Cal. (Ruggiero et al. 1991)
Red-breasted nuthatch		x			YES	uses smaller snags; Brown lists in mature & OG
White breasted nuthatch		x			YES	uses smaller snags; Brown lists in mature & OG
Pygmy nuthatch		x			YES	uses smaller snags; Brown lists in mature & OG
Winter wren	x				YES	assoc. w/ OG in no. Cal. (Raphael 1988)
House wren					no	
Western bluebird					no	
Mountain bluebird					no	
Golden-crowned kinglet	x				YES	assoc. w/ OG in no. Cal. (Raphael 1988)
Ruby-crowned kinglet					no	
American robin					no	
Hermit thrush	x				YES	assoc. w/ OG in no. Cal. (Raphael 1988)
Swainson's thrush					no	
Townsend's solitaire					no	
Varied thrush	x				YES	assoc. w/ OG in no. Cal. in winter
Wrentit					no	
Cedar waxwing					no	
Brewer's blackbird					no	
Hermit/Townsend's warbler	x				YES	see individual species ratings
MacGillivray's warbler					no	
Black-throated gray warbler					no	
Nashville warbler					no	
Hermit warbler					no	

* "old-growth associated list" = "short list" (see Appendix 5-D)

Appendix 5-A
Terrestrial Vertebrates ("Long List") - Birds Part 4

Species	References									Information from USFWS Draft Recovery Plan (Anthony et al.)									
										USFWS listing status	State listing			OG assoc.			Endemic		OG assoc. Reference
	RP	UF	SVO	LSO	PS	KP	OFW	WO	CWH		WA	OR	CA	WA	OR	CA	Loc	Broa	
Orange-crowned warbler		x						x	x					?	P	P			Ruggiero et al. 1991
Townsend's warbler		x						(x)	x					?	P	?			Ruggiero et al. 1991
Yellow warbler									x										
Wilson's warbler	x	x		x				x						+	P	*			Ruggiero et al. 1991, Raphael 1985 (CA)
Yellow-rumped warbler		x						x	x					P	P	P			Ruggiero et al. 1991
Hutton's vireo		x							x					P	P	P			Ruggiero et al. 1991
Solitary vireo		x		x				x	x					P	+	+			Ruggiero et al. 1991
Warbling vireo	x	x						x	x					P	P	P			Ruggiero et al. 1991
Western tanager		x		x				x	x					P	P	+			Ruggiero et al. 1991
Chipping sparrow		x												?	P	?			Ruggiero et al. 1991
Dark-eyed junco		x						x						P	P	P			Ruggiero et al. 1991
Rufous-sided towhee		x												?	P	P			Ruggiero et al. 1991
Song sparrow		x												P	P	?			Ruggiero et al. 1991
Black-headed grosbeak		x		x					x					P	+	+			Ruggiero et al. 1991
Evening grosbeak		x						x	x					P	P	P			Ruggiero et al. 1991
Pine grosbeak								x											
Pine siskin		x		x				x	x					P	P	P			Ruggiero et al. 1991
Purple finch		x						x	x					P	P	P			Ruggiero et al. 1991
Cassin's finch									x										
Red crossbill		x		x				x	x					+	+	P			Ruggiero et al. 1991
White-winged crossbill							x												
Common redpoll							x												

Appendix 5-A
Terrestrial Vertebrates ("Long List") - Birds Part 4 (continued)

	More abundant in OG forest				Species lists				
	field data	SAT judgment	Assoc w/ OG forest	Requires OG elements	Federal USFWS T&E	Federal USFWS Candidat	USFS sensitive species	State list	Inadeq. field data
Species	A	B	C	D	E	F	G	H	I
Orange-crowned warbler									
Townsend's warbler		x	x						
Yellow warbler									
Wilson's warbler	x								
Yellow-rumped warbler									
Hutton's vireo									
Solitary vireo									
Warbling vireo		x							
Western tanager									
Chipping sparrow									
Dark-eyed junco									
Rufous-sided towhee									
Song sparrow									
Black-headed grosbeak									
Evening grosbeak									
Pine grosbeak									
Pine siskin									
Purple finch									
Cassin's finch									
Red crossbill			x	x					
White-winged crossbill									
Common redpoll									

Appendix 5-A
Terrestrial Vertebrates ("Long List") - Birds Part 4 (continued)

Species	Criteria for assigning species to old-growth associated list				Conclusion: On old-growth associated list? *	Comments
	1	2	3	4		
Orange-crowned warbler					no	
Townsend's warbler	x				YES	mature (Brown '85, Marcot '85), OG (Brown '85)
Yellow warbler					no	
Wilson's warbler	x				YES	in OG in no. Cal. (Raphael 1985), but also in yng grth
Yellow-rumped warbler					no	
Hutton's vireo					no	
Solitary vireo					no	
Warbling vireo	x				YES	assoc. w/ OG in no. Cal. (Raphael 1988)
Western tanager					no	
Chipping sparrow					no	
Dark-eyed junco					no	
Rufous-sided towhee					no	
Song sparrow					no	
Black-headed grosbeak					no	
Evening grosbeak					no	
Pine grosbeak					no	
Pine siskin					no	
Purple finch					no	
Cassin's finch					no	
Red crossbill		x			YES	large canopy, no fragmentation; species complex
White-winged crossbill					no	
Common redpoll					no	

* "old-growth associated list" = "short list" (see Appendix 5-D)

Appendix 5-A
Terrestrial Vertebrates ("Long List") - Mammals Part 1

Species	References									Information from USFWS Draft Recovery Plan (Anthony et al.)									
										USFWS listing	State listing			OG assoc.			Endemic		OG assoc.
	RP	UF	SVO	LSO	PS	KP	OFW	WO	CWH	status	WA	OR	CA	WA	OR	CA	Loc	Broa	Reference
MAMMALS																			
Marten	x		x	x	x	x	x	x	x		G	S	S	+	+	+			Marshall 1991
Ermine		x						x	x					?	P	?			Ruggiero et al. 1991
Long-tailed weasel								x	x										
Fisher	x	x	x	x	x	x	x	x	x	C2	S	S	SC	+	+	+			Ruggiero et al. 1991
Wolverine	x			x			x	x		C2	M	T	T						
Gray wolf	x			x						E	E								
Black bear								x	x										
Grizzly bear	x			x				x		T	E								
Porcupine								x	x										
Mountain beaver									x										
Brush rabbit								x											
Raccoon								x	x										
Ringtail							x												
Opposum								x											
Dusky-footed woodrat	x							x	x				SC			*		X	Raphael 1985,88
Bushy-tailed woodrat	x			x				x	x									X	
Northern flying squirrel	x	x		x				x	x				SC	?	*	?			Carey 1992 (OR)
Western gray squirrel					x			x	x										
Golden mantled ground squirrel								x	x										
Cascade mantled ground squirrel								x											
Siskiyou chipmunk								x	x										
Yellow pine chipmunk (1)									x										
Yellow-cheeked chipmunk									x										
Allen's chipmunk									x										
California chipmunk									x										
Douglas squirrel		x		x				x	x					?	?	*			Raphael 1988 (CA)
Townsend's chipmunk		x						x							*				Rosenberg & Anthony 1992
Red tree vole (P.longicaudus)	x	x		x				x	x						*		X		Ruggiero et al. 1991; Gomez 1992
Red tree vole (P.pomo)	x	x		x				x	x				SC			+	X		Ruggiero et al. 1991
White-footed vole	x		x	x				x		C2		S(R)	SC				X		Gomez 1992
Western red-backed vole	x	x		x				x	x							*	X		Raphael 1988

Appendix 5-A
Terrestrial Vertebrates ("Long List") - Mammals Part 1 (continued)

	More abundant in OG forest				Species lists				
	field data	SAT judgment	Assoc w/ OG forest	Requires OG elements	Federal USFWS T&E	Federal USFWS Candidat	USFS sensitive species	State list	Inadeq. field data
Species	A	B	C	D	E	F	G	H	I
MAMMALS									
Marten			x	x				x	
Ermine									
Long-tailed weasel									
Fisher			x	x		x		x	
Wolverine						x	R6	x	x
Gray wolf					x		R6	x	
Black bear									
Grizzly bear					x		R6	x	
Porcupine									
Mountain beaver									
Brush rabbit									
Raccoon									
Ringtail									
Opposum									
Dusky-footed woodrat	x		x					x	
Bushy-tailed woodrat									
Northern flying squirrel	x		x	x				x	
Western gray squirrel									
Golden mantled ground squirrel									
Cascade mantled ground squirrel									
Siskiyou chipmunk									
Yellow pine chipmunk (1)									
Yellow-cheeked chipmunk									
Allen's chipmunk									
California chipmunk									
Douglas squirrel	x		x	x					
Townsend's chipmunk	x								
Red tree vole (P.longicaudus)	x		x						
Red tree vole (P.pomo)		x	x					x	
White-footed vole						x	R6	x	x.
Western red-backed vole	x			x					

Appendix 5-A
Terrestrial Vertebrates ("Long List") - Mammals Part 1 (continued)

Species	Criteria for assigning species to old-growth associated list				Conclusion: On old-growth associated list? *	Comments
	1	2	3	4		
MAMMALS						
Marten		x			YES	uses snags & down logs for den sites
Ermine					no	assoc. w/ early succ. stages too
Long-tailed weasel					no	assoc. w/ early succ. stages too
Fisher		x			YES	uses snags & down logs for den sites
Wolverine					no	high elev./subalpine associate
Gray wolf					no	
Black bear					no	
Grizzly bear					no	
Porcupine					no	
Mountain beaver					no	most abund. in early growth stages
Brush rabbit					no	
Raccoon					no	
Ringtail					no	
Opposum					no	
Dusky-footed woodrat	x		x		YES	also in early shrub stages; but OG use > mid-succ.
Bushy-tailed woodrat					no	
Northern flying squirrel	x	x	x		YES	
Western gray squirrel					no	
Golden mantled ground squirrel					no	
Cascade mantled ground squirrel					no	
Siskiyou chipmunk					no	
Yellow pine chipmunk (1)					no	
Yellow-cheeked chipmunk					no	
Allen's chipmunk					no	
California chipmunk					no	
Douglas squirrel	x	x			YES	requires lg conifers w/ seed production
Townsend's chipmunk	x				YES	but also is abundant in early stages
Red tree vole (P.longicaudus)	x				YES	recov plan shows OR only
Red tree vole (P.pomo)	x				YES	recov plan shows CA only
White-footed vole					no	riparian assoc.; not sig. across seral stages (Gomez)
Western red-backed vole	x				YES	

* "old-growth associated list" = "short list" (see Appendix 5-D)

Appendix 5-A
Terrestrial Vertebrates ("Long List") - Mammals Part 2

Species	References									Information from USFWS Draft Recovery Plan (Anthony et al.)									
										USFWS listing	State listing			OG assoc.			Endemic		OG assoc.
Species	RP	UF	SVO	LSO	PS	KP	OFW	WO	CWH	status	WA	OR	CA	WA	OR	CA	Loc	Broa	Reference
Heather vole (1)								x											
Southern red-backed vole		x						x						P					Ruggiero et al. 1991
Forest deer mouse	x	x		x										+			X		Ruggiero et al. 1991
Deer mouse		x		x					x					+	+	*			Rug. 91 (WA,OR); Raph 88 (CA)
Western jumping mouse									x										
Pacific jumping mouse									x										
Pinyon mouse		x							x							P			Ruggiero et al. 1991
Marsh shrew		x		x											+				Ruggiero et al. 1991
Montane shrew		x												P	P	P			Ruggiero et al. 1991
Masked shrew								x											
Dusky shrew								x											
Trowbridge's shrew		x						x	x					P	P	P			Ruggiero et al. 1991
Pacific shrew		x		x					x						+	*			Rugg 91 (OR), Raph 88 (CA)
Vagrant shrew		x						x						P	P	?			Ruggiero et al. 1991
Coast mole		x												P	P	?			Ruggiero et al. 1991
Shrew-mole	x	x		x				x	x					P	+	?			Ruggiero et al. 1991
Big brown bat		x		x				x	x						*				Ruggiero et al. 1991
Silver- haired bat	x	x		x				x	x					+	*	?			Ruggiero et al. 1991
Western (Townsend's) big-eared bat	x									C2	C	S(C	SC						
Pallid bat								x											
Hoary bat								x	x										
Brazillian free-tailed bat								x											
Red bat									x										
Long-legged myotis	x	x		x				x	x		M			*	*	?			Ruggiero et al. 1991
Yuma myotis		x		x				x	x					*	*	?			Ruggiero et al. 1991 (Myotis A complex)
California myotis		x		x				x	x					*	*	?			Ruggiero et al. 1991 (Myotis B complex)
Keen's myotis		x		x										*	*	?			Ruggiero et al. 1991 (Myotis B complex)
Long-eared myotis		x		x				x	x					*	*	?			Ruggiero et al. 1991 (Myotis B complex)
Western small-footed myotis		x		x					x					*	*	?			Ruggiero et al. 1991 (Myotis B complex)
Fringed myotis		x		x										?	*	?			Ruggiero et al. 1991
Little brown myotis		x		x				x	x					*	*	?			Ruggiero et al. 1991 (Myotis A complex)
Black-tailed deer								x											
Mule deer								x	x										

Appendix 5-A
Terrestrial Vertebrates ("Long List") - Mammals Part 2 (continued)

	More abundant in OG forest				Species lists				
	field data	SAT judgment	Assoc w/ OG forest	Requires OG elements	Federal USFWS T&E	Federal USFWS Candidat	USFS sensitive species	State list	Inadeq. field data
Species	A	B	C	D	E	F	G	H	I
Heather vole (1)									
Southern red-backed vole		x		x					x
Forest deer mouse		x?	x						
Deer mouse	x		x						
Western jumping mouse									
Pacific jumping mouse									
Pinyon mouse									
Marsh shrew									
Montane shrew									
Masked shrew			x						
Dusky shrew			x						x
Trowbridge's shrew			x						
Pacific shrew	x		x						
Vagrant shrew									
Coast mole			x						
Shrew-mole		x?	x						x
Big brown bat	x			x					
Silver- haired bat	x			x					
Western (Townsend's) big-eared bat						x	R6	x	
Pallid bat			x						
Hoary bat			x	x					
Brazillian free-tailed bat									
Red bat									
Long-legged myotis	x		x	x				x	
Yuma myotis	x		x	x					
California myotis	x		x	x					
Keen's myotis	x		x	x					
Long-eared myotis	x		x	x					
Western small-footed myotis	x		x	x					
Fringed myotis	x								
Little brown myotis	x		x	x					
Black-tailed deer									
Mule deer									

Appendix 5-A
Terrestrial Vertebrates ("Long List") - Mammals Part 2 (continued)

Species	Criteria for assigning species to old-growth associated list 1	2	3	4	Conclusion: On old-growth associated list? *	Comments
Heather vole (1)					no	
Southern red-backed vole	x				YES	little data available
Forest deer mouse	x				YES	
Deer mouse	x				YES	data show OG, but also very abund. in early seral veg.
Western jumping mouse					no	
Pacific jumping mouse					no	
Pinyon mouse					no	assoc. w/ early seral stages
Marsh shrew					no	strong riparian assoc. (Gomez 92)
Montane shrew					no	
Masked shrew					no	boreal, widespread species
Dusky shrew					no	
Trowbridge's shrew					no	broad assoc. w/ all forest stages
Pacific shrew	x				YES	abund in young forest (Gomez 92) but taxonomy uncertain
Vagrant shrew					no	low elev, early stage assoc. (Gomez 92) but tax. uncertain
Coast mole					no	fossorial, tied to soil structure
Shrew-mole	x				YES	regional OG analysis shows "*" (Aubry)
Big brown bat	x				YES	Christy & West in press; comb. w/ fringed in Rugg. et al. '91
Silver- haired bat	x				YES	Christy & West in press
Western (Townsend's) big-eared bat					no	Christy & West in press
Pallid bat					no	cliffs and caves (Ingles 1967)
Hoary bat		x			YES	Christy & West in press
Brazilian free-tailed bat					no	assoc. w/ caves (Brown 1985)
Red bat					no	
Long-legged myotis	x	x	x		YES	Christy & West in press
Yuma myotis	x	x			YES	part of "Myotis A" group in Ruggiero et al. 1991
California myotis	x	x			YES	part of "Myotis B" group in Ruggiero et al. 1991
Keen's myotis	x	x			YES	part of "Myotis B" group in Ruggiero et al. 1991
Long-eared myotis	x	x			YES	part of "Myotis B" group in Ruggiero et al. 1991
Western small-footed myotis	x	x			YES	part of "Myotis B" but NOT OG associated
Fringed myotis	x				YES	? combined w/ big brown bat in Ruggiero et al. 1991
Little brown myotis	x	x			YES	part of "Myotis A" group in Ruggiero et al. 1991
Black-tailed deer					no	
Mule deer					no	

* "old-growth associated list" = "short list" (see Appendix 5-D)

Appendix 5-A
Terrestrial Vertebrates ("Long List") - Mammals Part 3

Species	References: RP	UF	SVO	LSO	PS	KP	OFW	WO	CWH	Information from USFWS Draft Recovery Plan (Anthony et al.): USFWS listing status	State listing: WA	OR	CA	OG assoc.: WA	OR	CA	Endemic: Loc	Broa	OG assoc. Reference
Elk					x			x	x										
Mountain lion								x	x										
Lynx					x					C2									

Species	More abundant in OG forest: field data	SAT judgment	Assoc w/ OG forest	Requires OG elements	Species lists: Federal USFWS T&E	Federal USFWS Candidat	USFS sensitive species	State list	Inadeq. field data
	A	B	C	D	E	.F	G	H	I
Elk			x	x					
Mountain lion									
Lynx			x	x		x	R6		

Species	Criteria for assigning species to old-growth associated list: 1	2	3	4	Conclusion: On old-growth associated list? *	Comments
Elk		x			YES	OG assoc. on Olympic Peninsula
Mountain lion					no	
Lynx		x			YES	req. old for. cov. & early seral for feeding; Koehler 199?

* "old-growth associated list" = "short list" (see Appendix 5-D)

Appendix 5-A
Terrestrial Vertebrates ("Long List")

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Appendix 5-B

Vascular Plant Species Closely Associated With Old-Growth Forests in National Forests Within the Range of the Northern Spotted Owl ("Short List")

Key for status codes and references appear at the end of this appendix.

Appendix 5-B
Vascular Plant Species Closely Associated with Old-Growth Forests

SCIENTIFIC NAME	COMMON NAME	STATUS FED	STATUS WA	STATUS OR	STATUS CA	CRITERIA FOR OLD-GROWTH ASSOCIATION	REFERENCES
Achlys triphylla	Vanilla leaf					1	13,35,36
Adenocaulon bicolor	Trail plant					1	11,14,35,36
Adiantum pedatum	Western maidenhair fern					1	35,36
Allotropa virgata	Candy stick					1	13,35,36,37
Anemone deltoidea	Threeleaf anemone					1	35,36
Angelica tomentosa	California angelica					2	11,12
Apocynum pumilum	Dogbane					2	12, 14
Arceuthobium tsugense	Dwarf mistletoe					1	35,36
Arnica latifolia	Mountain arnica					1	35,36,37,38
Asarum caudatum	Wild ginger					1	11,12,35,38
Asarum hartwegii	Wild ginger					2	11, 12
Asarum wagneri	Green-flowered wild ginger			C1		4	
Bensoniella oregana	Bensoniella	C2		C1	R,1B	3	4,8,19
Berberis pumila	Dwarf mahonia					2	11,12
Boschniakia strobilacea	Ground cone					2	11
Botrychium ascendens				C		4	28
Botrychium crenulatum	Southwestern moonwort	C2		C		3	
Botrychium minganense	Victorin's grape fern		S	2		3	24,35,37
Botrychium montanum	Mountain grape-fern			2		3	35,37
Botrychium pumicola	Crater Lake (pumice) grapefern	C1		C1	1A	4	17, 18
Calypso bulbosa	Fairy-Slipper					1	11,13,14,35,36
Chamaecyparis lawsoniana	Port Orford cedar					1	35,38
Chamaecyparis nootkatensis	Alaska yellow cedar					1	35,36,38
Chimaphila menziesii	Pipsissewa					1	35,36
Chimaphilia umbellata	Common pipsissiwa					1	13,35,36,37
Cimicifuga elata	Tall bugbane		S	C		3	35,37
Clintonia uniflora	Queen's cup					1	2,12,35,36
Coptis asplenifolia	Spleenwort-leaved goldthread		S			2	16,25
Coptis laciniata	Goldthread					1	35,36,37
Corallorhiza maculata	Pacific coral root					1	35,36,37
Corallorhiza mertensiana	Western coral-root					1	35,36,37
Cupressus bakeri	Baker's cypress			2		3	19
Cypripedium fasciculatum	Clustered lady's slipper		T	C		4	11
Cypripedium montanum	Mountain lady's slipper					3	8,11,12

Appendix 5-B
Vascular Plant Species Closely Associated with Old-Growth Forests (continued)

SCIENTIFIC NAME	COMMON NAME	STATUS FED	STATUS WA	STATUS OR	STATUS CA	CRITERIA FOR OLD-GROWTH ASSOCIATION	REFERENCES
Dentaria californica	Toothwort					2	13
Disporum hookeri	Fairy bell					1	13
Dryopteris austriaca	Spreading wood-fern					1	35,36
Eburophyton austiniae	Phantom orchid					1	35,36,37
Erythronium montanum	Avalanche lily					1	35,36
Fritillaria gentneri	Gentner's mission-bells	C2		C		4	
Galium kamtschaticum	Boreal bedstraw		S			2	16
Gaultheria humifusa	Western wintergreen					1	35,36
Gaultheria ovatifolia	Oregon wintergreen					1	35,36
Goodyera oblongifolia	Rattlesnake plantain					1	35,36
Gymnocarpium dryopteris	Oak fern					1	35,36
Habenaria orbiculata	Large round-leaved rein-orchid					1	35,36
Habenaria saccata	Slender bog orchid					1	35,36
Habenaria unalascensis	Alaska rein-orchid					1	35,36
Haplopappus Whitneyi discoides	Whitney haplopappus			2		2	11, 12, 15
Hemitomes congestum	Gnome plant					2	13,15,35,37
Hieracium scouleri	Woolly-weed					2	39
Hypopitys monotropa	Pinesap					1	13,35,36,37
Lathyrus polyphyllus	Leafy peavine					1	35,38
Linnea borealis longifolia	(No common name)					2	13
Listera borealis	Northern twayblade		S			3	40
Listera caurina	Western twayblade					1	11, 12,35,36,37
Listera convallarioides	Broad-lipped twayblade					1	35,36
Listera cordata	Twayblade				4	1	35,36,37
Luzula hitchcockii	Smooth woodrush					1	35,36
Lysichitum americanum	Skunk cabbage					1	35,36
Melica subulata	Melic grass					1	35,38
Menziesia ferruginea	Fool's huckleberry					1	35,36
Mitella breweri	Brewer's mitrewort					1	35,36
Monotropa uniflora	Indian pipe					1	15,35,36,37
Oxalis oregana	Redwood sorrel					1	13
Phlox adsurgens	Woodland phlox					2	11,12,13
Picea breweriana	Brewer spruce					1	13,35,38
Pityopis californica	Pinefoot					2	2,8,35,37
Platanthera obtusata	Small northern bog orchid		S			3	25
Pleuricospora fimbriolata	Fimbriate pinesap		S			3	8,13,30,35,37
Poa laxiflora	Loose-flowered bluegrass			2		3	20,31
Polystichum munitum var. imbricans	Imbricate sword-fern					2	11,12
Pterospora andromedea	Woodland pinedrops					1	11,12,15,35,36

Appendix 5-B
Vascular Plant Species Closely Associated with Old-Growth Forests (continued)

SCIENTIFIC NAME	COMMON NAME	STATUS FED	STATUS WA	STATUS OR	STATUS CA	CRITERIA FOR OLD-GROWTH ASSOCIATION	REFERENCES
Pyrola asarifolia	Alpine pyrola					1	2,35,36,37,38
Pyrola chlorantha	Greenish wintergreen					1	35,36
Pyrola dentata	Toothleaf pyrola					1	35,38,39
Pyrola picta	White vein pyrola					1	35,36
Pyrola picta ssp. dentata	Nootka wintergreen					2	11,12
Pyrola secunda	One-sided pyrola					1	35,36,37,38
Pyrola uniflora	Single flowered pyrola					1	35,36
Rubus lasiococcus	Dwarf bramble					1	35,38
Rubus nivalis	Snow bramble					1	35,36,37
Rubus pedatus	Fiveleaved bramble					1	35,36
Sarcodes sanguinea	Snow Plant					2	15
Satureja douglasii	Yerba buena					1	35,38
Selaginella oregana	Oregon selaginella					1	35,36
Silene nuda	Not available			2		4	17
Smilacina racemosa	Solomons seal					1	13,35,36
Smilacina stellata	Star-flowered solomon-plume					1	35,36
Streptopus amplexifolius	Clasping-leaved twisted-stalk					1	35,36,37
Streptopus roseus	Rosy twisted-stalk					1	35,36
Streptopus streptopoides	Twisted-stalk					1	35,36
Synthyris schizantha	Fringed synthyris					1	35,36
Taxus brevifolia	Pacific yew					1	2,35,36,37,38
Thuja plicata	Western red cedar					1	35,36,37
Tiarella trifoliata	Three-leaved foamflower					1	35,36,37,38
Tiarella unifoliata	Coolwort foamflower					1	35,38
Trillium ovatum	Wake-robin					1	13,35,36
Trillium ovatum ssp. oettingeri	Salmon Mtns. Wakerobin				4	1	11
Vaccinium alaskaense	Alaska huckleberry					1	35,36
Vaccinium membranaceum	Thin-leaved huckleberry					1	35,36,38
Vaccinium ovalifolium	Oval-leaf huckleberry					1	35,36
Vaccinium parvifolium	Red huckleberry					1	35,38
Vancouveria hexandra	Inside-out flower					1	11,12,13
Vancouveria planipetala	Inside-out flower					1	11,12,13
Vicia americana var. villosa	American vetch					1	35,38
Viola glabella	Pioneer violet					1	35,36
Viola orbiculata	Round-leaved violet					1	35,36
Viola renifolia	Kidney-leaved violet		EX			4	16,33,34
Whipplea modesta	Yerba de Selva					1	13
Xerophyllum tenax	Beargrass					1	35,36,38

Appendix 5-B
Vascular Plant Species Closely Associated With Old-Growth Forests

Key to Status Codes

FED ====> Federally Listed Status of a Species.

Codes used:

E =endangered
C =candidate
C1 =category 1 candidate, taxa for which the U.S. Fish and Wildlife Service has sufficient information to support a proposal to list as threatened or endangered under the Endangered Species Act.
C2 =category 2 candidate, U.S. Fish and Wildlife Service candidates that need additional information to propose as threatened or endangered under the Endangered Species Act.
C3 =taxa which have proven to be more abundant or widespread than previously believed and/or which have no identifiable threats. This status is based only on the most recently published Candidate Notice of Review.

WA ====> Status Listing for Species in Washington

Codes used: Same as codes for Federal.

EX =extinct

OR ====> Status Listing for Species in Oregon

Codes used: Same as codes for Federal.

CA ====> Status Listing for Species in California

Codes used:

Endangered code same as Federal plus:

- For State listed plants
  E = listed endangered
  R = listed rare

Appendix 5-B
Vascular Plant Species Closely Associated With Old-Growth Forests

Key to Status Codes (continued)

- For Federal candidates and Federally listed plants
    - T = Federally listed, threatened
    - 1 = enough data is on file to support the Federal listing
    - 1* = enough data is on file to support Federal listing, but plant presumed extinct
    - 2 = threat and/or distribution data are insufficient to support Federal listing
    - 2* = threat and/or distribution data are insufficient to support Federal listing; presumed extinct
    - 3a = extinct
    - 3b = taxonomically invalid
    - 3c =too widespread and/or not threatened

- California Native Plant Society Codes

1 = List 1; plants extinct, rare or endangered in California and elsewhere
List 1A; presumed extinct
List 1B; rare and endangered in California and elsewhere
2 = List 2; plants rare or endangered in California, but more common elsewhere
3 = List 3; plants about which we need more information
4 = List 4; plants of limited distribution - watch list
Forest Plan Group A; plants most sensitive to habitat manipulation
Forest Plan Group B; plants found in wet meadows, bogs, seeps, etc.
Forest Plan Group C; plants moderately sensitive to habitat manipul.

- California Native Plant Society R-E-D Code

R or "Rarity":

1 = rare, but found in sufficient numbers and distributed widely enough that the potential for extinction or extirpation is low at this time
2 = occurrence confined to several populations or to one extended population
3 = occurrence limited to one or a few highly restricted populations, or present in such small numbers that it is seldom reported

Appendix 5-B
Vascular Plant Species Closely Associated With Old-Growth Forests

Key to Status Codes (continued)

E or "Endangerment":

1 = not endangered
2 = endangered in a portion of its range
3 = endangered throughout its range

D or "Distribution":

1 = more or less widespread outside California
2 = rare outside California
3 = endemic to California

- Forest Service Pacific Southwest Region's Sensitive Plant List 8/90 management sensitivity codes

1 = current or potential threats or jeopardy from Forest management activities
2 = no or minimal threats or jeopardy from Forest management activities
3 = insufficient data at this time to evaluate threats or jeopardy from Forest management activities

Key to criteria for old-growth association: see Table 5-1

Appendix 5-B
Vascular Plant Species Closely Associated With Old-Growth Forests

Reference Codes

1 = number not used
2 = Ruggiero, L.F.; Jones, L.L.C.; Aubry, K.B. 1991b. Plant and animal habitat associations in Douglas-fir forests of the Pacific Northwest: an overview. Pages 447-462 in Ruggiero et al., eds. Wildlife and vegetation of unmanaged Douglas-fir forests. Gen. Tech. Rep. PNW-GTR-285. Portland, OR: USDA Forest Service, Pacific Northwest Research Station. 533 p.
3 = number not used
4 = Bingham, personal communication, May 20, 1992.
5 = Topik, Regional Ecologist, personal communication, 1992.
6 = Six Rivers National Forest. October 1992. FWS candidate or sensitive plant species of the Six Rivers National Forest known or suspected to occur in habitat conservation areas.
7 = Diversity Database California Department of Fish & Game, 1992.
8 = Lisa Hoover, Forest Botanist, Forest TE&S Plants Program, Six Rivers National Forest, 1992.
9 = Marla Knight, Forest Botanist, Forest TE&S Plants Program, Klamath National Forest, 1992.
10 = Dave Esle, Forest Botanist, Forest TE&S Plants Program, Mendocino National Forest, 1992.
11 = Julie Nelson, Forest Botanist, Forest TE&S Plants Program, Shasta-Trinity National Forest, 1992.
12 = Sheila Logan, Zone Ecologist, Ecological Classification Program Data, Shasta-Trinity National Forest, 1992.
13 = Bingham, B. October 1992. Arcata, CA: Old-growth program, Forest Service, Pacific Southwest Research Station.
14 = Vivian Long, Botanist, Shasta-Trinity National Forest, 1992.
15 = Munz, P.A.; Keck, D.D. 1973. A California flora with supplement. Berkeley and Los Angeles, CA: UC Press. 1681 p.
16 = Hitchcock, C.L; Cronquist. 1973. Flora of the Pacific Northwest. Seattle, WA: University of Washington Press.
17 = Carol Tyson, District Botanist, Winema National Forest, 1992.
18 = Cindi O'Neil, District Botanist, Deschutes National Forest, 1992.
19 = Linda Mullens, Botanist, Siskiyou National Forest, 1992.
20 = Larry Scofield, Botany Division of Resources, Salem BLO, Salem, OR., 1992.
21 = number not used
22 = Wayne Rolle, Botanist, Rogue River National Forest, 1992.
23 = Wagner, W.J.; Lord, L.P. 1956. The morphological and cytological distinctress of *Botrychium minganence* and *Botrychium lunaria* in Michigan. Bulletin of the Torrey Botanical Club. 83(4): 261-280.
24 = Steve Rust, Botanist, Wenatchee National Forest, 1992.
25 = Laura Potash, Botanist, Mt Baker-Snoqualmie National Forest, 1992.
26 = Meinke, R.J. Threatened and endangered vascular plants of Oregon: an illustrated guide. Portland, OR: U.S. Fish and Wildlife Service.

Appendix 5-B
Vascular Plant Species Closely Associated With Old-Growth Forests

Reference Codes (continued)

27 = Bierly, K.F.; Stockhouse, R.E., II. 1982. Coast fawn lilly (*Erythronium revolutum*) sensitive species conservation report. Contract # 400-0410-2-384. Prepared for USDA Forest Service, Siuslaw National Forest.
28 = John Gamon, Botanist, Washington National Heritage Program, 1992.
29 = Moldenke, A. 1981. Endangered and threatened plant status report. Eugene, OR: USDA Forest Service, Willamette National Forest.
30 = Species management guide for *Pleuricospora fimbriolata*. 1988. USDA Forest Service, Gifford Pinchot National Forest.
31 = Species management guide for loose-flowered bluegrass *Poa laxiflora*. 1988. USDA Forest Service, Siuslaw National Forest.
32 = Linda Kunze, Wetlands Ecologist, Washington Natural Heritage Program, 1992.
33 = An illustrated guide to the endangered, threatened and sensitive vascular plants of Washington. 1981. Olympia, WA: Washington Natural Heritage Program.
34 = Hulten, E. 1968. Flora of Alaska and neighboring territories. Stanford, CA: Stanford University Press.
35 = R-6 Ecology Data Base Analysis (Robin Lesher). Oct - Nov 1992.
36 = Jan Henderson and Robin Lesher, Ecologists, Mt. Baker-Snoqualmie and Olympic National Forests, 1992.
37 = Cindy McCain, Ecologist and Jenny Dimling, Botanist, Willamette National Forest, 1992.
38 = Tom Atzet, Pat Martinez and Lisa McCrimmon, Ecologist, Rogue River and Siskiyou National Forests, 1992.
39 = Brad Smith, Ecologist, Wenatchee and Okanogan National Forests, 1992.
40 = George Wooton, Botanist, Okanogan National Forest, 1992.

Additional Sources/References:

Eastman, D.C. 1990. Rare and endangered plants of Oregon. Beautiful America Publishing Co.

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Appendix 5-C

Fish Species and Stocks at Risk in National Forests Within the Range of the Northern Spotted Owl

Appendix 5-C
Fish Species and Stocks at Risk in National Forests Within the Range of the Northern Spotted Owl.

Anadromous Fish

Forest	Species/Race	Stock
California		
Mendocino	Chinook	
	Fall	Lower Eel River
	Steelhead Trout	
	Winter	Sacramento River
	Summer	Eel River
Six Rivers	Chinook Salmon	
	Spring/ Summer	Klamath River Smith River
	Fall	Lower Klamath River Tributaries Smith River
	Coho Salmon	Klamath River
	Steelhead Trout	
	Summer	Eel River Mad River Smith River Klamath River
	Coastal Cutthroat	California Coastal Streams
Shasta-Trinity	Chinook	
	Spring/ Summer	Klamath River
	Fall	Lower Klamath River Tributaries
	Steelhead Trout	
	Winter	Sacramento River
	Summer	Klamath River
Klamath	Chinook	
	Spring/ Summer	Klamath River
	Fall	Lower Klamath River Tributaries
	Coho Salmon	Klamath River
	Steelhead Trout	
	Summer	Klamath River

Appendix 5-C
Fish Species and Stocks at Risk in National Forests Within the Range of the Northern Spotted Owl.

Anadromous Fish (continued)

Forest	Species/Race	Stock
Oregon		
Mt. Hood	Chinook Salmon	
	Spring/ Summer	Sandy River Hood River
	Fall	Hood River
	Coho Salmon	Clackamas River Sandy River Hood River
	Steelhead Trout	
	Winter	Lower Columbia River Tributaries above Bonneville Dam Clackamas River Hood River Fifteen Mile Creek
	Summer	Lower Columbia River Tributaries above Bonneville Dam Hood River
	Sea-run Cutthroat Trout	Hood River
Willamette	Chinook Spring/ Summer	Willamette River
	Steelhead Winter	Calapooia River
Siuslaw	Chinook Salmon	
	Spring/ Summer	Alsea River Siletz River
	Fall	Yachats River Yaquina River
	Coho Salmon	Siuslaw River Umpqua River Yachats River Alsea River

Appendix 5-C
Fish Species and Stocks at Risk in National Forests Within the Range of the Northern Spotted Owl.

Anadromous Fish (continued)

Forest	Species/Race	Stock
Siuslaw (continued)	Coho Salmon	Beaver Creek Siletz River Salmon River Nestucca River
	Chum Salmon	Umpqua River Alsea River Yaquina River Siletz River Nestucca River
	Steelhead Trout Winter	 Siuslaw River Big Creek Tenmile Creek Yachats River Alsea River Yaquina River Siletz River Salmon River Nestucca River
	Summer	Siletz River
	Sea-run Cutthroat Trout	Oregon Coastal Streams
Umpqua	Chinook Salmon Spring/ Summer	South Umpqua
	Coho Salmon	Umpqua River
	Chum Salmon	Umpqua River
	Sea-run Cutthroat Trout	Oregon Coastal Streams
Siskiyou	Chinook Salmon Spring/ Summer	Coquille River
	Fall	Winchuck River Pistol River Rogue River
	Coho Salmon	Winchuck River Chetco River Pistol River Rogue River

Appendix 5-C
Fish Species and Stocks at Risk in National Forests Within the Range of the Northern Spotted Owl.

Anadromous Fish (continued)

Forest	Species/Race	Stock
Siskiyou (continued)	Coho Salmon	Elk River Sixes River Coquille River
	Chum Salmon	Elk River Sixes River
	Steelhead Trout Winter Summer	 Illinois River Rogue River
	Sea-run Cutthroat Trout	Oregon Coastal Streams
Rogue River	Coho Salmon	Rogue River
Washington		
Mt. Baker-Snoqualmie	Chinook Salmon Spring/ Summer	White River Stillaguamish River North Fork Nooksack River South Fork Nooksack River
	Coho Salmon	Nooksack River
	Steelhead Trout Winter	 Nooksack River
	Summer	Stillaguamish River Nooksack River
Olympic	Chinook Salmon Spring/ Summer	Skokomish River Dosewallips River Dungeness River Elwha River Wynoochee River
	Fall	Duckabush River Dosewallips River Dungeness River
	Coho Salmon	Lyre River Elwha River
	Chum Salmon	Hood Canal (early-timed) Elwha River

Appendix 5-C

Fish Species and Stocks at Risk in National Forests Within the Range of the Northern Spotted Owl.

Anadromous Fish (continued)

Forest	Species/Race	Stock
Olympic (continued)	Pink Salmon	Skokomish River Dungeness River Elwha River
	Steelhead Trout Winter	 Skokomish River
	Sea-run Cutthroat Trout	Washington Coastal and Puget Sound Tributaries (except Grays Harbor and Hood Canal Tributaries) Grays Harbor and Hood Canal Tributaries
Gifford Pinchot	Steelhead Trout Winter	 Lower Columbia River Tributaries above Bonneville Dam Toutle River Wind River
	Summer	Wind River
	Sea-run Cutthroat Trout	Toutle River Kalama River
Wenatchee	Sockeye Salmon	Wenatchee River
	Steelhead Trout Summer	 Wenatchee River Entiat River
Okanogan	Chinook Salmon Spring/ Summer	 Methow River Okanogan River
	Steelhead Trout Summer	Methow River Okanogan River

NOTE: Some stocks occur in more than one river system or National Forest.

Appendix 5-C

Fish Species and Stocks at Risk in National Forests Within the Range of the Northern Spotted Owl.

Resident Fish

Forest	Species
Shasta-Trinity	Red-band Trout
Mt. Hood	Red-band Trout
Willamette	Bull Trout
	Oregon Chub
Umpqua	Oregon Chub
Rogue River	Bull Trout
Deschutes	Bull Trout
Winema	Bull Trout
Mt. Baker-Snoqualmie	Bull Trout
Olympic	Olympic Mudminnow
Gifford Pinchot	Bull Trout
Wenatchee	Bull Trout
Okanogan	Bull Trout

Species Names

Common Name	Scientific Name
Chinook salmon	*Oncorhynchus tshawytscha*
Coho salmon	*O. kisutch*
Steelhead trout	*O. mykiss*
Redband trout	*O. mykiss gibbsi*
Sea-run cutthroat trout	*O. clarkii clarkii*
Sockeye salmon	*O. nerka*
Chum salmon	*O. keta*
Pink salmon	*O. gorbuscha*
Bull trout	*Salvelinus confluentus*
Oregon Chub	*Oregonichthys crameria*
Olympic mudminnow	*Novumbra hubbsi*

References

Nehlsen, W.; Williams, J.W.; Lichatowich, J.A. 1991. Pacific salmon at the crossroads: stocks at risk from California, Oregon, Idaho, and Washington. Fisheries. 16(2): 4-21.

Williams, J.E.; Johnson, J.E.; Hendrickson, D.A.; [and others]. 1989. Fishes of North America endangered, threatened, and of special concern. Fisheries. 14(6): 2-20.

Appendix 5-D

Attributes of Terrestrial (Non-Fish) Vertebrates Closely Associated With Old-Growth Forests in National Forests Within the Range of the Northern Spotted Owl ("Short List")

Table of Contents

Appendix 5-D
Terrestrial Vertebrates ("Short List") - Amphibians and Reptiles

P=Primary; S=Secondary
/=most/less use; ( )=equal use; *=spec. hab. req.

Canopy: <=25% (Sparse); young growth w/ legacies (Comp); classic old growth (Class. OG)

Species	Breeding, foraging, and resting habitat								Microhabitat				
	Successional stages					Old growth stand structural stages							
	Young		Mid	Late successional									
	Grass/forb	Shrub/sap	Pole	Mature	Old growth	Sparse	Comp	Class. OG	Talus	Logs	Duff/litt	Lg snags	Lg tree
Amphibians													
Oregon Slender salamander	S	P/S	(PS)	(PS)	P/S		X	X		X			
Larch Mt. salamander			S	P	P				X				
Siskiyou Mt. salamander			P	P	P (assumed				X				
Del Norte salamander			S/P	S/P	P/S	X			X				
Van Dyke's salamander			S	(PS)	P/S			X	X	X	X		
Dunn's salamander	S	S	S/P	(PS)	P		X	X	X	X	X		
Black salamander	(PS)	(PS)	P/S	(PS)	(PS)	X	X	X	X	X	X		
California slender salamander	S	S/P	(PS)	P/S	P/S		X	X	X	X	X		
Clouded salamander	P	P	(PS)	S	(PS)	X	X	X	X	X	X	X	X
Pacific giant salamander			(PS)	(PS)	P/S	X	X	X	X	X	X		
Cope's giant salamander	P*	P*	(PS)*	(PS)*	P*		X	X			X		
Olympic salamander			P/S	P/S	P				X				
Northwestern salamander	(PS)	(PS)	S	(PS)	P/S		X	X		X	X		
Shasta salamander				P	P	X		X	X	X			
Roughskin newt	(PS)	(PS)	(PS)	P/S	P/S		X	X		X	X		
Tailed frog	S	S	P/S	P/S	P/S		X	X	X	X			
16 amphibian species													
Reptiles													
0 reptile species													

* = special habitat features required

Appendix 5-D
Terrestrial Vertebrates ("Short List") - Amphibians and Reptiles (continued)

Species	Dispersal capability: Stand (~<60 ac)	Dispersal capability: Landscape (~<1-5K ac)	Dispersal capability: Range (across provinces)	Lehmkuhl vulner. risk rating	Brown versatil. rating	Migratory or resident (m or r)	Strong riparian assoc.?
Amphibians							
Oregon Slender salamander	X			28	20	R	
Larch Mt. salamander	X			28	10	R	
Siskiyou Mt. salamander	X			28	16	R	
Del Norte salamander	X				16	R	
Van Dyke's salamander	X			28	18	R	X
Dunn's salamander	X			24	14	R	X
Black salamander	X				18	R	X
California slender salamander	X				26	R	
Clouded salamander	X			30	22	R	
Pacific giant salamander	X			29	17	R	X
Cope's giant salamander	X					R	X
Olympic salamander	X			28	13	R	X
Northwestern salamander	X			23	19	R	X
Shasta salamander	X					R	X
Roughskin newt	X			23	19	R	X
Tailed frog	X			24	14	R	X

16 amphibian species

Reptiles

0 reptile species

Appendix 5-D
Terrestrial Vertebrates ("Short List") - Amphibians and Reptiles (continued)

Species	Presence													
	By state			By physiographic province (from Draft Recovery Plan)										
				Washington				Oregon				California		
	WA	OR	CA	OLPE	WACA	WACAE	WA Lowln	ORCAW	ORCAE	OCOR	OR KLAM	CA KLAM	CA Cas	CA Coast
Amphibians														
Oregon Slender salamander		X						X	X					
Larch Mt. salamander	X	X			X			X	X					
Siskiyou Mt. salamander		X	X								X	X		
Del Norte salamander		X	X								X	X		X
Van Dyke's salamander	X			X	X	X	X							
Dunn's salamander	X	X	X				X	X	X	X	X			X
Black salamander		X	X								X	X	X	X
California slender salamander		X	X								X			X
Clouded salamander		X	X					X	X	X	X	X		X
Pacific giant salamander	X	X	X		X	X	X	X	X	X	X	X	X	X
Cope's giant salamander	X	X		X	X	X	X	X	X	X				
Olympic salamander	X	X	X	X	X	X	X	X	X	X	X	X		X
Northwestern salamander	X	X	X	X	X	X	X	X	X	X	X	X		X
Shasta salamander			X										X	
Roughskin newt	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Tailed frog		X	X	X	X	X		X	X	X	X	X		X
16 amphibian species														
Reptiles														
0 reptile species														

Appendix 5-D
Terrestrial Vertebrates ("Short List") - Amphibians and Reptiles (continued)

Species	Degree of endemism: Broad (not really endemic to the range of the NSO)	Local (is endemic to the range of the NSO)	Restricted (very tiny range)	General abundance within NSO range (qualit. rank: S = scarce everywhere, C = common somewhere)	Population trend w/in NSO range: Increasing	Stable	Decreasing	References
Amphibians								
Oregon Slender salamander								
Larch Mt. salamander								
Siskiyou Mt. salamander		X		C			** X	2,3a,21-9
Del Norte salamander			X	S			** X	2,3a,21-9
Van Dyke's salamander			X	C			** X	2,3a,21-2,21-9
Dunn's salamander		X		S			** X	2,21-2,21-9
Black salamander	X	(x popn.)		C			** X	2,3a,21-9
California slender salamander		X		C			** X	2,3a,21-9
Clouded salamander	X			C			** X	2,21-9
Pacific giant salamander	X			C		X		2,21-9
Cope's giant salamander	X			C			** X	2,3a,14a,21-2,21-9
Olympic salamander	X			C?			** X	2,3a,21-2,21-9
Northwestern salamander		X		S			** X	21-9
Shasta salamander	X			C			** X	2,3a,21-2,21-9
Roughskin newt		X		C		X		2,3a,21-2,21-9
Tailed frog			X	S			** X	21-2
16 amphibian species	X			C			** X	2,3a,3b,21-2,21-9
Reptiles	X			S			** X	2,3a,21-2,21-9
0 reptile species								

Appendix 5-D
Terrestrial Vertebrates ("Short List") - Amphibians and Reptiles (continued)

Species	Comments
Amphibians	
Oregon Slender salamander	
Larch Mt. salamander	
Siskiyou Mt. salamander	
Del Norte salamander	
Van Dyke's salamander	Disjunct pops in w. WA and so. ID
Dunn's salamander	rocks, streams, waterfalls (Beatty and Blaustein 1992)
Black salamander	
California slender salamander	
Clouded salamander	
Pacific giant salamander	
Cope's giant salamander	
Olympic salamander	
Northwestern salamander	
Shasta salamander	uses limestone areas
Roughskin newt	OG associate in WA only (Ruggiero et al. 1991)
Tailed frog	
16 amphibian species	
Reptiles	
0 reptile species	

Appendix 5-D
Terrestrial Vertebrates ("Short List") - Birds Part 1

P=Primary; S=Secondary

/=most/less use; ( )=equal use; *=spec. hab. req.

						Canopy: <=25%	young growth w/ legacies	classic old growth					
	Breeding, foraging, and resting habitat												
	Successional stages					Old growth stand structural stages							
	Young		Mid	Late successional					Microhabitat				
Species	Grass/forb	Shrub/sap	Pole	Mature	Old growth	Sparse	Comp	Class. OG	Talus	Logs	Duff/litt	Lg snags	Lg tree
BIRDS													
Marbled murrelet			S	S	P			X					X
Barrow's goldeneye				P	P			X				X	
Bufflehead				P	P			X				X	
Wood duck				P	P			X		X		X	
Hooded merganser				P	P			X				X	
Common merganser				P	P			X				X	X
Harlequin duck			P	P	P								
Northern goshawk			S	P/S	P/S	X		X					X
Bald eagle	S			S	(PS)	X		X				X	X
Barred owl			S	(PS)	(PS)	X		X				X	
Northern pygmy-owl	S	S	S	P/S	P/S	X		X				X	
Northern spotted owl			S	S	P/S	X		X				X	X
Flammulated owl	P	P		P	P	X	X	X				X	
Great gray owl				P	P			X				X	X
Vaux's swift	P	P	S	S	P/S	X	X	X				X	X
Pileated woodpecker	S		S	S	P/S	X		X		X		X	X
Hairy woodpecker			S	S	P/S	X		X		X		X	
White-headed woodpecker			S	S	S/P			X				X	
Black-backed woodpecker			S	S/P	(PS)	X		X				X	
Three-toed woodpecker			S	(SP)	P/S	X		X		X		X	
Red-breasted sapsucker			S	S	S	X						X	

Appendix 5-D
Terrestrial Vertebrates ("Short List") - Birds Part 1 (continued)

	~ <60 ac	~ <1-5K ac	across provinces				
	Dispersal capability			Lehmkuhl vulner. risk rating	Brown versatil. rating	Migratory or resident (m or r)	Strong riparian assoc.?
Species	Stand	Landscape	Range				
BIRDS							
Marbled murrelet				24	6	R/D	X
Barrow's goldeneye				27	9	M/D/R	X
Bufflehead				27	9	M/R	X
Wood duck				27	25	M/R	X
Hooded merganser				27	12	D/M/R	X
Common merganser				27	9	D	X
Harlequin duck					6	M	X
Northern goshawk				26	19	E	
Bald eagle					19	D/R	X
Barred owl					21	R	
Northern pygmy-owl					36	R	
Northern spotted owl				26	12	R	
Flammulated owl						M	
Great gray owl						R	
Vaux's swift				27	34	M	
Pileated woodpecker				27	27	R	
Hairy woodpecker				22	22	R	
White-headed woodpecker					12	E/R	
Black-backed woodpecker					16	R	
Three-toed woodpecker					15	D/M	
Red-breasted sapsucker			X	26	26	D/R	

Appendix 5-D
Terrestrial Vertebrates ("Short List") - Birds Part 1 (continued)

	Presence													
	By state			By physiographic province (from Draft Recovery Plan)										
				Washington				Oregon				California		
Species	WA	OR	CA	OLPE	WACA	WACAE	WA Lowln	ORCAW	ORCAE	OCOR	OR KLAM	CA KLAM	CA Cas	CA Coast
BIRDS														
Marbled murrelet	X	X	X	X	X	X	X			X	X	X		X
Barrow's goldeneye	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Bufflehead	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Wood duck	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Hooded merganser	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Common merganser	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Harlequin duck	X	X	X	X	X	X	X	X	X	X	X			X
Northern goshawk	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Bald eagle	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Barred owl	X	X		?	X	X	X	X	X					
Northern pygmy-owl		X	X	X	X	X	X	X	X	X	X	X	X	X
Northern spotted owl	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Flammulated owl	X	X	X			X		X	X		?	X	X	X
Great gray owl		X						X	X		X			
Vaux's swift	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Pileated woodpecker	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Hairy woodpecker	X	X	X	X	X	X	X	X	X	X	X	X	X	X
White-headed woodpecker	X	X	X			X		X	X		X	X	X	X
Black-backed woodpecker	X	X	X		X	X		X	X		X	X	X	
Three-toed woodpecker	X	X			X			X						
Red-breasted sapsucker	X	X	X	X	X		X	X	X	X	X	X	X	X

Appendix 5-D
Terrestrial Vertebrates ("Short List") - Birds Part 1 (continued)

Species	Degree of endemism: Broad (not really endemic to the range of the NSO)	Local (is endemic to the range of the NSO)	Restricted (very tiny range)	General abundance within NSO range (qualit. rank: S = scarce everywhere, C = common somewhere)	Population trend w/in NSO range: Increasing	Stable	Decreasing	References
BIRDS								
Marbled murrelet	X			S			X	2,3,5,7,9,16a,16b,21-10,21-12
Barrow's goldeneye	X			S			X	2,3,5,16a,16b,21-8,21-12
Bufflehead	X			C			?	2,3,5,9,16a,16b,21-8,21-12
Wood duck	X			C			?	2,3,5,16a,16b,21-8,21-12
Hooded merganser	X			S				2,3,5,16a,16b,21-8,21-12
Common merganser	X			C				2,3,16a,16b,21-8,21-12
Harlequin duck	X			S			X	1,2,5,7,9,16a,16b,21-8,21-12
Northern goshawk	X	X'(OLY)		S			X	2,3,6,9,16a,16b,21-8,21-12
Bald eagle	X			S		?		1,2,7,16a,16b,21-1,21-6,21-8,21-12
Barred owl	X			C	X			2,16a,16b,12-8,21-12
Northern pygmy-owl	X			C				2,4,5,9,16a,16b,21-8,21-12
Northern spotted owl	X	X		S			X	2,3,5,16a,16b
Flammulated owl	X			C	Sharp - insufficient data			5,7,9,16a,16b,21-1,21-6,21-12
Great gray owl	X			S			X	5,9,16a,16b,21-1,21-12
Vaux's swift	X			C		X		2,3,4,7,16a,16b,13,21-6,21-8,21-12
Pileated woodpecker	X			S			X	2,3,4,5,7,9,14b,16a,16b,21-1,21-8,21
Hairy woodpecker	X			C			X	2,3,4,14b,16a,16b,21-1,21-8,21-12
White-headed woodpecker	X			S				2,7,9,16a,16b,21-1,21-8,21-12
Black-backed woodpecker	X			S			?	2,9,16a,16b,21-1,21-8,21-12
Three-toed woodpecker	X			S				2,9,16a,16b,21-8
Red-breasted sapsucker	X			C			X	1,2,3a,4,5,14b,16b,21-8,21-12

Appendix 5-D
Terrestrial Vertebrates ("Short List") - Birds Part 1 (continued)

Species	Comments
BIRDS	
Marbled murrelet	
Barrow's goldeneye	
Bufflehead	
Wood duck	
Hooded merganser	
Common merganser	
Harlequin duck	
Northern goshawk	
Bald eagle	
Barred owl	
Northern pygmy-owl	
Northern spotted owl	
Flammulated owl	
Great gray owl	
Vaux's swift	
Pileated woodpecker	
Hairy woodpecker	
White-headed woodpecker	
Black-backed woodpecker	
Three-toed woodpecker	
Red-breasted sapsucker	

Appendix 5-D
Terrestrial Vertebrates ("Short List") - Birds Part 2

P=Primary; S=Seoondary
/=most/less use; ( )=equal use; *=spec. hab. req.

Species	Breeding, foraging, and resting habitat								Microhabitat				
	Successional stages					Old growth stand structural stages							
	Young		Mid	Late successional		Canopy: <=25%	young growth w/ legacies	classic old growth					
	Grass/forb	Shrub/sap	Pole	Mature	Old growth	Sparse	Comp	Class. OG	Talus	Logs	Duff/litt	Lg snags	Lg tree
Williamson's sapsucker			S	S	S	X						X	
Northern flicker	P	S	S	P/S	P/S	X		X		X		X	
Western flycatcher				S	P	X		X					
Hammond's flycatcher			S	(PS)	P			X					X
Chestnut-backed chickadee		S	P	P	P	X	X	X				X	
Brown creeper			S	P/S*	P/S*	X		X				X	
Red-breasted nuthatch			S	P	P	X		X		X		X	
White breasted nuthatch		S	S	P	P	X		X				X	X
Pygmy nuthatch			S	P	P	X		X				X	
Winter wren		P	S	P	P		X	X		X			
Golden-crowned kinglet		S	P/S	P/S	P	X							
Hermit thrush		P	(PS)	P	P/S*	X							
Varied thrush		P	S	P/S*	P/S*	X							
Hermit warbler			P/S	P/S	P/S	X							
Wilson's warbler		P	S	S/P	S/P								
Warbling vireo		S/P	S/P	S	P	X							
Red crossbill			S	P/S	P/S	X							

38 bird species

S* = secondary use in subalpine and lodgepole veg types only

Appendix 5-D
Terrestrial Vertebrates ("Short List") - Birds Part 2 (continued)

Species	Dispersal capability: Stand (~<60 ac)	Dispersal capability: Landscape (~<1-5K ac)	Dispersal capability: Range (across provinces)	Lehmkuhl vulner. risk rating	Brown versatil. rating	Migratory or resident (m or r)	Strong riparian assoc.?
Williamson's sapsucker			X		15	D/M	
Northern flicker			X	24	33	R	
Western flycatcher			X		24	M	
Hammond's flycatcher			X	25	26	M	
Chestnut-backed chickadee			X	13	28	R	
Brown creeper			X	19	29	R	
Red-breasted nuthatch			X	19	24	R	
White breasted nuthatch			X		17	R	
Pygmy nuthatch			X		8	R	
Winter wren			X	14	27	D	
Golden-crowned kinglet			X	16	27	R	
Hermit thrush			X	23	30	D/E	
Varied thrush			X	20	28	D/E	
Hermit warbler			X	18	25	M	
Wilson's warbler			X	24	33	M	
Warbling vireo			X		26	M	
Red crossbill			X	23	23	R	

38 bird species

Appendix 5-D
Terrestrial Vertebrates ("Short List") - Birds Part 2 (continued)

	Presence													
	By state			By physiographic province (from Draft Recovery Plan)										
				Washington				Oregon				California		
Species	WA	OR	CA	OLPE	WACA	WACAE	WA Lowln	ORCAW	ORCAE	OCOR	OR KLAM	CA KLAM	CA Cas	CA Coast
Williamson's sapsucker	X	X	X			X			X		X	X	X	
Northern flicker	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Western flycatcher	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Hammond's flycatcher	X	X	X	X	X	X	X	X	X			X	X	
Chestnut-backed chickadee	X	X	X	X	X	X	X	X		X	X	X	X	X
Brown creeper	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Red-breasted nuthatch	X	X	X	X	X	X	X	X	X	X	X	X	X	X
White breasted nuthatch	X	X	X		X	X	X	X	X	X	X	X	X	X
Pygmy nuthatch	X	X	X			X			X			X	X	X
Winter wren	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Golden-crowned kinglet	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Hermit thrush	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Varied thrush	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Hermit warbler	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Wilson's warbler	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Warbling vireo	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Red crossbill	X	X	X	X	X	X	X	X	X	X	X	X	X	X

38 bird species

Appendix 5-D
Terrestrial Vertebrates ("Short List") - Birds Part 2 (continued)

	not really endemic to the range of the NSO	is endemic to the range of the NSO	very tiny range	qualit. rank: S = scarce everywhere C = common somewhere				
	Degree of endemism			General abundance within	Population trend w/in NSO range			
Species	Broad	Local	Restricted	NSO range	Increasing	Stable	Decreasing	References
Williamson's sapsucker	X			C		X		2,5,13,21-1,21-8,21-12
Northern flicker	X			C			X	2,3a,3b,4,5,14b,16a,21-8,21-12
Western flycatcher	X			C			X	1,2,4,5,14b,16b,21-8,21-12
Hammond's flycatcher	X			C			X	1,2,3a,4,5,13,14b,21-8,21-12
Chestnut-backed chickadee	X			C			X	1,2,3a,3b,4,5,14b,16a,21-8,21-12
Brown creeper	X			C			X	1,2,3a,4,5,14b,16a,21-8,21-12
Red-breasted nuthatch	X			C			X	1,2,3a,4,5,14b,16a,21-8,21-12
White breasted nuthatch	X			C			X	2,3b,4,5,14b,16a,21-8,21-12
Pygmy nuthatch	X			C				2,5,16a,21-8,21-12
Winter wren	X			C			X	1,2,3a,4,5,14b,16a21-8,21-12
Golden-crowned kinglet	X			C			X	2,3a,3b,4,5,14b,16a,21-8,21-12
Hermit thrush	X			C			X	1,2,3a,4,5,13,14b,21-8,21-12
Varied thrush	X			C				2,3a,3b,4,5,16b,21-8,21-12
Hermit warbler	X			C			X	1,2,3a,4,5,14b,21-8,21-12
Wilson's warbler	X			C		X		1,2,3a,4,5,13,14a,21-8,21-12
Warbling vireo	X			C			X	1,2,4,5,13,14b,16a,21-8,21-12
Red crossbill	X			C			X	2,3a,3b,4,5,14b,16a,21-8,21-12

38 bird species

Appendix 5-D
Terrestrial Vertebrates ("Short List") - Birds Part 2 (continued)

Species	Comments
Williamson's sapsucker	
Northern flicker	assoc'd w/ open forests
Western flycatcher	incr. assoc'n with stand age (Marcot 1985)
Hammond's flycatcher	
Chestnut-backed chickadee	incr. assoc'n with stand age (Marcot 1985)
Brown creeper	
Red-breasted nuthatch	+/- equal use pole & med sawt stages (Marcot 1985)
White breasted nuthatch	
Pygmy nuthatch	
Winter wren	shifts to late shrub stage in fall (Marcot 1985)
Golden-crowned kinglet	
Hermit thrush	
Varied thrush	
Hermit warbler	
Wilson's warbler	
Warbling vireo	
Red crossbill	

38 bird species

Appendix 5-D
Terrestrial Vertebrates ("Short List") - Mammals Part 1

P=Primary; S=Secondary
/=most/less use; ( )=equal use; *=spec. hab. req.

	Breeding, foraging, and resting habitat								Microhabitat				
	Successional stages					Old growth stand structural stages							
	Young		Mid	Late successional		Canopy: <=25%	young growth w/ legacies	classic old growth					
Species	Grass/forb	Shrub/sap	Pole	Mature	Old growth	Sparse	Comp	Class. OG	Talus	Logs	Duff/litt	Lg snags	Lg tree
MAMMALS													
Marten			S	P	P			X		X		X	X
Fisher			S	P	P	X		X	X	X		X	X
Dusky-footed woodrat		P	P	P	P	X	X	X		X	X		
Northern flying squirrel			S	P	P	X		X		X		X	X
Douglas squirrel		P	P	P	P	X	X	X		X		X	X
Townsend's chipmunk	S	S	P/S	P/S	P/S		X	X	X	X			
Red tree vole (P.longicaudus)			(PS)	S/P	S/P	X	X	X			X		X
Red tree vole (P.pomo)											X		X
Western red-backed vole			P	P	P	X	X	X		X	X	X	
Southern red-backed vole			P	P	P		X	X	X	X			
Forest deer mouse				P	P			X		X			
Deer mouse	S	P	(PS)	S	S	X	X		X	X	X	X	
Pacific shrew	S	P/S	S	S	S	X	X			X	X		
Shrew-mole	S	S	S/P	P/S	S/P		X	X		X	X		
Big brown bat	P/S		S	S/P	P/S	X		X				X	
Silver- haired bat	P		P	S/P	P/S	X	X	X				X	
Hoary bat		P	P	P/S	P/S	X	X	X					X
Long-legged myotis	S	P	S/P	P/S	P/S		X	X				X	X
Yuma myotis	P	P	S/P	P	P		X	X				X	
California myotis	P/S	S/P	P	P/S	S/P	X	X	X		X		X	X
Keen's myotis	P/S	P/S	S	S/P	S/P		X	X				X	

Appendix 5-D
Terrestrial Vertebrates ("Short List") - Mammals Part 1 (continued)

Species	Dispersal capability: Stand (~<60 ac)	Dispersal capability: Landscape (~<1-5K ac)	Dispersal capability: Range (across provinces)	Lehmkuhl vulner. risk rating	Brown versatil. rating	Migratory or resident (m or r)	Strong riparian assoc.?
MAMMALS							
Marten			X	26	23	R	X
Fisher			X	26	23	R	
Dusky-footed woodrat		?			28		?(rec plan)
Northern flying squirrel		?		28	26	R	
Douglas squirrel		?		28	26	R	
Townsend's chipmunk	X				32	R	
Red tree vole (P.longicaudus)	X			28	14	R	
Red tree vole (P.pomo)	X						
Western red-backed vole	X			21	16	R	
Southern red-backed vole	X			18	19	R	
Forest deer mouse	X			27		R	
Deer mouse	X				42	R	
Pacific shrew	X			28	28	R	X
Shrew-mole	X			226	34	R	X
Big brown bat			?	25	33	R	X
Silver- haired bat			?	25	28	M/R	
Hoary bat			?		25	M	X
Long-legged myotis			?	25	32	M/R	X
Yuma myotis			?	25	30	?	Feeding
California myotis			?	25	27	R	
Keen's myotis		?		25	21	?	Feeding

Appendix 5-D
Terrestrial Vertebrates ("Short List") - Mammals Part 1 (continued)

	Presence													
	By state			By physiographic province (from Draft Recovery Plan)										
				Washington				Oregon				California		
Species	WA	OR	CA	OLPE	WACA	WACAE	WA Lowln	ORCAW	ORCAE	OCOR	OR KLAM	CA KLAM	CA Cas	CA Coast
MAMMALS														
Marten	X	X	X	X	X	X	X	X	X	X	X	X		
Fisher	X	X	X	X	X	X		X	X	X	X	X		X
Dusky-footed woodrat		X	X					X		X	X	X	X	X
Northern flying squirrel	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Douglas squirrel	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Townsend's chipmunk	X	X		X	X	X	X	X	X	X	X			
Red tree vole (P.longicaudus)		X						X	X	X	X			
Red tree vole (P.pomo)			X								X		X	
Western red-backed vole		X	X					X	X	X	X	X	X	
Southern red-backed vole	X			X	X	X	X							
Forest deer mouse	X			X	X	X	X							
Deer mouse	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Pacific shrew		X	X							X	X	X	X	X
Shrew-mole	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Big brown bat	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Silver- haired bat	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Hoary bat	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Long-legged myotis	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Yuma myotis	X	X	X	X	X	X	X	X	X	X	X	X	X	X
California myotis	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Keen's myotis	X			X			X							

Appendix 5-D
Terrestrial Vertebrates ("Short List") - Mammals Part 1 (continued)

Species	Degree of endemism: Broad (not really endemic to the range of the NSO)	Local (is endemic to the range of the NSO)	Restricted (very tiny range)	General abundance within NSO range (qualit. rank: S = scarce everywhere; C = common somewhere)	Population trend w/in NSO range: Increasing	Stable	Decreasing	References
MAMMALS								
Marten	X			S			X	1,2,3a,5,21-1,21-11
Fisher	X			S			X	2,3a,5,21-1,21-11
Dusky-footed woodrat	X			C				1,2,3a,5,21-3,21-4,21-11
Northern flying squirrel	X			C				1,2,3a,5,21-3,21-11
Douglas squirrel	X			C				2,3a,5,21-3,21-5,21-11
Townsend's chipmunk		X		C				1,2,3a,5,21-4,21-5,21-11
Red tree vole (P.longicaudus)		X		S				1,2,3a,5,11a,21-4
Red tree vole (P.pomo)	X							1,2,5,21-11
Western red-backed vole		X		C				1,2,3a,5,19,21-4,21-11
Southern red-backed vole		X						1,2,3a,5,21-5
Forest deer mouse	X							1,2,3a,3b,21-5
Deer mouse	X			C				2,3a,5,21-3,21-5,21-11
Pacific shrew	X			C				2,3a,5,21-4,21-11
Shrew-mole	X							1,2,3a,5,21-3,21-5,21-11
Big brown bat	X			C				2,3a,5,21-3,21-11
Silver- haired bat	X							2,5,11c,21-3,21-5,21-11
Hoary bat	X			C				2,5,21-3,21-11
Long-legged myotis	X			C				2,3a,5,21-3,21-5,21-11
Yuma myotis	X			C				2,3a,5,19,21-3,21-11
California myotis	X			C				1,2,3a,5,19,21-3,21-11
Keen's myotis		X						2,3a,21-5

Appendix 5-D
Terrestrial Vertebrates ("Short List") - Mammals Part 1 (continued)

Species	Comments
MAMMALS	
Marten	
Fisher	
Dusky-footed woodrat	
Northern flying squirrel	
Douglas squirrel	
Townsend's chipmunk	
Red tree vole (P.longicaudus)	
Red tree vole (P.pomo)	little data available on habitat needs
Western red-backed vole	
Southern red-backed vole	
Forest deer mouse	
Deer mouse	
Pacific shrew	
Shrew-mole	
Big brown bat	
Silver- haired bat	
Hoary bat	
Long-legged myotis	
Yuma myotis	
California myotis	
Keen's myotis	

Appendix 5-D
Terrestrial Vertebrates ("Short List") - Mammals Part 2

P=Primary; S=Secondary
/=most/less use; ( )=equal use; *=spec. hab. req.

Species	Breeding, foraging, and resting habitat: Successional stages: Young		Mid	Late successional		Old growth stand structural stages			Microhabitat				
	Grass/forb	Shrub/sap	Pole	Mature	Old growth	Sparse (Canopy: <=25%)	Comp (young growth w/ legacies)	Class. OG (classic old growth)	Talus	Logs	Duff/litt	Lg snags	Lg tree
Long-eared myotis		S	S/P	(PS)	P/S	Feeding	X	X				X	X
Fringed myotis	P	P	S	S	S	Feeding							
Little brown myotis	P	P	S/P	(PS)	P/S	X	X	X		X		X	
Lynx	P	P	P/S	P/S	P/S								
Elk	P/S	P/S	P/S	(PS)	(PS)	X							

26 mammal species

Species	Dispersal capability: Stand (~<60 ac)	Landscape (~<1-5K ac)	Range (across provinces)	Lehmkuhl vulner. risk rating	Brown versatil. rating	Migratory or resident (m or r)	Strong riparian assoc.?
Long-eared myotis			?	25	30	R	Feeding
Fringed myotis			?	25	30	?	Feeding
Little brown myotis			?	25	34	R	Feeding
Lynx			X		21	R	
Elk			X	*28	32	M	

26 mammal species

Appendix 5-D
Terrestrial Vertebrates ("Short List") - Mammals Part 2 (continued)

	Presence													
	By state			By physiographic province (from Draft Recovery Plan)										
				Washington				Oregon				California		
Species	WA	OR	CA	OLPE	WACA	WACAE	WA Lowln	ORCAW	ORCAE	OCOR	OR KLAM	CA KLAM	CA Cas	CA Coast
Long-eared myotis	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Fringed myotis	X	X	X		X	X		X	X	X	X	X	X	X
Little brown myotis	X	X	X	X	X	X	X	X	X	X	X	X	X	X
Lynx	X					X								
Elk	X	X	X	X	X	X	X	X	X	X	X	X	X	X

26 mammal species

	Degree of endemism			General abundance within NSO range	Population trend w/in NSO range			References
	not really endemic to the range of the NSO	is endemic to the range of the NSO	very tiny range	qualit. rank: S = scarce everywhere C = common somewhere				
Species	Broad	Local	Restricted	NSO range	Increasing	Stable	Decreasing	**References**
Long-eared myotis	X			S				2,3a,5,19,21-3,21-5,21-11
Fringed myotis	X			C				2,3a,5,21-3,21-5,21-11
Little brown myotis	X			C				2,3a,5,21-3,21-11
Lynx	X			S				2,20,21-6
Elk	X			C				2,3a,21-4,21-6,21-11

26 mammal species

Appendix 5-D
Terrestrial Vertebrates ("Short List") - Mammals Part 2 (continued)

Species	Comments
Long-eared myotis	
Fringed myotis	
Little brown myotis	
Lynx	
Elk	

26 mammal species

Appendix 5-D
Attributes of Terrestrial Vertebrates

Key to Information on Habitat Attributes Database

Breeding, Resting, and Foraging Habitat

Successional stages - Reference 2 was the primary source of information. Information on various species was also provided by 3b, 7, 8, 9, 11a, 11b, 11c and 20.

Only vegetative communities used by northern spotted owls were assessed for use by each species for breeding, resting, and foraging. Those vegetative communities include: conifer hardwood, mixed conifer forest (southwest Oregon), temperate conifer forest, high temperate coniferous forest, subalpine forest parks and lodgepole pine (Cascades). Subalpine forest and lodgepole are only considered as dispersal habitat for northern spotted owls. Within this section the following codes denote the combined use of vegetative communities and successional stages for breeding, resting, and foraging of species.

P = Primary use of the successional stage for breeding, resting, and foraging by the species.
S = Secondary use of the successional stage for breeding, resting, and foraging by the species.
P/S = A combination of primary and secondary use of the successional stage, with disproportionately more primary use than secondary use by the species.
S/P = A combination of primary and secondary use of the successional stage, with disproportionately more secondary use than primary use by the species.
(PS)= A combination of primary and secondary use of the successional stage, with approximately half the use being primary and half being secondary by the species.

Young - Grass/forb = shrubs less than 40 percent crown cover and less than 5 feet tall; unit may range from mainly devoid of vegetation to dominance by herbaceous species (grasses and forbs); tree regeneration generally less than 5 feet tall and 40 percent crown cover.

Young - Shrub/sap = Shrubs greater than 40 percent crown canopy; average stand diameter greater than 1 inch dbh and tree canopy closure less than 60 percent; saplings are 1 to 4 inches dbh; poles 4 to 9 inches dbh.

Pole = Average stand diameters between 1 and 21 inches dbh and crown cover exceeding 60 percent.

Appendix 5-D
Attributes of Terrestrial Vertebrates

Key to Information on Habitat Attributes Database (continued)

Late successional - Mature = Stand with average diameters exceeding 21 inches in dbh; crown cover may be less than 100 percent, decay and decadence required for old growth may be lacking, and dead and down material required by old growth is lacking.

Late successional - Old growth = Stands over 200 years old with at least two tree layers (overstory and understory), decay in living trees, snags, and down woody material. Some of the overstory layer may be composed of long-lived successional species (that is, Douglas-fir, western redcedar).

Stand structure - Reference 5 computer database was the primary source document for sparse structure types. Components and Classic OG were calculated from other attribute columns as explained below.

Sparse = An "X" denotes that the species' use of habitat types with sparse canopy closure (less than 25 percent) was Moderate to High.

Components = primarily young growth with legacy components of older successional stages (i.e., down logs, large trees and snags). An "X" in this column denotes the primary use of shrub/sap or pole successional stages and the use of at least one of the four microhabitat components listed below (down logs, duff/litter, large snags, large trees).

Classic OG = classic old-growth forest with multistory and multispecies stands and a high decadence component. An "X" in this column denotes the primary use of old growth successional stage and the use of at least one of the four microhabitat components listed below.

Dispersal habitat = No primary information source documents were identified. This column is a description of habitat used by species for juvenile dispersal from natal areas, and adult dispersal from occupied habitats.

Microhabitat - References used were 2, 5, 7, 8, 9, and 19. Other sources included 11a, 11b, 11c and 20. An "X" denotes a close association (primary use) by the species with the specified habitat component (**talus, down logs, duff/litter, large snags, and large trees**).

Dispersal capability - No primary source documents were identified. An "X" in one of the following columns denotes the capability of juveniles and adults to disperse from natal and occupied habitat.

Stand = species will generally disperse in less than about a 60 acre area.

Landscape = species will generally disperse within approximately 60 acres to 5000 acres (subwatershed).

Appendix 5-D
Attributes of Terrestrial Vertebrates

Key to Information on Habitat Attributes Database (continued)

Range = species has the capability to disperse across physiographic province boundaries.

Lehmkuhl vulnerability rating - Reference 3a was used. The rating is a risk rating of local extinction of species. The higher the rating value the higher the risk of local extinction. Risk score = 3 * (frequency + abundance) + 2 * (body size + vagility) + migratory status + variance in abundance. Scores for frequency, abundance and variation were assessed from data presented by Lehmkuhl and others. Total risk was calculated as the weighted sum.

Brown versatility rating - Reference 2. The rating is the sum of the number of plant communities and successional stages used for breeding plus the number of plants communities and successional stages used for feeding by a species. The higher the rating the higher the versatility of the species to use different vegetation communities.

Migratory Status - References 4, 11c, 16a, and 16b were used. Below are codes used to denote migratory status. More than one code was used for species which are known or suspected to have mixed migratory habits.

R = yearlong residents and nomads
M = latitudinal migrants including neotropical, lower-latitude nearctic, and high latitude nearctic migrants
D = displacement migrants
E = elevational migrants including seasonal downslope and upslope movements

Riparian Assoc. - References 1, 2, and 7 were used. An "X" denotes a strong riparian association for that species.

State and Physiographic province - Individual species range maps, which were derived from references 21-1 through 21-12 were used. An "X" denotes presence of the species in the state or province.

Degree of endemism - References 1, 3b, 16a, 16b, 16c and 18 along with individual species range maps, which were derived from reference 21-1 through 21-12, were used. An "X" in one of the following columns denotes the geographic range of the species as it relates to the range of the northern spotted owl.

Broad = geographic range extends beyond the range of the northern spotted owl (that is, not strictly endemic within the owl's range).

Local = geographic range does not extend beyond the range of the northern spotted owl but is fairly broad throughout at least one physiographic province therein.

Appendix 5-D
Attributes of Terrestrial Vertebrates

Key to Information on Habitat Attributes Database (continued)

Restricted = geographic range is restricted to a small portion of the northern spotted owls' range, that is, occurs within a small portion of one or only a few physiographic provinces therein.

General abundance - References 13, 16a, 16b were used. Codes denote the general abundance of species throughout the range of the northern spotted owl.

S = scarce everywhere within the range of the northern spotted owl.
C = common in at least some areas within the range of the northern spotted owl.

Population trend - References 7, 9, 13, 14a, and 14b were used. Population trend of amphibians was based on trend in their preferred (macro)habitat.

References - References for information summarized in this data table are coded as listed below.

1 USDI. 1992. Recovery plan for the northern spotted owl - draft, appendix D. Portland, OR: U.S. Department of the Interior. 662 p.

2 Brown, E.R., tech. ed. 1985. Management of wildlife and fish habitats in forests of western Oregon and Washington. Portland, OR: USDA Forest Service, Pacific Northwest Region. Vol 2.

3a Lehmkuhl, J.F.; Ruggiero, L.F. 1991. Forest fragmentation in the Pacific Northwest and its potential effects on wildlife. In: Wildlife and vegetation of unmanaged Douglas-fir forests. PNW-GTR-285. Portland, OR: USDA Forest Service, Pacific Northwest Region. 45-46 p.

3b Ruggiero, L.F. 1991. Wildlife habitat relationships and viable populations. In: Wildlife and vegetation of unmanaged Douglas-fir forests. PNW-GTR-285. Portland, OR: USDA Forest Service, Pacific Northwest Region. 456-462 p.

4 Marcot, B.G. 1984. Habitat relationships of birds and young-growth Douglas-fir in northwestern California. 161 & 233-234 p. Ph.D. dissertation.

5 Zeiner, D.C.; Laudenslayer, W.R., Jr.; Mayer, K.E.; White, M., eds. 1988. California's wildlife. Sacramento, CA: California Department of Forestry and Fire Protection. 166 p. 3 additional vol. 1 computer disk.

Vol I, Amphibians and reptiles. 1988.
Vol II, Birds. 1990.
Vol III, Mammals. 1990.
California Department of Fish and Game Wildlife Habitat Relationship System computer database; species sort by specified habitats

Appendix 5-D
Attributes of Terrestrial Vertebrates

Key to Information on Habitat Attributes Database (continued)

7 Rodrick, E.; Milner R., tech. eds. 1991. Management recommendations for Washington's priority habitats and species. Olympia, WA: Washington Department of Wildlife. 206 p.

8 Beatty, J.J.; Blaustein, A.R.; Storm, R.M. 1992. A report to the northern spotted owl recovery team (subgroup addressing other species and older forest ecosystems, Robert G. Anthony, Chairperson): the biology of amphibians and reptiles. Corvallis, OR: Oregon State University. 86 p.

9 Marshall, D. 1992. Sensitive vertebrates of Oregon. Portland, OR: Oregon Department of Fish and Wildlife. 226 p.

11a Huff, M.H.; Holthausen, R.S.; Aubry, K.B. 1992. Habitat management for red tree voles in Douglas-fir forests. PNW-GTR-302. Portland, OR: USDA Forest Service, Pacific Northwest Region. 22 p.

11b Carey, A.B. 1991. The biology of arboreal rodents in Douglas-fir forests. PNW-GTR-276. Olympia, WA: USDA Forest Service, Pacific Northwest Region. 53 p.

11c Christy, R.E.; West, S.D. [In press]. Biology of bats in Douglas-fir forests. PNW-GTR. Portland, OR: USDA Forest Service, Pacific Northwest Region. 64 p.

13 Sharp, B.E. 1992. Neotropical migrants on National Forest in the Pacific Northwest: a compilation of existing information. Portland, OR: Ecological Perspectives. 847 p.

14a Raphael, M.G. 1988. Long-term trends in amphibians, reptiles, and mammals in Douglas-fir forests of northwestern California. Management of amphibians, reptiles, and small mammals in North America: Proceedings of a symposium; 1988 July 19-21; Flagstaff, AZ. GTR-RM-166. Ft. Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 23-31 p.

14b Raphael, M.G.; Rosenburg, K.V.; Marcot, B.G. 1988. Large-scale changes in bird populations of Douglas-fir forests, northwestern California. In: Jackson J.A., ed. Bird conservation. Madison, WI: University of Wisconsin Press, Ltd. 63-83 p.

16a Robbins, C.S.; Bertel, B.; Zim, H.S. 1966. A guide to field identification: birds of North America. Racine, WI: Golden Press New York. 344 p.

16b National Geographic Society. 1983. Field guide to the birds of North America. Washington, DC: National Geographic Society. 465 p.

Appendix 5-D
Attributes of Terrestrial Vertebrates

Key to Information on Habitat Attributes Database (continued)

16c Ehrlich, P.R.; Dobkin, D.S.; Wheye, D. 1988. The birder's handbook: a field guide to the natural history of North America birds. New York, NY: Simon and Schuster, Fireside. 814 p.

18 Ingles, L.G. 1976. Mammals of the Pacific states: California, Oregon, Washington. Stanford, CA: Stanford University Press. 520 p.

19 Verner, J.; Boss, A.S. tech. coords. 1980. California wildlife and their habitats: western Sierra Nevada. GTR-PSW-37. Berkeley, CA: USDA Forest Service, Pacific Southwest Forest and Range Experiment Station. 443 p.

20 Butts, T.W. 1992. Lynx (*Felix lynx*) biology and management. A literature review and annotated bibliography. Missoula, MT: USDA Forest Service, Northern Region. 268 p.

The following references were used to develop the individual species range maps:

21-1 Marshall, D.B. 1992. Threatened and sensitive wildlife of Oregon's forests and woodlands. Portland, OR: Audubon Society of Portland. 66 p.

21-2 Zeiner, D.C.; Laudenslayer, W.P., Jr.; Mayer, K.E., eds. 1988. California's wildlife. Vol. I - Amphibians and reptiles. Sacramento, CA: California Department of Fish and Game. 272 p.

21-3 Ingles, L.G. 1965. Mammals of the Pacific states: California, Oregon, and Washington. Stanford, CA: Stanford University Press. 506 p.

21-4 Maser, C.; Mate, B.R.; Franklin, J.F.; Dyrness, C.T. 1981. Natural history of Oregon Coast mammals. Gen. Tech. Rep. PNW-133. Portland, OR: USDA Forest Service. 496 p.

21-5 Dalquest, W.W. 1948. Mammals of Washington. Vol. 2. Lawrence, KS: University of Kansas. 144 p.

21-6 Rodrick, E.; Milner, R., tech. eds. 1991. Management recommendations for Washington's priority habitats and species. Olympia, WA: Washington Department of Wildlife. 189 p.

21-7 Hall, E.R.; Kelson, K.R. 1959. The mammals of North America, Vol. II. New York, NY: The Ronald Press.

21-8 Peterson, R.T. 1990. A field guide to western birds. Third edition. Boston, MA: Houghton Mifflin Co. 432 p.

Appendix 5-D
Attributes of Terrestrial Vertebrates

Key to Information on Habitat Attributes Database (continued)

21-9 Leonard, W.; Brown, H.; Jones, L., [and others]. [In press]. Amphibians of Washington and Oregon. Seattle, WA: Audubon Society. 30 p.

21-10 USDI Fish and Wildlife Service. Data via Oregon State Center for GIS.

21-11 Zeiner, D.C.; Laudenslayer, W.F., Jr.; Mayer, K.E.; White M., eds. 1990. California's wildlife. Vol. III - Mammals. Sacramento, CA: California Department of Fish and Game. 407 p.

21-12 Zeiner, D.C.; Laudenslayer, W.F., Jr.; Mayer, K.E.; White M., eds. 1990. California's wildlife. Vol. II - Birds. Sacramento, CA: California Department of Fish and Game. 731 p.

Appendix 5-E

List of Expert Viability Panel Participants

Appendix 5-E
List of Expert Viability Panel Participants

Nonvascular Plants

Robin Lesher	Panel Leader, Forest Service, Mt. Baker-Snoqualmie National Forest, Mountlake Terrace, Washington
Joseph Ammirati	University of Washington, Department of Biology, Seattle, Washington
John Cristy	Oregon Natural Heritage Program, Portland, Oregon
William Denison	Oregon State University, Department of Botany and Plant Pathology, Corvallis, Oregon
Daniel Norris	Oregon State University, Department of Botany and Plant Pathology, Corvallis, Oregon

Vascular Plants

Joan Ziegltrum	Panel leader, Forest Service, Olympic National Forest, Olympia, Washington
Kenneth Berg	California Department of Fish and Game, Sacramento, California
Bruce Bingham	Forest Service, Pacific Southwest Forest and Range Experiment Station, Redwood Sciences Laboratory, Arcata, California
Rex Crawford	Washington Natural Heritage Program, Olympia, Washington
Lisa McCrimmon	Forest Service, Siskiyou National Forest, Grants Pass, Oregon
David Peter	Forest Service, Mt. Baker-Snoqualmie National Forest, Mountlake Terrace, Washington
Steven Rust	Forest Service, Wenatchee National Forest, Wenatchee National Forest

Invertebrates

Review was contracted with:

David Olson	The Xerces Society, Portland, Oregon
Ingrith Deyrup-Olsen	University of Washington, Department of Zoology, Seattle, Washington

Appendix 5-E
List of Expert Viability Panel Participants (continued)

Fish

Gordon H. Reeves	Forest Service, Pacific Northwest Research Station, Forestry Sciences Laboratory, Corvallis, Oregon
James R. Sedell	Forest Service, Pacific Northwest Research Station, Forestry Sciences Laboratory, Corvallis, Oregon

Amphibians and Reptiles

Martin G. Raphael	Panel leader, Forest Service, Pacific Northwest Research Station, Forestry Science Laboratory, Olympia, Washington
Keith Aubry	Forest Service, Pacific Northwest Research Station, Forestry Sciences Laboratory, Olympia, Washington
Andrew Blaustein	Oregon State University, Department of Zoology, Corvallis, Oregon
John Brode	California Department of Fish and Game, Inland Fisheries Division, Rancho Cordova, California
R. Bruce Bury	USDI Fish and Wildlife Service, National Ecology Research Center, Fort Collins, Colorado
P. Stephen Corn	USDI Fish and Wildlife Service, National Ecology Research Center, Fort Collins, Colorado
Lawrence C. Jones	Forest Service, Pacific Northwest Research Station, Forestry Sciences Laboratory, Olympia, Washington
Hartwell Welsh	Forest Service, Pacific Southwest Forest and Range Experiment Station, Redwood Sciences Laboratory, Arcata, California

Birds

Bruce G. Marcot	Panel Leader, Forest Service, Pacific Northwest Research Station, Portland, Oregon
Andrew Hanson	Oregon State University, Forestry Sciences Department, Corvallis, Oregon
Mark Huff	Forest Service, Pacific Northwest Research Station, Forestry Sciences Laboratory, Olympia, Washington

Appendix 5-E
List of Expert Viability Panel Participants (continued)

David Manuwal	University of Washington, College of Forest Resources, Seattle, Washington
David Marshall	Consultant, Portland, Oregon
Kevin McGarigal	Oregon State University, Forestry Sciences Department, Corvallis, Oregon
Kimberly Nelson	Oregon State University, Cooperative Research Unit, Department of Fish and Wildlife, Corvallis, Oregon

Mammals

Robert G. Anthony	Panel leader, Oregon State University, Cooperative Research Unit, Department of Fish and Wildlife, Corvallis, Oregon
Andrew Carey	Forest Service, Pacific Northwest Research Station, Forestry Sciences Laboratory, Olympia, Washington
Stephen Cross	Southern Oregon State College, Department of Biology, Ashland, Oregon
Fredrick F. Gilbert	University of Northern British Columbia, Dean of Natural Resources/Environmental Studies, Prince George, British Columbia
James Hallot	Washington State University, Department of Zoology, Pullman, Washington
Christine McGuire	Western Washington University, Huxely College, Bellingham, Washington
Cynthia Zabel	Forest Service, Pacific Southwest Forest and Range Experiment Station, Redwood Sciences Laboratory, Arcata, California

Appendix 5-F

Invertebrate Species Closely Associated With Old-Growth Forests in National Forests Within the Range of the Northern Spotted Owl

Key to status codes and references appear at the end of this appendix.

Appendix 5-F
Invertebrate Species - Class Diplopoda

Phylum Arthropoda
Class Diplopoda (millipedes)
Order Chordeumatida
Family Caseyidae

	OG forest assoc.	Ripar. assoc.	Fed. status	Reference FWS	Reference Ols	Common name
Caseya benedictae	1				1	
Caseya briophila	1				1	
Caseya buckketti	1				1	
Caseya longiloba	1				1	
Caseya megasoma	1				1	
Caseya megasoma	1				1	
Caseya shastaensis	1				1	
Harpaphe haydeniana	1			1		
Metopiona sheari	1				1	
Ochrogramma heterogona	1				1	
Ochrogramma formulosa	1				1	
Ochrogramma haigi	1				1	
Opiona bifurcata	1				1	
Opiona casualis	1				1	
Opiona communis angusta	1				1	
Opiona confusa	1				1	
Opiona distincta	1				1	
Opiona exigua	1				1	
Opiona facetia	1				1	
Opiona fisheri	1				1	
Opiona goedeni	1				1	
Opiona scytonotoides	1				1	
Opiona siliquae	1				1	
Tuhaphe levii	1				1	
TOTAL DIPLOPODA:	24	0				

Appendix 5-F
Invertebrate Species - Class Arachnida

	OG forest assoc.	Ripar. assoc.	Fed. status	Reference FWS	Reference Ols	Common name
Class Arachnida						
Order Araneida (spiders)						
Family Agelenidae						
Cybaeina minuta	1				1	
Order Phalangida (harvestman)						
Cryptomaster leviathan	1				1	
Isolachus spinosus	1				1	
Pentanychus hamatus	1				1	
Pentanchyus clavatus	1				1	
Pentanchyus bilobatus	1				1	
Pentanchyus flavescens	1				1	
Pentanchyus pacificus	1				1	

TOTAL ARACHNIDA:	8	0

Appendix 5-F
Invertebrate Species - Class Insecta

Class Insecta (insects)

	OG forest assoc.	Ripar. assoc.	Fed. status	Reference FWS	Reference OIs	Common name
Order Orthoptera						
Boonacris alticola	1			1		
Pristoceuthophilus celatus	1			1		
Pristoceuthophilus cercalis	1			1		
Pristoceuthophilus sargentae	1			1		
Tropidischia xanthostoma	1			1		
Order Hemiptera						
Boreostolis americanus	1			1		
Plinthisus longisetosus	1			1		
Thylochromus nitidulus	1			1		
Eurychilopterella sp.	1			1		
Phytocoris nobilis	1			1		
Pithanus maerkelii	1			1		
Polymerus castellaeni	1			1		
Vanduzeenia borealis	1			1		
Acalypta lillianis	1			1		
Acalypta saundersi	1			1		
Derephysia foliacea	1			1		
Order Coleoptera						
Pterecus humboldti	1				1	
Cychrus tuberculatus	1			1		
Metrius contractus	1			1		
Promecognathus laevissimus	1			1		
Zacotus mathewsii	1			1		
Omus dejeani	1			1		
Lobosoma horridum	1			1		
Acneus beeri		1	C2	1		
Acneus burnelli			C2	1		
Cicindela columbica		1		1		
Pterostichus rothi	1			1		
Order Plecoptera						
Nemoura wahkeena		1	C2	1		
Solperia fenderi		1	C2	1		
Order Trichoptera						
Eobrachycentrus gelidae		1	C2	1		
Agapetus denningi		1	C2	1		
Homoplecta schuhi		1	C2	1		
Ochrotrichia alsea		1	C2	1		
Lepidostoma goedeni		1	C2	1		
Apatania tavaia		1	C2	1		
Farula davisi		1	C2	1		
Farula jewetti		1	C2	1		

Appendix 5-F
Invertebrate Species - Class Insecta (continued)

	OG forest assoc.	Ripar. assoc.	Fed. status	Reference FWS	Reference Ols	Common name
Farula reaperi		1	C2	1		
Limnephilus alconura		1	C2	1		
Limnephilus atereus		1	C2	1		
Neothremma andersoni		1	C2	1		
Oligophlebodes mostbento		1	C2	1		
Philocasca oron		1	C2	1		
Dolophilodes oregona		1	C2	1		
Tinodes siskyou		1	C2	1		
Rhyacophila ambilis		1	C2	1		
Rhyacophila colonus		1	C2	1		
Rhyacophila fenderi		1	C2	1		
Rhyacophila haddocki		1	C2	1		
Rhyacophila lineata		1	C2	1		
Rhyacophila mosana		1	C2	1		
Rhyacophila unipunctata		1	C2	1		
Desmona bethula		1	C2	1		
Cryptochia shasta		1	C2	1		
Goeracea oregona		1	C1	1		
Neothremma genella		1	C2	1		
Neothremma siskyou		1	C2	1		
Ochrotrichia vertreesi		1	C2	1		
Abellan hydropsyche		1	C2	1		

TOTAL INSECTA:	*24*	*34*

Appendix 5-F
Invertebrate Species - Class Mollusca

Phylum Mollusca

	OG forest assoc.	Ripar. assoc.	Fed. status	Reference FWS	Reference Ols	Common name
Fluminicola columbiana		1	C2	1		Columbia pebblesnail
Fisherola nuttalli nuttalli			C3	1		Shortface lanx
Monadenia fidelis minor			C2	1		Dalles sideband
Monadenia troglodytes chaceana	1	1	C2	1		No common name
Monadenia troglodytes troglodytes	1	1	C2	1		Shasta sideband
Monadenia troglodytes wintu	1	1	C2	1		Wintu sideband
Monadenia fidelis pronotis		1	C2	1		Rocky coast sideband
Monadenia setosa	1	1	C2	1		Trinity bristlesnail
Vespericola karokorum	1	1	C1	1		Karok hesperian
Juga hemphilli hemphilli	1	1		1		Barren juga
Juga hemphilli dallesensis	1	1		1		Dalles juga
Juga hemphilli subsp.	1	1		1		No common name
Juga (J.) n. sp. 1	1	1		1		Brown juga
Juga (J.) n. sp. 3	1	1		1		Tall juga
Juga (O.) n. sp. 1		1		1		No common name
Juga (O.) n. sp. 2		1		1		No common name
Juga (C.) actifilosa	1	1		1		Scalloped juga
Juga (C.) occata		1		1		Topaz juga
Amnicola (L.) n. sp.	1	1		1		No common name
Vorticifex neritoides				1		Nerite rams-horn
Physella columbiana				1		Rotund physa
Fluminicola seminalis	1	1		1		Vagrant pebblesnail
Lanx alta	1			1		Highcap lanx
Lanx patelloides				1		Kneecap lanx
Helisoma newberryi newberryi		1		1		Great Basin rams-horn
Vespericola columbiana columbiana				1		Columbia hesperian
Hemphillia malonei	1	1		1		Malone jumping-slug
Hemphillia pantherina	1	1		1		Panther jumping-slug
Hemphillia glandulosa glandulosa	1	1		1		Warty jumping-slug
Hemphillia barringtoni	1	1		1		Burrington jumping-slug
Prophysaon coeruleum	1	1		1		Blue-gray tail-dropper
Prophysaon dubium	1	1		1		Papillose tail-dropper
Monodenia fidelis columbiana	1	1		1		Columbia sideband
Monadenia fidelis beryllica	1	1		1		Green sideband
Monadenia fiddelis celeuthia	1	1		1		Traveling sideband
Monadenia fidelis ochromphalous	1	1		1		Yellow-base sideband
Monadenia fidelis leonina	1	1		1		Tawny sideband
Monadenia fidelis klamathica	1	1		1		No common name
Monadenia churchi	1	1		1		Klamath sideband
Trilobopsis roperi	1	1		1		Shasta chaparral
Trilobasis tehamana	1	1		1		Tehama chaparral

Appendix 5-F
Invertebrate Species - Class Mollusca (continued)

	OG forest assoc.	Ripar. assoc.	Fed. status	Reference FWS	Reference OIs	Common name
Vespericola shasta	1	1		1		Shasta hesperian
Vespericola sierrana	1	1		1		Siskyou hesperian
Vespericola megasoma euthales	1	1		1		Large hesperian
Megomphix hemphilli	1	1		1		Oregon megomphix
Anodonta wahlametensis				1		Willamette floater
Juga (Oreobasis) chacei	1	1		1		No common name
Juga (Oreobasis) orickensis	1	1		1		No common name
Lanx subrotundata	1			1		Rotund lanx
Monadenia callipeplus	1	1		1		No common name
Monadenia cristulata	1	?		1		No common name
Monadenia fidelis salmonensis	1	1		1		No common name
Monadenia fidelis scottiana	1	?		1		No common name
Monadenia rotifera	1	?		1		No common name
Haplotrema voyanum	1	?		1		Hooded lancetooth
Helminthoglypta hertleini		1		1		Oregon shoulderband
Deroceras hesperium	1	1		1		Evening fieldslug
Anodonta californiensis		1	C2	1		California floater

TOTAL MOLLUSCA:	*43*	*45*

TOTALS BY CLASS AND HABITAT

DIPLOPODA	24	0
ARACHNIDA	8	0
INSECTA	24	34
MOLLUSCA	43	45

GRAND TOTAL	99	79

TOTALS BY CLASS:

ARTHROPODS	91
MOLLUSCS	58
ALL	149

Appendix 5-F
Invertebrate Species

Federal Status: E = endangered, T = threatened, C = candidate

OG = Old Growth

References

FWS = USDI. 1992. Recovery plan for the northern spotted owl - draft. Portland, OR: U.S. Department of the Interior. 662 p.

OLS = Olson, David M. 1992. The northern spotted owl conservation strategy: implications for Pacific Northwest forest invertebrates and associated ecosystem processes. Final contract report prepared for the Northern Spotted Owl EIS Team, USDA Forest Service. Portland, OR: The Xerces Society. 51 pp. + map. (From Table 1)

From Table 1, Olson 1992:

"This list is not exhaustive; invertebrate distributions and diversity are not well known in the Pacific Northwest and not all available published species accounts were reviewed, nor all appropriate specialists interviewed. Only four taxonomic revisions were examined for this list, and only six of the roughly fifty or so specialists familiar with the regional fauna were interviewed. This list is intended to provide examples to clarify taxonomic and ecological trends, and should be viewed as a tool for direction, not as a catalog of all relevant species. Some species reviewed possessing relatively limited distributions across several counties were arbitrarily excluded to focus on species with extremely narrow known ranges. All of the species are understory specialists and many of them are wingless or flightless." (p. 43)

Appendix 5-G

Viability Ratings of Fish Stocks at Risk, Under the Five Final Environmental Impact Statement Alternatives

Appendix 5-G
Viability Ratings of Fish Stocks at Risk, Under the Five Final Environmental Impact Statement Alternatives

A five-class rating scheme for viability was used.

Province	Alt. A	Alt. B	Alt. C	Alt. D	Alt. E
Olympic	L 1,4,5	M 3,4,5	MH 3,4,5	MH 3,4,5	L 1,4,5
WA Cascades	L 1,4,5	ML 2,4,5	ML 2,4,5	M 3,4,5	L 1,4,5
OR Coast Range	L 1,4,5	L 1,4,5	ML 2,4,5	M 3,4,5	L 1,4,5
OR Cascades	L 1,4,5	L 1,4,5	L 1,4,5	M 3,4,5	L 1,4,5
Klamath	L 1,4,5	L 1,4,5	L 1,4,5	M 3,4,5	L 1,4,5

1 - Approximately <25% area of key watersheds within alternative
2 - Approximately 26-50% area of key watersheds within alternative
3 - Approximately >50% area of key watersheds within alternative
4 - Has no watershed restoration program
5 - Lacks adequate riparian management area standards

Viability ratings codes:

H = high
MH = medium high
M = medium
ML = medium low
L = low

Appendix 5-H

Species with Risk to Viability, All Taxonomic Classes, Closely Associated With Old-Growth Forests in National Forests Within the Range of the Northern Spotted Owl

Table of Contents

Appendix 5-H
Species With Risk to Viability - Non-vascular Plants

Non-vascular Plants

1. Live wood

Lichens

	Medium Risk to Viability					High Risk to Viability				
Alternative:	A	B	C	D	E	A	B	C	D	E
Alectoria sarmentosa	1				1					1
Bryoria capillaris	1				1					1
Bryoria tortuosa	1				1					1
Calicium abietinum					1					
Calicium adaequatum					1					
Calicium adspersum					1					
Calicium glaucellum					1					
Calicium viride					1					
Chaenotheca chrysocephala					1					
Chaenotheca ferruginea					1					
Chaenotheca subroscida					1					
Hypnum circinale					1					
Lobaria hallii	1				1					1
Lobaria linita	1				1					1
Lobaria oregana	1				1					1
Lobaria pulmonaria	1				1					1
Microcalicium arenarium					1					
Nephroma antiquorum	1				1					1
Nephroma isidiosum	1				1					1
Nephroma occultum	1				1					1
Pseudocyphellaria anomala	1				1					1
Pseudocyphellaria anthraspis	1				1					1
Pseudocyphellaria aurata	1				1					1
Pseudocyphellaria croccata	1				1					1
Pseudocyphellaria rainierensis	1				1					1
Sphaerophorus globosus	1				1					
Sticta weigelii	1				1					1
Usnea longissima	1	1	1	1	1	1				1
Teloschistes flavicans	1	1	1	1	1	1				1

Appendix 5-H
Species With Risk to Viability - Non-vascular Plants (continued)

	Medium Risk to Viability					High Risk to Viability				
Alternative:	A	B	C	D	E	A	B	C	D	E
Liverworts										
Herbertus aduncus	1				1	1				1
Herbertus sakuraii	1	1	1	1	1	1				1
Ptilidium californicum (CA only)	1	1	1	1	1					1
Ptilidium californicum (OR & WA)					1					
Radula bolanderi					1					
Scapania bolanderi					1					
Mosses										
Antitrichia curtipendula	1				1					
Iwatsukiella leucotricha	1	1	1	1	1	1				1
Pterigynandrum filiforme	1				1	1				1
Ulota megalospora (CA only)	1	1	1	1	1	1				1

Appendix 5-H
Species With Risk to Viability - Non-vascular Plants (continued)

Alternative:	Medium Risk to Viability A	B	C	D	E	High Risk to Viability A	B	C	D	E
2. Decaying wood										
Lichens										
Icmadophila ericetorum	1				1					1
Liverworts										
Bazzania ambigua	1				1					
Bazzania denudata	1				1					
Bazzania tricrenata	1				1					
Blepharostoma trichophyllum	1				1					
Calypogeia azurea	1				1					
Calypogeia fissa	1				1					
Calypogeia muelleriana	1				1					
Calypogeia suecica	1				1					
Cephalozia bicuspidata ssp. lammersiana	1				1					
Cephalozia connivens	1				1					
Cephalozia lunulifolia	1				1					
Diplophyllum albicans	1				1					
Diplophyllum plicatum	1				1					
Geocalyx graveolens	1				1					
Kurzia makinoana	1				1					
Lepidozia reptans	1				1					
Lophocolea bidentata	1				1					
Lophocolea cuspidata	1				1					
Lophocolea heterophylla	1				1					
Lophozia incisa	1				1					
Lophozia longiflora	1				1					
Riccardia latifrons	1				1					
Riccardia palmata	1				1					
Scapania umbrosa	1				1					
Mosses										
Brotherella roellii (WA Cascades only)	1	1	1	1	1	1	1	1	1	1
Buxbaumia piperi	1	1	1	1	1	1				1
Buxbaumia viridis	1	1	1	1	1	1				1
Herzogiella seligeri	1				1					
Orthodontium gracile (Redwoods no. CA)	1				1					

Appendix 5-H
Species With Risk to Viability - Non-vascular Plants (continued)

	Medium Risk to Viability					High Risk to Viability				
Alternative:	A	B	C	D	E	A	B	C	D	E
Plagiothecium undulatum	1				1					
Pseudotaxiphyllum elegans	1				1					
Rhizomnium glabrescens	1				1					
Tetraphis geniculata	1	1	1	1	1	1				1
Tetraphis pellucida	1				1					

3. Soil and bases of trees

	Medium Risk to Viability					High Risk to Viability				
Alternative:	A	B	C	D	E	A	B	C	D	E
Liverworts										
Scapania americana	1				1					
Mosses										
Anthoceros bulbiculosus	1				1					
Bartramiopsis lescurii	1	1	1	1	1	1	1	1	1	1
Brachythecium hylotapetum	1				1					1
Ditrichum schimperi	1				1					
Epipterygium tozeri	1				1					
Fissidens pauperculus	1				1					
Isopterygiopsis pulchella	1				1	1				1
Plagiomnium insigne	1				1					
Pohlia pacifica	1				1					
Rhizomnium nudum	1	1	1	1	1	1				1
Rhytidiopsis robusta	1				1					
Roellia roellii	1				1					
Schistostega pennata	1	1	1	1	1	1				1
Trichodon cylindricus	1				1					

Appendix 5-H
Species With Risk to Viability - Non-vascular Plants (continued)

4. Rock

Alternative:	Medium Risk to Viability A	B	C	D	E	High Risk to Viability A	B	C	D	E
Liverworts										
Apometzgeria pubescens	1	1	1	1	1	1				1
Metzgeria conjugata	1	1	1	1	1	1				1
Radula brunnea	1	1	1	1	1	1				1
Mosses										
Andreaea heinemanii	1				1					1
Andreaea schofioldiana	1				1					1
Byrum gemmascens	1				1	1				1
Heterocladium macounii	1				1	1				1
Heterocladium procurrens	1				1	1				1
Plagiothecium piliferum	1				1	1				1

5. Water

Alternative:	Medium Risk to Viability A	B	C	D	E	High Risk to Viability A	B	C	D	E
Liverworts										
Conocephalum conicum	1				1					
Pellia neesiana	1				1					
Tritomaria exsecta	1				1					
Tritomaria exsectiformis	1				1					
Tritomaria quinquedentata	1	1	1	1	1	1				1
Mosses										
Dichodontium pellucidum	1				1					
Dicranella palustra	1	1			1	1				1
Hookeria lucens	1				1					
Hygrohypnum bestii	1	1			1	1				1
Pleuroziopsis ruthenica	1	1	1	1	1	1	1	1	1	1
Porotrichum bigelovii	1				1					
Rhytidiadelphus subpinnatus	1				1					

Appendix 5-H
Species With Risk to Viability - Non-vascular Plants (continued)

6. Other

Fungi

	Medium Risk to Viability					High Risk to Viability				
Alternative:	A	B	C	D	E	A	B	C	D	E
Albatrellus caeryliopus	1	1	1		1					1
Aleuria rhenana	1	1	1	1	1	1	1	1	1	
Catathelasma ventricosa	1	1	1		1					1
Collybia bakerensis	1				1	1				1
Collybia racemosa	1	1			1	1				1
Cortinarius boulderensis	1	1	1		1					1
Cortinarius cyanites	1	1	1		1					1
Cortinarius olympianus	1	1	1		1					1
Cortinarius rainerensis	1	1	1		1					1
Cortinarius tabluaris	1	1	1		1					1
Cortinarius variipes	1	1	1		1					1
Cortinarius valgus	1	1	1		1					1
Ganoderma tsugae	1				1	1				1
Ganoderma oregana	1				1	1				1
Geopora cooperi	1				1	1				1
Gomphus kauffmanii	1	1	1		1					1
Gymnopilus punctifolius	1				1	1				1
Hericium abietis	1				1	1				1
Laetiporus sulfureus	1				1	1				1
Mycena lilacifolia	1				1	1				1
Mycena marginella	1				1	1				1
Mythicomyces corneipes	1	1			1	1				1
Otidea leporina	1	1			1	1				1
Otidea onotica	1	1			1	1				1
Otidea smithii	1	1			1	1				1
Oxyporus nobilissimus	1				1	1				1
Phaeocollybia kauffmanii	1		1		1					1
Pholiota scamba	1				1	1				1
Pholiota pulchella	1				1	1				1
Pleurocybella porrigens	1				1	1				1
Polyozellus multiplex	1	1	1		1					1
Rhodocybe speciosa	1				1	1				1
Sarcosphaera eximia	1				1					1
Sarcosoma mexicana	1	1			1	1				1

Appendix 5-H
Species With Risk to Viability - Non-vascular Plants (continued)

	Medium Risk to Viability					High Risk to Viability				
Alternative:	A	B	C	D	E	A	B	C	D	E
Sparasis radicata	1				1	1				1
Tricholomopsis fulvescens	1				1	1				1
Mosses										
Ulota obtusiuscula					1					
TOTAL non-vasc.	133	38	31	19	147	49	4	4	4	82

Appendix 5-H
Species With Risk to Viability - Vascular Plants

	Medium Risk to Viability					High Risk to Viability				
Alternative:	A	B	C	D	E	A	B	C	D	E

Vascular plants

Allotropa virgata	1				1					
Chamaecyparis lawsoniana (so.)	1				1					1
Coptis asplenifolia					1					
Cypripedium fasciculatum			1	1						
Cypripedium montanum			1	1						
Pyrola uniflora	1				1					
Taxus brevifolia (nw Cal.)	1				1					

TOTAL vascular	4	0	2	2	5	0	0	0	0	1

Appendix 5-H
Species With Risk to Viability - Invertebrates

	Medium Risk to Viability					High Risk to Viability				
Alternative:	A	B	C	D	E	A	B	C	D	E

Invertebrates
Phylum Arthropoda
Class Diplopoda (millipedes)
Order Chordeumatida
Family Caseyidae

Caseya benedictae	
Caseya briophila	
Caseya bucketti	
Caseya longiloba	
Caseya megasoma	
Caseya megasoma	
Caseya shastaensis	
Harpaphe haydeniana	
Metopiona sheari	(Not rated by alternative)
Ochrogramma heterogona	
Ochrogramma formulosa	
Ochrogramma haigi	
Opiona bifurcata	
Opiona casualis	
Opiona communis angusta	
Opiona confusa	
Opiona distincta	
Opiona exigua	
Opiona facetia	
Opiona fisheri	
Opiona goedeni	
Opiona scytonotoides	
Opiona siliquae	
Tuhaphe levii	

Appendix 5-H
Species With Risk to Viability - Invertebrates (continued)

	Medium Risk to Viability					High Risk to Viability				
Alternative:	A	B	C	D	E	A	B	C	D	E

Class Arachnida
Order Araneida (spiders)
Family Agelenidae

Cybaeina minuta	

Order Phalangida (harvestman)

Cryptomaster leviathan	
Isolachus spinosus	
Pentanychus hamatus	
Pentanchyus clavatus	
Pentanchyus bilobatus	
Pentanchyus flavescens	
Pentanchyus pacificus	

Class Insecta (insects)
Order Orthoptera

Boonacris alticola	
Pristoceuthophilus celatus	(Not rated by alternative)
Pristoceuthophilus cercalis	
Pristoceuthophilus sargentae	
Tropidischia xanthostoma	

Order Hemiptera

Boreostolis americanus	
Plinthisus longisetosus	
Thylochromus nitidulus	
Eurychilopterella sp.	
Phytocoris nobilis	
Pithanus maerkelii	
Polymerus castellaeni	
Vanduzeenia borealis	
Acalypta lillianis	
Acalypta saundersi	
Derephysia foliacea	

Order Coleoptera

Pterecus humboldti	
Cychrus tuberculatus	
Metrius contractus	

Appendix 5-H
Species With Risk to Viability - Invertebrates (continued)

	Medium Risk to Viability					High Risk to Viability				
Alternative:	A	B	C	D	E	A	B	C	D	E
Promecognathus laevissimus										
Zacotus mathewsii										
Omus dejeani										
Lobosoma horridum										
Acneus beeri										
Acneus burnelli										
Cicindela columbica										
Pterostichus rothi										
Order Plecoptera										
Nemoura wahkeena										
Solperia fenderi										
Order Trichoptera										
Eobrachycentrus gelidae										
Agapetus denningi										
Homoplecta schuhi										
Ochrotrichia alsea										
Lepidostoma goedeni										
Apatania tavaia										
Farula davisi										
Farula jewetti										
Farula reaperi										
Limnephilus alconura										
Limnephilus atereus										
Neothremma andersoni										
Oligophlebodes mostbento										
Philocasca oron										
Dolophilodes oregona										
Tinodes siskyou										
Rhyacophila ambilis										
Rhyacophila colonus										
Rhyacophila fenderi										
Rhyacophila haddocki										
Rhyacophila lineata										
Rhyacophila mosana										
Rhyacophila unipunctata										
Desmona bethula										
Cryptochia shasta										

(Not rated by alternative)

Appendix 5-H
Species With Risk to Viability - Invertebrates (continued)

Alternative:	Medium Risk to Viability A	B	C	D	E	High Risk to Viability A	B	C	D	E
Goeracea oregona										
Neothremma genella										
Neothremma siskyou										
Ochrotrichia vertreesi										
Abellan hydropsyche										

Phylum Mollusca

Fluminicola columbiana	(Not rated by alternative)
Fisherola nuttalli nuttalli	
Monadenia fidelis minor	
Monadenia troglodytes chaceana	
Monadenia troglodytes troglodytes	
Monadenia troglodytes wintu	
Monadenia fidelis pronotis	
Monadenia setosa	
Vespericola karokorum	
Juga hemphilli hemphilli	
Juga hemphilli dallesensis	
Juga hemphilli subsp.	
Juga (J.) n. sp. 1	
Juga (J.) n. sp. 3	
Juga (O.) n. sp. 1	
Juga (O.) n. sp. 2	
Juga (C.) actifilosa	
Juga (C.) occata	
Amnicola (L.) n. sp.	
Vorticifex neritoides	
Physella columbiana	
Fluminicola seminalis	
Lanx alta	
Lanx patelloides	
Helisoma newberryi newberryi	
Vespericola columbiana columbiana	
Hemphillia malonei	
Hemphillia pantherina	

Appendix 5-H
Species With Risk to Viability - Invertebrates (continued)

	Medium Risk to Viability					High Risk to Viability				
Alternative:	A	B	C	D	E	A	B	C	D	E
Hemphillia glandulosa glandulosa										
Hemphillia barringtoni										
Prophysaon coeruleum										
Prophysaon dubium										
Monodenia fidelis columbiana										
Monadenia fidelis beryllica										
Monadenia fiddelis celeuthia										
Monadenia fidelis ochromphalous										
Monadenia fidelis leonina										
Monadenia fidelis klamathica										
Monadenia churchi										
Trilobopsis roperi										
Trilobasis tehamana										
Vespericola shasta										
Vespericola sierrana										
Vespericola megasoma euthales										
Megomphix hemphilli										
Anodonta wahlametensis										
Juga (Oreobasis) chacei										
Juga (Oreobasis) orickensis										
Lanx subrotundata										
Monadenia callipeplus										
Monadenia cristulata										
Monadenia fidelis salmonensis										
Monadenia fidelis scottiana										
Monadenia rotifera										
Haplotrema voyanum										
Helminthoglypta hertleini										
Deroceras hesperium										
Anodonta californiensis										

(Not rated by alternative)

Appendix 5-H
Species With Risk to Viability - Fish

	Medium Risk to Viability					High Risk to Viability				
Alternative:	A	B	C	D	E	A	B	C	D	E
Fish										
No. of fish stocks at risk:	112	112	112	112	112	112	112	112	112	112

See Appendix 5-K for the full list of fish stocks.

Appendix 5-H
Species With Risk to Viability - Amphibians and Reptiles

	Medium Risk to Viability					High Risk to Viability				
Alternative:	A	B	C	D	E	A	B	C	D	E
Amphibians										
Oregon Slender salamander	1				1					1
Larch Mt. salamander	1	1	1	1	1	1				1
Siskiyou Mt. salamander	1	1	1	1	1	1	1	1	1	1
Del Norte salamander	1	1	1		1	1				1
Van Dyke's salamander (Coastal, Olym. Pe	1	1	1	1	1	1	1	1	1	1
Van Dyke's salamander (Cascades)	1	1	1	1	1	1	1	1	1	1
Dunn's salamander	1				1					
Black salamander	1				1					1
Clouded salamander (Oregon)	1				1					1
Clouded salamander (California)	1	1			1					1
Pacific giant salamander	1				1					1
Cope's giant salamander	1				1					1
Olympic salamander (R.olympicus)	1	1	1		1	1				1
Olympic salamander (R.kezeri)	1	1	1	1	1	1	1	1	1	1
Olympic salamander (R. cascadae)	1	1	1	1	1	1	1	1		1
Olympic salamander (R. varigatus)	1	1	1	1	1	1	1	1	1	1
Northwestern salamander	1				1					1
Shasta salamander	1	1	1	1	1	1	1	1	1	1
Roughskin newt	1				1					
Tailed frog	1	1	1		1	1				1
TOTAL	20	12	11	8	20	11	7	7	6	18
Reptiles										
(no species)	0	0	0	0	0	0	0	0	0	0

Appendix 5-H
Species With Risk to Viability - Birds

Birds

Alternative:	Medium Risk to Viability A	B	C	D	E	High Risk to Viability A	B	C	D	E
Marbled murrelet	1	1	1	1	1	1	1	1	1	1
Barrow's goldeneye	1				1					
Bufflehead	1	1	1	1	1					
Harlequin duck	1	1	1		1					
Northern goshawk	1	1			1	1				1
Northern pygmy-owl	1				1					
Flammulated owl	1	1	1	1	1					1
Northern spotted owl	1				1	1				1
Great gray owl	1	1	1	1	1					
Vaux's swift	1				1					
Pileated woodpecker	1				1					
White-headed woodpecker	1	1	1	1	1					1
Black-backed woodpecker	1	1			1					1
Three-toed woodpecker	1									
Red-breasted sapsucker	1				1					
Williamson's sapsucker	1				1					
Hammond's flycatcher	1				1					1
Pygmy nuthatch	1	1	1	1	1					
Red crossbill					1					
TOTAL birds	18	9	7	6	18	3	1	1	1	7

Appendix 5-H
Species With Risk to Viability - Mammals

Mammals

Alternative:	Medium Risk to Viability A	B	C	D	E	High Risk to Viability A	B	C	D	E
Marten (Olympic Peninsula)	1	1	1	1	1	1	1			1
Marten (Washington Cascades)	1				1					
Marten (Oregon Coast range)	1	1	1	1	1	1	1			1
Marten (Oregon Cascades)	1	1	1		1					1
Marten (Klamath Province)	1				1					
Fisher (CA, so. OR)	1	1	1		1	1				1
Fisher (no. OR, WA)	1	1	1	1	1	1	1	1	1	1
Red tree vole (P.longicaudus)	1	1	1	1	1	1	1	1		1
Red tree vole (P.pomo)	1	1	1	1	1	1	1	1		1
Big brown bat	1				1					
Silver- haired bat	1				1					1
Lynx	1	1	1	1	1	1				1
TOTAL mammals	12	8	8	6	12	7	5	3	1	9

1 = denotes viability risk
blank = denotes no viability risk

Appendix 5-I

Comparison of Species Lists of Terrestrial (Non-Fish) Vertebrates: Final Environmental Impact Statement and Scientific Analysis Team

Appendix 5-I
Comparison of Species Lists - Amphibians and Reptiles

List of species with viability risk under 1 or more alternatives from SAT evaluation.	On FEIS list of 32 spp.?	On SAT long list?	On SAT short list?	Alt. B Med. Risk	Alt. B High Risk
Amphibians					
Oregon Slender salamander		X	X		
Larch Mt. salamander		X	X	X	
Siskiyou Mt. salamander		X	X	X	X
Del Norte salamander	X	X	X	X	
Van Dyke's salamander (Coast., Oly. Pen.)		X	X	X	X
Van Dyke's salamander (Cascades)		X	X	X	X
Dunn's salamander		X	X		
Black salamander	X	X	X		
Clouded salamander (Oregon)		X	X		
Clouded salamander (California)		X	X	X	
Pacific giant salamander		X	X		
Cope's giant salamander		X	X		
Olympic salamander (R.olympicus)	X	X	X	X	
Olympic salamander (R.kezeri)	X	X	X	X	X
Olympic salamander (R. cascadae)	X	X	X	X	X
Olympic salamander (R. varigatus)	X	X	X	X	X
Northwestern salamander	X	X	X		
Shasta salamander		X	X	X	X
Roughskin newt	X	X	X		
Tailed frog	X	X	X	X	

Reptiles

(no species)

SAT = Scientific Analysis Team
FEIS = Final Environmental Impact Statement

Appendix 5-I
Comparison of Species Lists - Birds

List of species with viability risk under 1 or more alternatives from SAT evaluation.	On FEIS list of 32 spp.?	On SAT long list?	On SAT short list?	Alt. B Med. Risk	Alt. B High Risk
Birds					
Marbled murrelet	X	X	X	X	X
Barrow's goldeneye		X	X		
Bufflehead		X	X	X	
Harlequin duck		X	X	X	
Northern goshawk	X	X	X	X	
Bald eagle	X	X	X		
Northern pygmy-owl		X	X		
Flammulated owl		X	X	X	
Great gray owl		X	X	X	
Vaux's swift	X	X	X		
Pileated woodpecker		X	X		
Hairy woodpecker	X	X	X		
White-headed woodpecker		X	X	X	
Black-backed woodpecker		X	X	X	
Three-toed woodpecker		X	X		
Red-breasted sapsucker	X	X	X		
Williamson's sapsucker		X	X		
Hammond's flycatcher		X	X		
Western flycatcher	X	X	X		
Winter wren	X	X	X		
Pygmy nuthatch		X	X	X	
Chestnut-backed chickadee	X	X	X		
Golden-crowned kinglet	X	X	X		
Brown creeper	X	X	X		
Hermit warbler	X	X	X		
Varied thrush	X	X	X		
Red crossbill		X	X		

SAT = Scientific Analysis Team
FEIS = Final Environmental Impact Statement

Appendix 5-I
Comparison of Species Lists - Mammals

List of species with viability risk under 1 or more alternatives from SAT evaluation.	On FEIS list of 32 spp.?	On SAT long list?	On SAT short list?	Alt. B Med. Risk	Alt. B High Risk
Mammals					
Marten (Olympic Peninsula)		X	X	X	X
Marten (Washington Cascades)		X	X		
Marten (Oregon Coast range)		X	X	X	X
Marten (Oregon Cascades)		X	X	X	
Marten (Klamath Province)		X	X		
Fisher (CA, so. OR)	X	X	X	X	
Fisher (no. OR, WA)	X	X	X	X	X
Pacific shrew	X	X	X		
Douglas squirrel	X	X	X		
Western red-backed vole	X	X	X		
Shrew-mole	X	X	X		
Red tree vole (P.longicaudus)	X	X	X	X	X
Red tree vole (P.pomo)	X	X	X	X	X
Big brown bat	X	X	X		
Silver- haired bat	X	X	X		
Fringed myotis	X	X	X		
Little brown bat	X	X	X		
Yuma myotis	X	X	X		
California myotis	X	X	X		
Keen's myotis	X	X	X		
Lynx		X	X	X	

SAT = Scientific Analysis Team
FEIS = Final Environmental Impact Statement

Appendix 5-J

Species for Which Information is Most Limited

Appendix 5-J
Species for Which Information is Most Limited

NON-VASCULAR PLANTS
1. Live wood
Lichens

Species	May be at least locally common to abundant	Rare to uncommon but wide-spread	Locally endemic where known	Closely assoc'd w/ old-growth forests and conditions	Specialized to specific substrates or edaphic conditions	High elevation forests	On fringe of range of northern spotted owl	Other; may still need further study
Bacidia herrei								X
Cavernularia hultenii								X
Cavernularia lophyrea								X
Cetraria californica	X			X				
Cetrelia cetrarioides	X			X				
Collema nigrescens		X						
Dendriscocaulon intricatulum								X
Heterodermia leucomelos								X
Hypocenomyce friesii								X
Hypogymnia duplicata								X
Hypogymnia oceanica								X
Hypogymnia rugosa								X
Leptogium cyanescens		X						
Lichinodium canadense								X
Lopadium pezizoideum								X
Pannaria leucostictoides								X
Pannaria rubigninosa								X
Pannaria saubinetii								X
Parmotrema chinense		X		X				
Parmotrema crinitum		X		X				
Platismatia norvegica		X		X				
Ramalina thrausta								X

Appendix 5-J
Species for Which Information is Most Limited (continued)

Species	May be at least locally common to abundant	Rare to uncommon but wide-spread	Locally endemic where known	Closely assoc'd w/ old-growth forests and conditions	Specialized to specific substrates or edaphic conditions	High elevation forests	On fringe of range of northern spotted owl	Other; may still need further study
Liverworts								
Douinia ovata	X				X			
Mosses								
Pseudoleskea stenophylla	X				X			
2. Decaying wood								
Mosses								
Pseudoleskea saviana								X
3. Soil and bases of trees								
Lichens								
Peltigera neopolydactyla								X
Peltigera pacifica								X
4. Rock								
Mosses								
Lescuraea incurvata								X
Pseudoleskea incurvata	X				X			
Pseudoleskea patens	X				X			
Pseudoleskea radicosa	X				X			
Thamnobryum neckeroides	X							

5. Water
(no species)

Appendix 5-J
Species for Which Information is Most Limited (continued)

Species	May be at least locally common to abundant	Rare to uncommon but wide-spread	Locally endemic where known	Closely assoc'd w/ old-growth forests and conditions	Specialized to specific substrates or edaphic conditions	High elevation forests	On fringe of range of northern spotted owl	Other; may still need further study
6. Other								
Fungi								
Collybia racemosa			X	X	X			
Elaphomyces granulatus	X							
Elaphomyces muricatus	X							
Hysterangium crassirhachis	X							
Hysterangium setchelli	X							
Rhizopogon atroviolaceus	X							
Tuber rufum	X							
TOTAL NONVASCULAR PLANTS	14	5	1	6	6	0	0	19
VASCULAR PLANTS								
Orchids								
Listera borealis								X
Platanthera sparsiflora			X		X			
Grape ferns								
Botrychium pumicola								X
Others with Listing Status								
Asarum wagneri								X
Fritillaria gentneri								X
Silene nuda								X

Appendix 5-J
Species for Which Information is Most Limited (continued)

Species	May be at least locally common to abundant	Rare to uncommon but wide-spread	Locally endemic where known	Closely assoc'd w/ old-growth forests and conditions	Specialized to specific substrates or edaphic conditions	High elevation forests	On fringe of range of northern spotted owl	Other; may still need further study
Viola renifolia		X						X
Others Without Listing Status								
Angelica tomentosa								X
Berberis pumila					X			
Synthyris schizantha								X
TOTAL VASCULAR PLANTS	0	1	1	0	2	0	0	8
INVERTEBRATES (all poorly known and require study)	0	0	0	0	0	0	0	149
FISH	0	0	0	0	0	0	0	0

TERRESTRIAL VERTEBRATES

Amphibians

TOTAL AMPHIBIANS	0	0	0	0	0	0	0	0

Appendix 5-J
Species for Which Information is Most Limited (continued)

Species	May be at least locally common to abundant	Rare to uncommon but wide-spread	Locally endemic where known	Closely assoc'd w/ old-growth forests and conditions	Specialized to specific substrates or edaphic conditions	High elevation forests	On fringe of range of northern spotted owl	Other; may still need further study
Reptiles								
0 reptile forms on short list	0	0	0	0	0	0	0	0
Birds								
TOTAL BIRDS	0	0	0	0	0	0	0	0
Mammals								
Hoary bat		X		X				X
Long-legged myotis				X				X
Yuma myotis				X				X
California myotis				X				X
Keen's myotis		X		X				X
Long-eared myotis				X				X
Fringed myotis				X				X
Little brown myotis				X				X
Pallid bat								X
Wolverine						X		
TOTAL MAMMALS	0	2	0	8	0	1	0	9

Appendix 5-K

Strategy for Managing Habitat of At-Risk Fish Species and Stocks in National Forests Within the Range of the Northern Spotted Owl

Table of Contents

Appendix 5-K
Strategy for Managing Habitat of At-Risk Fish Species

List of Tables

List of Figures

APPENDIX 5-K

Strategy for Managing Habitat of At-Risk Fish Species and Stocks in National Forests Within the Range of the Northern Spotted Owl

INTRODUCTION

Many fish stocks of anadromous salmonids (*Oncorhynchus* spp.) are presently in questionable conditions. (A stock is a locally adapted population that is reproductively isolated from other stocks [Ricker 1972]). The Endangered Species Committee of the American Fisheries Society recently identified 214 fish stocks in California, Oregon, Washington, and Idaho that are in need of special management considerations because of low or declining numbers (Nehlsen et al. 1991). Another, the Illinois River winter steelhead trout (*O. mykiss*), is being considered for threatened and endangered status. Another 101 were believed to face a high risk of extinction and 58 a moderate risk. An additional 106 fish stocks are believed to already be extinct (Nehlsen et al. 1991). To date, 4 have been listed as threatened and endangered. Figure 5-K-1 shows the distribution and status of these fish stocks in the area of the northern spotted owl. One, the Sacramento River winter chinook salmon (*Oncorhynchus tshawytscha*), has been listed under the Endangered Species Act. Higgins et al. (1992) and USDI (1992) also identified stocks of anadromous salmonids that were in danger of extinction. These fish stocks are primarily subsets of those identified by Nehlsen et al. (1991). For this report, we only considered fish stocks identified by Nehlsen et al. (1991).

Primary factors contributing to the decline of anadromous salmonid stocks include: (1) degradation and loss of freshwater and estuarine habitats due to urbanization, agriculture, livestock grazing, mining, timber harvest, and dams; (2) over-exploitation 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 non-local stocks (Nehlsen et al. 1991). Often two or more of these factors operating in concert are responsible for a decline in fish stock numbers.

The status of anadromous fish stocks in northern California, Oregon, and Washington reflects the condition of fish throughout North America. Williams et al. (1989) listed 364 species and subspecies of fish in North America that are in need of special management considerations because of low population numbers. This is an increase of 139 species since 1979. No species were removed from the list as a result of successful recovery programs. Allendorf (1988) reported that a large proportion of the freshwater fish fauna in western North America is in precarious condition and in need of special attention. He noted that the potential rates of loss of biodiversity rival those observed in the tropics. Moyle and Williams (1990) found that 57 percent of the native freshwater fish of California were extinct or in need of immediate action. The condition of these fish is attributable to the same suite of factors that are responsible for the state of anadromous salmonid stocks (Williams et al. 1989, Moyle and Williams 1990).

Loss and degradation of freshwater habitats are the most frequent factors responsible for the decline of anadromous salmonids 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 have resulted from an array of human activities including urbanization, agricultural activities, timber harvest and associated activities, livestock grazing, water withdrawal and diversion, and dams (Nehlsen et al. 1991). In the region of the northern spotted owl the first three are the activities that are primarily responsible for the loss or decrease in the quality of fish habitat. On lands within the range of the northern spotted owl managed by the Forest Service, the primary land management activities affecting fish habitat are timber harvest and associated activities, and some grazing.

Freshwater habitat may be disproportionately more important for the survival and persistence of anadromous salmonid stocks found in the range of the northern spotted owl than it would be for species and fish stocks found in more northerly areas. All anadromous salmonids spend a portion of their life cycle in freshwater. Adults return from the ocean to reproduce. Early life history stages (i.e., eggs, alevins, fry and juveniles) also occur in freshwater. Duration of freshwater residence ranges from a few days or weeks to 2 or more years depending on species and fish stocks.

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 often occur off the coast of northern California, Oregon and Washington (Bottom et al. 1986). Favorable conditions exist when the boundary is more southerly, which has occurred on average of 1 in 4 years in the last 40 years (Bottom et al. 1986). During favorable ocean conditions, survival of at least some fish stocks is greater than during less favorable conditions (Nickelson 1986).

Additionally, the coast in this region has a low shoreline/coastline ratio (Bottom et al. 1986). The consequence of this is that there are few well developed estuaries and other nearshore rearing areas. These areas are sites of early growth in the ocean, which is important for survival in the marine environment (Hager and Noble 1976, Bilton et al. 1982, Ward et al. 1989, Henderson and Cass 1991, Pearcy 1992). This is particularly important during times of unfavorable ocean conditions. In much of the region of the northern spotted owl, fish moving to the ocean do not have nearshore areas in which to grow. In contrast, British Columbia and southeast Alaska have higher shoreline/coastline ratios and thus more and better nearshore habitats. Because of the scarcity of nearshore habitats and the variable ocean conditions, the existence of adequate quantities and qualities of freshwater habitat is more critical for the survival and persistence of fish stocks in the range of the northern spotted owl than it is for fish stocks in more northerly areas. Compared to fish in areas with more stable ocean conditions and better developed nearshore habitats, fish in the region of the northern spotted owl are more dependent on freshwater environments to achieve larger sizes, which increase probability of marine survival.

CHARACTERISTICS OF FISH HABITAT IN NATIONAL FORESTS WITHIN THE RANGE OF THE NORTHERN SPOTTED OWL

Characteristics of High Quality Fish Habitat Conditions

Assemblages of anadromous salmonids associated with forests within the range of the northern spotted owl include five species of Pacific salmon and two species of trout (Table 5-K-1). Each species has a variable number of discreet fish stocks that are genetically isolated from each other and specifically adapted to local habitat characteristics. It is quite common for several species and numerous fish stocks to coexist in the same sections of stream systems throughout their range. As a result, the anadromous salmonid assemblage of most stream systems is a complex mixture of several species and stocks. Each species and fish stock has exacting but different habitat requirements (see Bjornn and Reiser 1991), requiring diverse and complex habitats to maintain populations of all groups.

The life history of anadromous salmonids adds to the complexity of freshwater habitat needs. All anadromous salmonids spawn in freshwater. Juvenile fish rear in streams and lakes for variable periods of time before moving to the ocean where they grow to adulthood (see Meehan and Bjornn 1991, Groot and Margolis 1991). Some species reside in freshwater for only a few weeks (e.g., pink and chum salmon), but more commonly, juveniles reside in freshwater for one to several years (e.g., coho salmon and cutthroat trout), growing to 8 inches or more in size before entering the ocean. Habitat needs are different for each species, age class and size class of juvenile fish, and for each season of the year (Bjornn and Reiser 1991, Groot and Margolis 1991). Therefore, freshwater habitats must provide good water quality and quantity, as well as numerous substrate and habitat types, cover, and food resources to accommodate the habitat needs of mixed anadromous salmonid assemblages.

Freshwater habitat requirements of anadromous salmonids have been well documented in the scientific literature (see Bjornn and Reiser 1991, Groot and Margolis 1991). A weakness of the documentation, however, is that habitat descriptions are species specific. The descriptions do not take into account that almost all habitats used by anadromous fish must accommodate complex assemblages of species and stocks, rather than a single species or stock. The more complex the salmonid community, the more complex are the habitats needed to meet the requirements of all species and sizes of fish at all seasons of the year.

The following characteristics of productive natural habitats for anadromous salmonids apply to 3rd- to 5th-order streams (Strahler 1957) which may support a mixed species assemblage of juvenile anadromous salmonids. (Streams of these orders are generally 15-50 feet wide and are typical of streams managed by the Forest Service within the range of the northern spotted owl.) Not all of the desired features are expected to occur in a specific reach of stream, but they generally will occur throughout a productive watershed. Factors such as climate and geology can exert strong influences on productivity of streams and influence fish habitat. Although these are beyond human control (Naiman et al. 1992), their effects must be considered in any management decisions.

Water Quality - All salmonids require high quality water for spawning, rearing, and migration (Bjornn and Reiser 1991). An abundance of cool (generally <68°F), well oxygenated water, free of excessive amounts of suspended sediments (Sullivan et al. 1987) and other pollutants is required at all times of the year. Water temperatures must be within the range that synchronize the time of migration and emergence of fish and other aquatic organisms (Sweeney and Vannote 1978, Quinn and Tallman 1987).

Water Quantity - Adequate flow is critical at specific times in life cycles for spawning, rearing, and migration. The fish are adapted to natural variations in flow regimes, but are adversely affected by disturbances that alter natural flow cycles (Statzner et al. 1988).

Channel Characteristics - The most productive stream systems for mixed salmonid assemblages have gradients <5 percent. They are comprised of constrained (i.e., ratio of valley width/active channel width <3) and unconstrained (i.e., ratio of valley width/active channel width >3) reaches, which contain a broad diversity and complexity of habitat features. Constrained reaches generally have fewer juvenile fish and less diverse assemblages than unconstrained areas. Constrained reaches are important, however, as sources of cool water (McSwain 1987), holding areas for adult salmonids, and are avenues of transport for sediment, wood, and other materials to unconstrained reaches (Naiman et al. 1992).

Unconstrained reaches are generally sites of high fish densities. They are also sites of sediment, organic material, and nutrient storage and processing (Stanford and Ward 1988). High quality habitats maintain a balance between high quality pools, riffles, glides, and side channels. Cover features such as large woody debris, boulders, undercut banks, overhanging vegetation, deep water, and surface turbulence are abundant in high quality habitats. Substrates consist of a variety of particle sizes ranging from silts to boulders to accommodate the spawning and rearing needs of all species (Everest et al. 1987, Sullivan et al. 1987). Spawning gravels contain low percentages of fine sediments, generally <20 percent (see Bjornn and Reiser 1991). Channels are free of obstructions that may interfere with the upstream or downstream migration of adult or juvenile salmonids.

Riparian Vegetation - Riparian vegetation regulates the exchange of nutrients and material from upland forests to streams (Swanson et al. 1982, Gregory et al. 1991). 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). Stream banks 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).

Watershed Conditions - There is a strong connection among all parts of the watershed (Naiman et al. 1992). Upland portions of watersheds are well vegetated, generally stable, and free from chronic and accelerated sedimentation. Watersheds are free from disturbances that alter natural streamflow regimens, the quality of water emanating from uplands, and delivery of large wood and sediment to streams occupied by fish (Naiman et al. 1992). Unstable headwall areas are vegetated with large conifers, or a combination of conifers and hardwoods.

The wide range of natural variation of individual factors and the complex interplay between stream habitat variables (e.g., numbers of pools and pieces of large wood, percent fine sediment, and water temperature) make it difficult to quantitatively establish levels 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.

Stream habitat variables should 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; and Ralph et al. unpub.). 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).

Current Conditions of Fish Habitat

Fish habitat in National Forests and other lands within the range of the northern spotted owl is currently in less than optimal condition (Hicks et al. 1991, Bisson et al. 1992). Habitat has been lost or the quality reduced because of past (Sedell and Luchessa 1982, Benner 1992, Bisson et al. 1992) and present land management and regulatory activities (Bisson and Sedell 1984, Grant 1986, Salo and Cundy 1987, Meehan 1991). These trends in habitat conditions represent the cumulative effects of these actions (Hicks et al. 1991).

The number of large, deep pools (i.e., >6 ft deep and >50 yd.^{2} surface areas) in many tributaries of the Columbia River have decreased in the past 50 years (Sedell and Everest 1991). This was determined by comparing quantitative habitat surveys done recently with surveys done by the Bureau of Fisheries, now the National Marine Fisheries Service, between 1934 and 1941 (Rich 1948, Bryant 1949, Bryant and Parkhurst 1950, Parkhurst 1950a-c, Parkhurst et al. 1950). The Bureau of Fisheries surveys are unique because they are the only long-term data set that quantifies fish habitat in a way that is replicable over time. In the Washington and Oregon Cascade Mountains, the historical surveys were generally in late-successional Douglas-fir forests that had not been extensively roaded and harvested.

Overall, there has been a 58 percent reduction in the number of large, deep pools in resurveyed streams in National Forests within the range of the northern spotted owl in western and eastern Washington (Table 5-K-2). A similar trend was found in streams on private lands in coastal Oregon where large, deep pools decreased by 80 percent (Table 5-K-2). 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 channel sinuosity by channelization (Furniss et al. 1991, and Benner 1992).

The Wind River in the Gifford Pinchot National Forest in Washington was the exception to the trend. Large, deep pools increased between 1937 and 1992 (Table 5-K-2). The upper western portion of the Wind River burned in the 1910's during the Yacolt Burn. Its channels were also cleared and used for log drives. Recovery has been a result of Forest Service restoration efforts and the flood of 1964, which probably helped to return large wood and boulders into the upper tributaries of the Wind River basin.

Ralph et al. (unpub.) reported the loss of pools in streams in basins with moderate levels of timber harvest (i.e., <50 percent of the basin harvested in the last 40 years) to intensive levels of timber harvest (i.e., >50 percent of the basin harvested within the last 40 years and a road density of >5.3 miles per mile^2) in western Washington. Habitat features in stream segments draining basins with old-growth forests were compared to those in streams in basins with moderate and intensive timber harvest levels. In streams in basins with moderate harvest levels, the percent of the area of pools and pool depth was less than that found in the streams draining old-growth forests. Pools >3 feet in depth were greatly reduced in the intensively harvested basins compared to those containing old growth. Bisson and Sedell (1984) reported similar results for other streams in western Washington. Such changes in habitat can result in a decrease in the diversity of the salmonid assemblage (Bisson and Sedell 1984; Reeves et al., in press).

The South Fork Umpqua River, in the Umpqua National Forest, was surveyed in 1937 by the Bureau of Commercial Fisheries on contract to the Forest Service. In 1990, seven tributaries were resurveyed by the Forest Service (J. Dose, Umpqua National Forest). In the area of two of these streams, Quartz and Castle Rock Creeks, there has been only a small amount of roading and logging and these streams serve as "controls" for evaluating changes in habitat conditions. The areas of the other five streams have been roaded and extensively logged, beginning in the early 1960's. Stream widths have increased 50 to 110 percent in the intensively logged areas. Width of one control stream decreased, while in the other it increased by 13 percent. Stream temperatures were taken on Quartz Creek and four of the five streams on various dates in July and August, 1937. All of the streams had temperatures below 65°F at that time. From 1980 to 1990, Quartz Creek, one of the controls, still exhibited a summer maximum water temperature regime below 65°F during the period July 1 to August 20. (Temperature data were not available from the other control, Castle Rock Creek.) Maximum water temperature in streams of four of the five logged areas when measured over the same 60-day summer period for the last 10 years, exceeded 65°F from 62 to 93 percent of the time. (Temperatures were not available from the fifth stream.) Numbers of pieces of large wood (>36" diameter and 50' long) reflect the same trends: much higher amount in the control streams than those in areas that have been roaded and harvested.

Causes and Implications of Habitat Degradation

Quantitative relationships between long-term trends in the abundance of fish and fish habitat and the effects of forest management practices have been difficult to establish (Hicks et al. 1991, Bisson et al. 1992). Because of inherent differences in stream size, storm magnitude, and geology, similar management practices may result in different responses (Hicks 1990). In addition, extended time periods may be required before the effects of land management activities are expressed in streams.

Despite the lack of strong quantitative relationships between forest management activities (and other activities as well), a primary consequence of these activities has been the simplification of fish habitat (Hicks et al. 1991, Bisson et al. 1992). Simplification of stream channels involves a decrease in the range and variability of stream flow velocities and depths (Kaufmann 1987), reductions in the amount of large wood and other structural elements (Bisson et al. 1987, Bilby and Ward 1991), elimination of physical and biological interactions between a stream and its floodplain (Naiman et al. 1992), and a decrease in the frequency and diversity of habitat types and substrates (Sullivan et al. 1987). Salo and Cundy (1987) and Meehan (1991) contain additional references detailing the link between effects of land management activities and the condition of fish habitat. The consequence of these changes has been a reduction in the diversity and quality of habitats available to fish.

A conference of management agencies and interested individuals and groups was convened recently by the Governor of Oregon (Oregon Governor's Coastal Salmonid Restoration Initiative, Newport, Oregon, 15-17 December 1992). For this conference, a panel of biologists from state and Federal agencies, universities, and private industries was asked to assess the degree to which various factors limit production of the wild species and stocks of anadromous salmonids in coastal Oregon (coho, chinook, and chum salmon; steelhead and sea-run cutthroat trout). The evaluation of factors limiting production of the wild species and stocks of anadromous salmonids in coastal Oregon which were presented at the Governor's conference is the most extensive and detailed current evaluation in the coastal forests with spotted owls. Although it was a subjective assessment, it drew upon the expertise and judgement of numerous resource specialists, scientists, and fisheries managers. The intent was to provide the basis needed to develop programs to protect and restore the production of these fish.

Results of the assessment of limiting natural production for freshwater components, spawning and rearing habitat, are shown in Table 5-K-3. Spawning gravel quantity and quality were rated as having a high potential for limiting production of chum salmon and fall and spring chinook (Table 5-K-3). Gravel quality was believed to be poor because it was unstable (i.e., gravel containing developing eggs and alevins was subjected to movement during higher flows resulting in dislodgement or burial of eggs and alevins). Coho salmon production had a medium potential to be limited by gravel quantity and quality (Table 5-K-3). For coho salmon, gravel quantity was the responsible factor for the ranking. Lack of gravel in many streams probably is a consequence of both historic activities, such as splash damming. (Splash dams were structures constructed on streams that created ponds. Logs were either dropped into the pool behind the dam or in the channel downstream. The dam was opened, generally during periods of high stream flows. The resulting flow then transported the logs downstream. The consequence of this was that stream channels were straightened and often scoured to bedrock.) More recent activities, such as stream channel clearance, have also reduced or eliminated the amount of large wood that trapped and stabilized gravels in coastal streams.

Many facets of rearing habitat were identified as having high potentials to limit every species and race of anadromous salmonids except fall chinook salmon (Table 5-K-3). Increased water temperature was important along the south coast. Reduced numbers of deep complex pools and large sized wood in streams have resulted in a simplified rearing habitat that has a high potential for limiting several species and life history stages. Wetland and estuarine rearing areas have also been degraded. Riparian areas presently have very few large trees growing within 100 to 200 feet of the stream, suggesting that streamside recruitment of large wood will be deficient for decades. Alteration of both high and low streamflows caused by irrigation withdrawal, forest management activities, and stream channel simplification has limited the natural productivity of many streams. Species and fish stocks that rear in fresh water for extended periods were believed to be most affected.

Large Wood - Large wood is essential for creating and maintaining good fish habitat in streams (Bisson et al. 1987). Large wood influences the routing and storage of sediment and 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). Refer to reviews by Bisson et al. (1987), Maser et al. (1988), and Naiman et al. (1992) for more detail on the role and function of large wood. Wood enters streams inhabited by fish either directly from the adjacent riparian zone or from upslope tributaries and hillslopes that are accessible to or not inhabited by anadromous fish (Naiman et al. 1992).

Large wood in streams has been reduced because of a variety of past and present-day timber harvesting and associated activities. Buffer zones have been inadequate because they have been too narrow and were vulnerable to windstorms and floods. In addition, harvest and salvage logging operations in buffer zones have further reduced the long-term recruitment of large wood (Bryant 1980, Bisson et al. 1987). Also, the absence of vegetative buffers in tributaries not inhabited by fish may eliminate sources of large wood for streams inhabited by fish (Naiman et al. 1992). Debris flows and dam-break floods resulting from timber harvest activities may remove large wood from channels and riparian vegetation from streambanks (Benda and Zhang 1990, Swanston 1991) on one portion of a drainage system and deposit this material downstream.

The absence of wood in many streams may also be the legacy of past activities. 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 networks that stored water to be released to flood streams and transport logs, also removed large amounts of wood from streams (Sedell and Luchessa 1982, Sedell et al. 1991).

Habitat Complexity - A primary factor influencing the diversity of stream fish communities is habitat complexity. Attributes of habitat complexity 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), the types and frequency of habitat units, and the variety of substrates (Sullivan et al. 1987). More complex 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).

Habitat simplification may result from timber harvest activities (Bisson and Sedell 1984; Hicks et al. 1991; Bisson et al. 1992; Frissel 1992; Ralph et al. unpub.). 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 (Furniss et al. 1991) reduces stream meandering, and decreases pools formed by stream meanders that undercut banks. Influxes of sediment from increased mass failures of roads (Megahan and Kidd 1972, Morrison 1975, Swanson and Dyrness 1975, Swanson et al. 1981, Ketcheson and Froehlich 1978, Marion 1981, Megahan et al. 1992, Coats 1987, Janda et al. 1975, Kelsey et al. 1981, Madej 1984, Beschta 1978, Nolan and Marron 1985) and from increased mass failures following harvest on unstable slopes (Morrison 1975, Swanson and Dyrness 1975, 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) can result in the loss of pools.

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., in press). One fish 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).

Water Temperature - 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 (Beschta et al. 1987).

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 (*Richardsonius balteatus*) and juvenile steelhead was influenced by water temperature; trout dominated at temperatures (<68°F) and shiners at temperatures (>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 juveniles (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 variability of eggs of spring chinook salmon were affected by elevated water temperatures.

Sediments - Increased levels of sediment can have negative impacts on anadromous fish and their habitat. Developing eggs and embryos of anadromous salmonids generally require gravel with <20 percent fines, which may vary in size from silt to sand (Bjornn and Reiser 1991). Survival of developing eggs and alevins decreases as the levels of fines increase (Cederholm and Reid 1987, Chapman 1988, Scrivener and Brownlee 1989, Everest et al. 1987, Bjornn and Reiser 1991). Also, fine sediment that is deposited or in suspension can reduce primary production and benthic invertebrate abundance (Cordane and Kelly 1961, Lloyd et al. 1987). This can reduce food availability for fish.

Increased sediments in streams can be a result of timber harvest and associated activities. Infilling of spawning gravel by fine sediments may result from accelerated erosion of road surfaces and by road failures (Megahan and Kidd 1972, Morrison 1975, Swanson and Dyrness 1975, Swanson et al. 1981, Ketcheson and Froehlich 1978, Marion 1981, Furniss et al. 1991, Megahan et al. 1992, Coats et al. 1985, Janda et al. 1975, Kelsey et al. 1981, Madej 1984, Nolan and Marron 1985, Cederholm and Reid 1987). Slope failures following harvest on unstable slopes may also result in increased levels of sediment (O'Loughlin 1972, Megahan and Kidd 1972, Morrison 1975, Swanson and Dyrness 1975, Swanson et al. 1981, Ziemer and Swanston 1977, Ketcheson and Froehlich 1978, Marion 1981, Megahan et al. 1992, Scrivener and Brownlee 1989).

Rate of Habitat Recovery - Recent work by Hicks (1990) and Bilby and Ward (1991) suggest that habitat is slow to recover to pre-harvest levels of complexity. Schwartz (1991) found that cutthroat trout populations in streams with coho salmon failed to recover to pre-timber harvest levels 25 years after harvest. Gurtz and Wallace (1984) believed that timber harvest has no analogue in the natural disturbance regime and therefore, some organisms may not have evolved an appropriate response to it. Yount and Niemi (1990) classified timber harvest as a "press disturbance". This suggests a differential response of species to the disturbance and the system may not recover to pre-disturbance states, due to the loss or alteration of functions and processes affecting the system.

Alteration of ecological processes and environmental conditions may affect several levels of ecological organization. Individual and population responses may vary depending on the magnitude and duration of the impact, species-specific requirements (Kelly and Harwell 1990, Yount and Niemi 1990), and the presence of refugia (Sedell et al. 1990). Because of variability in response by individuals and populations, members of a community are unlikely to exhibit a uniform response to disturbance or environmental alteration. The effect of disturbance on communities depends, in part, on the combined effect on both individuals and populations as well as the extent to which processes that influence the structure and composition of communities are altered (e.g., Reeves et al. 1987, Baltz et al. 1982).

CONSERVATION STRATEGY FOR FISH HABITAT IN NATIONAL FORESTS WITHIN THE RANGE OF THE NORTHERN SPOTTED OWL

In keeping with the principles and information presented in the previous sections, we have developed a conservation strategy for fish habitat in National Forests within the range of the northern spotted owl. The strategy is designed to provide a high probability for maintaining and restoring habitat for fish. Its focus is on maintaining and restoring ecological functions and processes that operate in a watershed to create habitat. We believe this type of approach is both prudent and necessary given the current perilous state of many native fish stocks of salmon and trout (Nehlsen et al. 1991, Higgins et al. 1992, USDI 1992), resident fish (Williams et al. 1989, USDI 1992), and other riparian dependent organisms (USDI 1992, Chapter 5 of this report) found on Federally managed lands within the range of the northern spotted owl.

This conservation strategy is a slightly modified version of one of 8 scenarios for managing anadromous salmonid habitat in National Forests in Idaho, Oregon, Washington, California, and Alaska evaluated as part of the Forest Service's Pacific Salmon Workgroup and Field Team (hereafter referred to as the Pacific Salmon Workgroup, also known as "PacFish") (USDA 1992a). This strategy is not a modification in substance or content of the selected Pacific Salmon Workgroup alternative but in the geographic areas to which the alternative applies. The Pacific Salmon Workgroup is only concerned with anadromous salmonids. The present effort includes portions of two National Forests that do not have anadromous salmonids, the Deschutes and Winema National Forests, However, we believe that the strategy presented here is applicable for management of aquatic habitats on these lands. Both of these National Forests have populations of bull trout, which is currently being considered for threatened and endangered status, primarily because of the degradation and loss of its habitat.

The Scientific Analysis Team was not asked to develop a set of management alternatives as was done for the Pacific Salmon Workgroup. The Forest Service will continue to evaluate all alternatives developed by the Pacific Salmon Workgroup independent of the Scientific Analysis Team's effort. The Forest Service may opt to adopt or implement another management strategy which could have a lower or higher probability of maintaining and restoring aquatic habitat. Regardless of the Forest Service's decision upon completion of the Pacific Salmon Workgroup's Management Strategy for Pacific Salmon and Steelhead Habitat, the content and assessment of the conservation strategy for habitat of fish proposed by the Scientific Analysis Team will not change.

In this section the scientific rationale for the proposed conservation strategy is set forth and the specific elements of that strategy are described.

Rationale and Basis for Conservation Strategy

The approach we have taken in developing our recommended conservation strategy for fish differs from comparable strategies for other organisms. Reasons for this rest primarily with the unique biological requirements of, and scientific uncertainties associated with, anadromous fish. Unlike other organisms whose habitat requirements may be well-defined and understood, anadromous fish occupy a range of habitats over large areas because of their life histories, environmental conditions, and interspecific interactions (Bisson et al. 1992). Over the course of its life, an individual fish may hatch in a headwater stream, rear in a lower-gradient alluvial reach, pass through an estuary on the way to the ocean, only to reoccupy many of the same habitats upon returning to spawn. The freshwater component of their life histories thus plays out over a grand scale that may span several hundred miles of river networks set within a landscape of many thousand square miles. Any conservation strategy to protect and restore fish habitat must take this scale into account.

A second factor is that the current level of scientific understanding of fish habitat relationships does not allow us to define specific habitat requirements for fish throughout their life cycle at the watershed level. The general habitat needs of fish are well known (i.e., deep resting pools, cover, certain temperature ranges, 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. Our understanding of fish habitat requirements is largely based on laboratory and site-specific studies that typically examine a single requirement for a single species at one point in its life cycle at a time. In natural watersheds, however, the 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.

There is the need to address fish habitat at a broad landscape scale. In addition, there is limited knowledge about how habitat should be distributed over a watershed through time. Consequently, we have not adopted a strategy of delineating specific watersheds with explicit standards for habitat elements. Rather, we have focused our efforts on developing a landscape-wide strategy that seeks to retain, restore, and protect those processes and landforms that contribute habitat elements to streams and promote good habitat conditions for fish and other riparian-dependent organisms. We have attempted to develop a conservation strategy that is aimed at restoring and maintaining the ecological health of watersheds (Karr et al. 1986, Karr 1991, Naiman et al. 1992). At the heart of this approach is a recognition that fish and other aquatic organisms have evolved within a dynamic environment that has been constantly influenced and changed by geomorphic and ecologic disturbances. Good stewardship of aquatic resources requires that land use activities not alter this disturbance regime beyond the range of conditions to which these organisms have become adapted.

The disturbance regime of watersheds in the Pacific Northwest includes both geomorphic and non-geomorphic processes. Important geomorphic processes include mass movements (i.e., debris slides, debris flows, deep-seated landslides), peak streamflows, bank erosion, dam-break floods, and ice rafting (Swanston 1991). Non-geomorphic processes include fire, windstorms, and vegetation mortality due to disease and insects. These processes influence the input rate, quantity, quality, and movement of water, sediment, nutrients and wood through streams. It is the interaction of these elements with the channel and surrounding riparian zone that determines the abundance and quality of fish habitat within watersheds. Habitat degradation occurs where a change in the character of disturbance processes, such as in their frequency, duration, magnitude, severity, or legacy of physical structure, pushes this interaction outside the range of conditions to which fish have evolved. Most of the habitat degradation caused by human activities is due to increasing the frequency or magnitude of disturbances (i.e., landslides and debris flows [Swanston and Swanson 1976]), or decreasing the physical legacy of disturbances (e.g., by reducing the quantity or quality of large woody debris delivered to channels by landslides and debris flows [Naiman et al. 1992]).

Our strategy is to maintain as close to a "natural" disturbance regime as is possible within watersheds and landscapes, many of which have already been altered by human activities. We recognize that disturbances are essential to maintain good aquatic habitat. Typically, elements that physically create this habitat (i.e., boulders, large wood, gravel) are contributed to streams by episodic events (Naiman et al. 1992). However, the rate at which these episodic disturbances occur should not be significantly increased due to human activities. And, when these disturbances do occur, they retain all of the elements necessary to create high quality habitat.

Doing this requires several approaches. Land-use activities need to be limited or excluded in parts of the landscape prone to geomorphic disturbances, such as mass movements or bank erosion. The distribution of land use activities, such as clearcuts or roads, needs to be analyzed to ensure that peak streamflows are not being increased. 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 further downstream. Riparian zones along larger channels need protection to limit bank erosion due to trampling, grazing, and compaction, to ensure an adequate and continuous supply of large wood to channels, and to provide shade and microclimate protection.

The approach we have taken is designed to accomplish these objectives. It needs to be emphasized, however, that it will require time for this strategy to work. Because it is based on natural disturbance processes, it may require timescales of decades to over a century to accomplish all of its objectives. Significant improvements in fish habitat, however, can be expected on the timescale of 10 to 20 years. Equally important, however, is that this strategy will protect existing good habitat from degradation. This is particularly true since this approach seeks to maintain and restore habitat over broad landscapes as opposed to individual projects or small watersheds. We believe that if this approach is conscientiously implemented and applied, it will provide protection for habitat for fish and other riparian-dependent species resources and restore currently degraded habitats.

RIPARIAN MANAGEMENT OBJECTIVES

Riparian and aquatic ecosystems are physical-biological systems in or near surface waters that have primary values associated with water and the proximity of land to water (Gregory et al. 1991). These ecosystems include terrestrial, semi-aquatic (land/water interface), and aquatic components and habitats. To manage ecosystems, it is crucial to analyze the whole system by pulling individual system components together and then evaluating all important influences, interconnections, and interactions (Naiman et al. 1992).

Riparian and aquatic ecosystems in National Forests within the range of the northern spotted owl will be managed to achieve the following specific riparian objectives:

1. Maintain or restore water quality to a degree that provides for stable and productive riparian and aquatic ecosystems. Water quality parameters that apply to these ecosystems include timing and character of temperature, sediment, and nutrients.

2. Maintain or restore the stream channel integrity, channel processes, and sediment regime under which the riparian and aquatic ecosystems developed. Elements of the sediment regime include the timing, volume, and character of sediment input and transport.

3. Maintain or restore instream flows to support desired riparian and aquatic habitats, the stability and effective function of stream channels, and the ability to route flood discharges.

4. Maintain or restore the natural timing and variability of the water table elevation in meadows and wetlands.

5. Maintain or restore the diversity and productivity of native and desired non-native plant communities in riparian zones.

6. Maintain or restore riparian vegetation to provide an amount and distribution of large woody debris characteristic of natural aquatic and riparian ecosystems.

7. Maintain or restore habitat to support populations of well-distributed native and desired non-native plant, vertebrate, and invertebrate populations that contribute to the viability of riparian-dependent communities.

8. Maintain or restore riparian vegetation to provide adequate summer and winter thermal regulation within the riparian and aquatic zones.

9. Maintain or restore riparian vegetation to help achieve rates of surface erosion, bank erosion, and channel migration characteristic of those under which the desired communities developed.

10. Maintain and restore riparian and aquatic habitats necessary to foster the unique genetic fish stocks that evolved within that specific geo-climatic ecoregion.

Components of the Fish Habitat Conservation Strategy

The Fish Habitat Conservation Strategy is designed to conserve and restore habitat for at-risk stocks of anadromous salmonids and resident fish in National Forests within the range of the northern spotted owl. It rests on four critical components: (1) identifying a landscape-level system of watershed refugia located on lands managed by the Forest Service within the range of the northern spotted owl; (2) establishing Riparian Habitat Conservation Areas for individual watersheds where land-use activities are restricted to those that either directly benefit or do not adversely affect fish habitat; (3) implementing watershed analysis as an explicit level of planning designed to evaluate geomorphic and ecologic processes operating in specific watersheds, identify boundaries of Riparian Habitat Conservation Areas, and provide a blueprint for restoration measures; and (4) initiating comprehensive watershed restoration measures on watersheds, with priority given to those having the greatest potential to provide high quality fish habitat. Each element addresses a critical aspect for maintaining and restoring fish habitat and ecological functions in streams. They are designed to act as a comprehensive package and will not achieve desired results if implemented alone or in some limited combination.

Component 1 - Designated Lands Providing Habitat Protection - Refugia or designated areas providing high quality fish habitat, either currently or in the future, are a cornerstone of most species conservation strategies. Refugia are habitats or environmental factors that convey protection to biotic communities at different temporal and spatial scales. Examples of aquatic refugia range from clean gravels at the particle scale, to well vegetated floodplains and side channels at the channel reach scale, to the condition of the whole watershed at the watershed scale (Sedell et al. 1990). In a review of case histories of recovery of aquatic systems following disturbance, Yount and Niemi (1990) and Niemi et al. (1990) found considerable evidence that the existence of spatial refugia–undisturbed habitats providing a source of colonists to adjacent areas–was critical to enable recovery of degraded systems. In stream systems where disturbance was widespread and no accessible refugia remained, biological recovery was delayed or entirely precluded.

At a minimum, refugia need to be considered at a watershed scale, rather than as fragmented areas of suitable habitat. Sedell et al. (1990), Moyle and Sato (1991), and Williams (1991) discuss several kinds of riverine and hyporheic habitats that can act as refugia, and provide examples of how they may function in the recovery of populations from natural catastrophe and anthropogenic disturbance. Sedell et al. (1990) argue that refugia at the scale of reaches or larger tend to be more resistant and resilient to a variety of disturbances. Moyle and Sato (1991) argue that to recover species, refugia should be focused at the watershed scale. Management and restoration strategies that focus on reaches or small segments of a watershed fail to consider the connectivity of stream ecosystems. Naiman et al. (1992), Sheldon (1988), and Williams et al. (1989) noted that past attempts to recover fish populations have been unsuccessful because of the failure to approach the problem from a basin perspective.

Even a system of isolated watersheds acting as refugia may not be sufficient for a regional conservation strategy. Fish stocks at risk are distributed across the entire range of the owl forests. Over its life history, an individual fish will travel through and occupy habitats in a range of watersheds of different sizes. Poor habitat conditions at any point of this journey will reduce chances of survival. Sheldon (1988) believed that 3rd-5th order watersheds should be the cornerstone of watershed-level recovery efforts for fish in general. This is likely an appropriate minimum size range for anadromous, and resident fish. Planning for habitat protection and restoration needs to include watersheds at the scale of about 100,000 acres (e.g., South Fork Umpqua River).

Watersheds that serve as refugia are crucial for maintaining and recovering habitat of at-risk stocks of anadromous salmonids and species of resident fish. These refugia should include areas that currently have good habitat as well as areas of degraded habitat. Areas presently in good condition would serve as anchors for the potential recovery of depressed fish stocks. Congressionally designated Wilderness, National Recreation Areas, and other specially designated areas currently contain high quality fish habitat in National Forests within the range of the northern spotted owl, and currently provide habitat for at-risk stocks and species. Habitat Conservation Areas identified for the northern spotted owl also contain some high quality fish habitat. However, less than 25 percent of the area of key watersheds identified by Johnson et al. (1991) were in Habitat Conservation Areas. Additionally, Habitat Conservation Area boundaries seldom encompass entire watershed boundaries and frequently do not contain an entire stream from headwaters to fish-bearing streams. Although these areas would be the anchors of a watershed refugia system, additional watersheds that currently have low quality habitat would become future sources of good habitat with the implementation of a comprehensive restoration program (Component 4).

A network of key watersheds located in National Forest throughout the range of the northern spotted owl was identified by Johnson et al. (1991) (Figures 5-K-2 through 5-K-4). These watersheds contain at-risk fish species and stocks and either good habitat or if they have habitat that is in a degraded state, have a high restoration potential (Reeves and Sedell 1992). Forest Service fish biologists in northern California have deleted some watersheds that were identified by Johnson et al. (1991) and added others. These changes are reflected in Figure 5-K-2. Under the Fish Habitat Conservation Strategy, key watersheds require a level II Watershed Analysis (Component 3). Key watersheds with poor habitat also receive priority in any restoration program (Component 4).

Establishment of a network of key watersheds is crucial for maintaining and restoring fish habitat in National Forests within the range of the northern spotted owl. In the short-term, identification of basins with good habitat and implementation of the components of this strategy will reduce the potential of future habitat loss or degradation. These areas would not only serve as physical refugia but also as source of individuals for recolonization of degraded areas as they improve. They will also be critical to initiate the restoration of degraded areas because of the extensive amount of habitat that is in poor condition due to the effects of past land-management activities. Key watersheds that currently contain poor habitat are believed to have the best opportunity for success.

The network of key watersheds, although crucial, will not be sufficient to assure the recovery of at-risk fish stocks. Key watersheds are important because they contain at-risk fish stocks and the best habitat or potential habitat. It is important, however, to limit those land-use activities that are destructive to fish and associated riparian-dependent species in all National Forests, whether in a key watershed or not. Riparian Habitat Conservation Areas must be established in all National Forests within the range of the northern spotted owl.

Component 2 - Riparian Habitat Conservation Areas - For Forest Service streams and lands to function as refugia, special considerations need to apply to those parts of watersheds which directly contribute to creating or maintaining aquatic habitat. Riparian Habitat Conservation Areas are portions of watersheds where riparian-dependent resources receive primary emphasis and where special standards and guidelines apply. Riparian Habitat Conservation Areas encompass 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 Habitat Conservation Areas include not only the more common Land and Resource Management Plan-designated riparian management zones or streamside management zones adjacent to rivers, streams, springs, seeps, wetlands, and marshes but also includes primary source areas for wood and sediment such as landslides and landslide-prone slopes in headwater areas and along streams. Riparian Habitat Conservation Areas generally parallel the stream network but also include other areas necessary for maintaining hydrologic, geomorphic, and ecologic processes (Figure 5-K-5). Every watershed in National Forests within the range of the northern spotted owl will have Riparian Habitat Conservation Areas.

Establishment of Riparian Habitat Conservation Areas will confer benefits to riparian dependent and associated species other than fish. It will enhance habitat conservation for organisms that are dependent on the transition zone between upslope and riparian areas. For example, many amphibians depend on wood created habitat in headwater streams (Bury et al. 1991, Chapter 5 this document). Improved travel and dispersal corridors for many terrestrial animals and plants and a greater connectivity of the watershed should also result from delineation of Riparian Habitat Conservation Areas.
Final boundaries of the Riparian Habitat Conservation Area in a watershed are determined by watershed analysis (Component 3). However, we have established a set of interim widths of Riparian Habitat Conservation Areas for all watersheds that will apply until the watershed analysis has been completed. The widths are designed to provide what we believe is a full measure of fish habitat and riparian protection until this analysis can be completed.

a. <u>Interim Widths of Riparian Habitat Conservation Areas for Different Water Bodies</u>

Interim widths of Riparian Habitat Conservation Areas vary with type of water body. They are defined as: 1) fish-bearing streams; 2) non-fish-bearing streams; 3) lakes; 4) ponds, reservoirs, and wetlands; and 5) other seasonally flowing or intermittent, streams. Streams in the last category may have little effect on fish habitat individually, but are collectively essential for maintaining processes that affect fish habitat. The last category also includes hydrologically, geomorphically, and ecologically significant areas such as landslides and landslide-prone areas, springs, seeps, marshes, and wetlands.

Several factors were considered in establishing interim widths of Riparian Habitat Conservation Areas for each stream type. One was how the various geomorphic and ecologic functions provided by riparian areas change with distance from the stream and with stream size. Key riparian processes considered in developing widths included sources of input of large and small woody debris and litter, shading, and buffering streams from the effects of strong winds and other microclimatic fluctuations (Gregory et al. 1991). We also considered the roles of vegetated and undisturbed floodplains in maintaining functioning side channels (used by fish for overwintering and refugia during peak flows) and hyporheic zones (which may supply cool or nutrient-rich groundwater during summer months) (Naiman et al. 1992). Additionally, we considered the use of Riparian Habitat Conservation Areas as breeding and rearing areas and dispersion corridors for organisms other than fish (Gregory et al. 1991, Gomez 1992).

Riparian areas contain a wide range of conditions along streams, lakes, springs, and wetlands. These include wide floodplains, narrower canyon reaches, multiple stream channels, and a diverse array of species and age-classes of vegetation. Many of these features are influenced by natural and anthropogenic disturbances (Grant 1986, Naiman et al. 1992). Boundaries of riparian areas are highly variable and irregular as a result of the natural character of the landscape and the local disturbance history. This variability and irregularity must be taken into account when planning land-management activities.

Physical features of streams vary widely with stream size. Inner gorges and floodplains are common in streams in National Forests within the range of the northern spotted owl. Inner gorges consist of the steep slopes immediately adjacent to a stream or river channel or floodplain and extend to the first significant break in slope. Widths of inner gorges on permanently flowing streams vary from 25 to 450 feet (M. Furniss, Six Rivers National Forest, personnel communication). Widths of the 100 year floodplains for permanently flowing streams vary from 50 to 800 feet in National Forests within the range of the northern spotted owl (Gregory and Ashkenas 1990).

An intact riparian forest in inner gorges and on 100-year floodplains is crucial for creating and maintaining habitat for fish and other riparian-dependent species (Gregory et al. 1991, Naiman et al. 1992). Riparian areas contribute wood and sediment to inner gorge areas. In smaller streams, the wood creates breaks in the channel gradient and forms pools for fish and other aquatic organisms. The wood also creates area of storage for sediment and organic material, which is a major energy source for organisms used as food by fish and other aquatic organisms (Bisson et al. 1987, Bilby and Ward 1991). Inner gorges may also be source areas of wood, sediments, and nutrients for wider floodplain areas located downstream (Gregory et al. 1991, Naiman et al. 1992)

Intact forests on floodplains are sources of large wood and provide refugia for aquatic organisms during floods (Naiman et al. 1992). Wood in these areas helps form habitat (Bisson et al. 1987), creates complexity (such as ranges of water velocities (Kaufmann 1987), and sites of material storage and nutrient processing (Bisson et al. 1987). Riparian vegetation in these areas may also influence the effect of flood events on the channel (Grant 1986, Sedell and Beschta 1991).

Several important processes and functions that influence the stream channel occur within 200 feet of the channel. McDade et al. (1990) and Van Sickle and Gregory (1990) reported that >90 percent of the wood in streams originated in this area. Stream bank stability is achieved within a distance equivalent to 0.5 to 1 site-potential tree height, which is generally within 200 feet of the channel (Sedell and Beschta 1991). Litter fall, nutrient retention and input (Gregory et al. 1987) and shade functions (Beschta et al. 1987) also generally occur within 100-200 feet of the channel.

Several studies (Steinblums 1977, Franklin et al. 1981, Heimann 1988, Andrus et al. 1988, Ursitti 1991, and Morman 1993) have found the basal area of conifers, which reflects the size and number of trees present, to be less in riparian areas of second-growth forests than in late-successional and old-growth forests. Riparian stands in late-successional and old-growth forests contain approximately 300 feet^2 per acre of basal area of conifers. This is less than the basal area of conifers found in upslope areas of the same forest (Gregory and Ashkenas 1990, Long 1987). Riparian areas in second-growth forests <80 years old generally have less than 100 feet^2 per acre. Riparian areas in second-growth forests 80 to 140 years old contain slightly more than 100 feet^{2}of basal area of conifers.

Maintenance of riparian forests in late-successional and old-growth forests and restoration in second-growth forests will depend on regeneration rates of conifers in the future. Regeneration of conifers in the riparian zones of natural stands is dependent, at least in part, on downed large trees. Researchers at the Pacific Northwest Research Station, Corvallis, Oregon found that more than 80 percent of conifer regeneration in the riparian zones along coastal Oregon streams that they studied occurred on down logs. The role of nurse trees in forest regeneration in the Pacific Northwest is widely recognized (Harmon et al. 1986). In riparian zones, nurse trees originate within 0 to 400 feet of the active channel. Greater retention of live trees and snags in riparian stands and adjacent upslope source areas will enhance the generation of future riparian forests.

Microclimate variability within riparian zones may be influenced by the condition of upslope stands. Chen (1991) and Chen et al. (in press) found that air temperatures in old-growth Douglas-fir stands were altered by the effects of surrounding clearcuts. Air temperatures were altered from 180 to 360 feet (i.e., 1 to 2 tree heights) from the edge. Wind velocities were altered up to 5 tree heights. Raynor (1971) found velocites altered up to 8 tree heights. Fritschen et al. (1970) reported that the microclimate of young forest stands (i.e., 40 to 60 years old) was altered up to 400 feet from the edge of a cut. While all of these values were measures for upland forests, they probably reflect the edge effects of clear-cuts on the micro-climate of adjacent riparian forests. The greater the widths of Riparian Habitat Conservation Areas the more stable will be the microclimate within riparian forests.

The abundance of amphibians in Pacific Northwest forest and riparian zones is influenced by habitat conditions in riparian areas (Bury et al. 1991, Gomez 1992). Amphibians populations are generally found less than 900 feet from water sources (Nussbaum et al. 1983). Gomez (1992) found that rough-skinned newts, tailed frogs, and western redbacked salamanders were the most abundant species of herptafauna in upland and riparian areas along the Oregon Coast Range. These organisms were found up to 600 feet from streams but were most abundant within 300 feet. Many species have specific tolerance thresholds (e.g., temperature and moisture) or microhabitat requirements (e.g., headwater seeps or talus slopes). Many also require downed wood, but may differ in types of wood (e.g., snag, bark on a log, or bark on the ground) or a particular decay class of wood (refer to Chapter 5 more specific requirements of specific species). Alteration of microhabitat climate may influence the suitability of riparian conditions for riparian-dependent organisms.

Many mammal populations are also dependent on riparian areas. Doyle (1986 and 1990) found that riparian areas in old-growth forests in the Cascades of Oregon were source areas for upland small mammal populations. Abundance of small mammals in coastal forests of Oregon were greatest within 300 feet of the stream, even though individuals were found up to 600 feet away (Gomez 1992). Chapter 5 of this document and USDI (1992) identify several mammal species that use or are dependent on riparian zones. Riparian corridors may also be important as dispersal, travel, and migratory routes for mammals (Gregory et al. 1991). The size (and limits on activities within) Riparian Habitat Conservation Areas should create a variety of microclimate and habitat conditions required by the large number of riparian-dependent organisms. This in turn should potentially accommodate a diverse assemblage of riparian-dependent organisms.

A riparian buffer zone is bordered by two edges; one is the stream and the other the adjacent upslope area. Each side is subjected to different sets of disturbances. If harvested, the upland side of the riparian forest is subjected to increased mortality from blowdown and increased stress resulting from more variable air temperatures and altered rates of evapotranspiration. The consequence of the latter factors is increased susceptibility to insect and disease (Geiger 1965, Caruso 1973, Ranney 1977, Wagner 1980). On the stream side, the stream can influence the microclimate of the riparian forest. The wider the stream, the greater the edge effect in terms of temperature and wind exposure. Additionally, the riparian forest is influenced by flood events and natural movements of the stream channel across the floodplain. The persistence of a riparian forest area is related to its length and width, due to mortality caused on both edges.

We believe that the character of any conservation program for maintaining and restoring habitat for at-risk stocks of anadromous salmonids and species of resident fish must maintain ecosystem functions and processes to have a high probability of success. A program of this nature is necessitated by the large number of fish stocks at risk (112) and the overall poor conditions of habitat and aquatic ecosystems in National Forests in the range of the northern spotted owl. We believe that it is prudent and justified to require Riparian Habitat Conservation Areas widths to incorporate areas larger than traditional riparian management areas, at least in the interim until a watershed analysis is completed.

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 2nd-order streams, which generally include the permanently flowing non-fish bearing streams and seasonally flowing or intermittent streams, may represent 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. 1981, 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. The Riparian Habitat Conservation Area widths specified for the different stream and wetland types were developed to maintain connections in watersheds that are currently in good condition and to initiate recovery of the connections in degraded areas.

Based on these criteria, we identify five types of streams or water-bodies and define interim widths of Riparian Habitat Conservation Areas for each:

1. <u>Fish-bearing Streams:</u> The Riparian Habitat Conservation Area consists 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 horizontal distance (600 feet, including both sides of the stream channel), whichever is greatest.

   The first 200 feet of the Riparian Habitat Conservation Area recognizes the adjacent land as a source of shade, large wood, detritus, and water of favorable temperature. The last 100 feet will serve to maintain microclimate and to protect the first 200 feet from fire and wind damage and help ensure that the integrity of the functional Riparian Habitat Conservation Area survives over the long-term to benefit fish habitat and riparian dependent species.

2. <u>Permanently Flowing Non-fish-bearing Streams:</u> The Riparian Habitat Conservation Area consists 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 one site-potential tree, or 150 feet horizontal distance (300 feet, including both sides of the stream channel), whichever is greatest.

3. <u>Lakes:</u> The Riparian Habitat Conservation Area consists of the body of water and the area to 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 horizontal distance, whichever is greatest.

4. Ponds, Reservoirs, and Wetlands Greater Than One Acre: The Riparian Habitat Conservation Area consists of the body of water (the maximum pool elevation of reservoirs) or wetland and the area to 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 horizontal distance, whichever is greatest.

5. Seasonally Flowing or Intermittent Streams, Wetlands Less Than One Acre, Landslides, and Landslide-Prone Areas: This category applies to riparian ecosystems with high variability in size and site-specific characteristics. The Riparian Habitat Conservation Area consists of the stream channel or wetland and the area from the edges of the stream channel or wetland to the top of the inner gorge, or to the outer edges of the riparian vegetation, or to the extent of landslides or landslide-prone areas, or to a distance equal to the height of one site-potential tree, or 100 feet horizontal distance (200 feet, including both sides of the channel), whichever is greatest.

We believe that the interim widths of the Riparian Habitat Conservation Areas will provide protection for riparian forests and maintain ecological functions and processes necessary for the creation and maintenance of habitat for fish and other-riparian dependent organisms. Existing data could be used to argue for wider Riparian Habitat Conservation Area widths, at least in certain stream categories. However, the interim widths will fully protect ecologically important areas within a watershed, such as floodplains. Interim Riparian Habitat Conservation Areas will also be able to survive some mortality in the short-run and still maintain its ecological integrity.

We emphasize that Riparian Habitat Conservation Area widths are applied to all streams in National Forests within the range of the northern spotted owl until a watershed analysis has been completed. If watershed analysis finds that because of the characteristics of a given site, narrower or wider Riparian Habitat Conservation Areas would provide the better function than the interim Riparian Habitat Conservation Area, then the Riparian Habitat Conservation Area width could be changed, and any allowable management activities would be adjusted to reflect these new Riparian Habitat Conservation Area dimensions.

A conceptual example of a Riparian Habitat Conservation Area is shown in Figure 5-K-5. This watershed is characterized by a stream drainage network that consists of a major fish-bearing stream, several fish-bearing tributaries, and some non-fish-bearing intermittent tributaries. The watershed also contains a marshy area near the watershed outlet, a large, inactive landslide, and many landslide-prone areas in steep terrain near the watershed boundary. The Riparian Habitat Conservation Area extends around and includes all these features.

b. Standards and Guidelines for Riparian Habitat Conservation Areas

Developing prescriptions for improving anadromous fish habitats includes formulating standards and guidelines that address the types of management activities that are allowed in Riparian Habitat Conservation Areas. In general, these standards and guidelines prohibit activities in Riparian Habitat Conservation Areas that are not designed specifically to improve the structure and function of the Riparian Habitat Conservation Area and benefit fish habitat. Management activities in Riparian Habitat Conservation Areas must contribute to improving or maintaining watershed and aquatic habitat conditions described in the Riparian Management Objectives. When activities are found to detract from meeting the Riparian Management Objectives, those activities will be modified, rescheduled, or discontinued. Further, for areas where riparian conditions are presently degraded, management activities must be designed to improve habitat conditions.

The standards and guidelines that follow are not all-inclusive. Watershed and riparian area management on lands managed by the Forest Service is guided by a variety of direction, including Best Management Practices, Land and Resource Management Plans, Forest Service manuals and handbooks, and other plans and directives. For the lands contained within the Riparian Habitat Conservation Area, these standards and guidelines supersede other direction, unless the conflicting standard or direction affords greater protection to riparian and fish habitat values and better foster attainment of the Riparian Management Objectives.

<u>Timber Management</u>

TM-1. Prohibit scheduled timber harvest, including fuelwood cutting, in Riparian Habitat Conservation Areas. Allow unscheduled harvest only as described in TM-2 and TM-3.

TM-2. Where catastrophic events such as fire, flooding, volcanic erruptions, severe winds, or insect or disease damage result in degraded riparian conditions, allow unscheduled timber harvest (salvage and fuelwood cutting) to attain Riparian Management Objectives. Remove salvage trees only when site-specific analysis by an interdisciplinary team determines that present and future woody debris needs are met and other Riparian Management Objectives are not adversely affected.

TM-3. Design silvicultural prescriptions for Riparian Habitat Conservation Areas and allow unscheduled harvest to control stocking, reestablish and culture stands, and acquire desired vegetation characteristics needed to attain Riparian Management Objectives.

<u>Roads Management</u>

RF-1. Keep road and landing construction in Riparian Habitat Conservation Areas to a minimum. No new roads or landings will be constructed in Riparian Habitat Conservation Areas until watershed, transportation, and geotechnical analyses are completed. Appropriate standards for road construction, maintenance, and operations will be developed from this analysis to ensure that Riparian Management Objectives are met. Valley bottom and mid-slope road locations may be used only when this analysis indicates that roads can be constructed and maintained in these locations and meet Riparian Management Objectives.

RF-2. Require that all roads on lands managed by the Forest Service, including those operated by others, are maintained and operated in a manner consistent with the planned uses and with meeting Riparian Management Objectives.

RF-3. Inventory and evaluate all existing roads in Riparian Habitat Conservation Areas. Through an interdisciplinary team review process, determine the influence of each road upon the Riparian Management Objectives. Roads that are found to pose a substantial risk to riparian conditions will be improved or obliterated. Priority will based on the potential impact to riparian resources, the ecological value of the riparian resources affected, and the need for each road. Roads not needed for future management activities will be closed, obliterated, and stabilized. All obliteration work will meet Riparian Management Objectives and provide for adequate long-term drainage and stability.

RF-4. Inventory and evaluate all existing culverts and stream crossings to identify those that present a risk to meeting Riparian Management Objectives. Culverts and stream crossings found to pose a substantial risk to riparian conditions will be improved to accommodate at least a 100-year flood, including associated bedload and debris. Priorities for upgrading will be based on the potential impact and the ecological value of the riparian resources affected. New stream crossings will be designed and constructed to accommodate at least the 100-year flood, including associated bedload and debris. Crossings will be constructed and maintained to prevent diversion of streamflow out of the channel and down the road in case of crossing failure. In locations found to have a high potential for failure, the roadway surface and fills will be hardened to further lessen the chance of roadway failure or severe erosion should the crossing over-top.

RF-5. Locate, design, construct, maintain, and operate roads to minimize disruption to natural hydrologic flow paths. This includes road-related activities that would divert streamflow and/or interrupt surface or subsurface flow paths.

RF-6. Apply design, construction, and maintenance procedures to limit sediment delivery to streams from the road surface. Outsloping of the roadway surface is preferred unless outsloping would increase sediment delivery to streams or where outsloping is infeasible. Route road drainage away from potentially unstable channels and hillslopes.

RF-7. Construct, reconstruct, and maintain all road crossings of existing and historic fish-bearing streams to provide for fish passage.

RF-8. Develop and carry out a Road Management Plan that will meet the Riparian Management Objectives. As a minimum, this plan shall include provisions for the following activities:

a. Conduct post-storm inspections of roads known to contribute to degrading the riparian resources. Conduct timely maintenance if deficiencies are found.

b. Inspect and maintain all roads providing for passenger car traffic (maintenance levels 3-5) during storms having a predicted high potential to cause problems.

c. Inspect roads providing for high-clearance vehicle use (maintenance level 2) and those closed, but needed in the future (maintenance level 1), following each storm having a runoff event with a recurrence interval of 1 year or greater. Correct deficiencies that would contribute to degrading riparian resources before the next storm.

d. During annual road maintenance, give high priority to identifying and correcting road drainage problems that contribute to degrading riparian resources.

e. During rainy periods, exclude traffic from roads that do not meet all-weather standards (maintenance levels 2-5).

RF-9. Designate sites to be used as water drafting locations during project-level analysis, or as part of road maintenance for fire management planning. Do not locate drafting sites where instream flows could become limiting to aquatic organisms. During periods of low flow, examine the drafting site and decide if water can continue to be extracted from that site. Design, construct, and maintain water drafting sites so they will not destabilize stream channels or contribute sediment to streams.

RF-10. Prohibit sidecasting of loose material in Riparian Habitat Conservation Areas during construction or maintenance activities.

<u>Grazing Management</u>

GM-1. Promptly adjust grazing practices to eliminate adverse effects of domestic and wild ungulates on riparian resources. If adjusting practices is not effective, eliminate grazing until it is shown that grazing can be reestablished and still attain the Riparian Management Objectives. Establish vegetation reference areas to measure potential site productivity and stream channel morphology that would exist without grazing, and to monitor the status of the ecosystem. Vegetation reference areas are to be located in areas representative of the vegetative community and stream channel types to be managed. Reference areas may include exclusion plots, larger exclosures, or sites with a low disturbance history. In addition to reference areas, conduct systematic monitoring of vegetation status using standardized procedures to determine the effects of grazing on riparian ecosystems and the ability to attain the Riparian Management Objectives.

GM-2. Locate new livestock management and handling facilities outside Riparian Habitat Conservation Areas. For existing livestock management and handling facilities inside the Riparian Habitat Conservation Area that are essential to proper management, apply standards that assure that Riparian Management Objectives are met. Where these objectives cannot be met, require relocation of livestock management and/or handling facilities.

<u>Recreation Management</u>

RM-1. Develop recreation facilities, including trails, within Riparian Habitat Conservation Areas only when such development is compatible with the attainment of Riparian Management Objectives.

RM-2. Monitor the impacts of dispersed or developed recreation in Riparian Habitat Conservation Areas. When Riparian Management Objectives are not being met, reduce impacts through education, use limits, more intensive maintenance, facility modification, and/or area closures. For example, harassment of fish during spawning or low water can be reduced by closing access roads or campgrounds during critical periods, or education of users.

RM-3. Coordinate with state agencies to eliminate non-native fish stocking, over fishing, and poaching.

Minerals Management

MM-1. For operations in Riparian Habitat Conservation Areas, ensure that adequate reclamation plans and bonds are included in approved plans of operation. Such plans and bonds must address the costs of removing facilities, equipment, and materials; recontouring disturbed areas to near pre-mining topography; isolating and neutralizing or removing of toxic or potentially toxic materials; salvaging and replacing topsoil; and preparing seedbed and revegetating to meet Riparian Management Objectives.

MM-2. Avoid locating permanent structures or support facilities within Riparian Habitat Conservation Areas. Road construction will be kept to the minimum necessary for the approved mineral activity. Such roads will be constructed and maintained to meet the Roads Management Standards and to minimize damage to resources in the Riparian Habitat Conservation Area. When a road is no longer required for mineral activity, it will be closed, obliterated, and stabilized.

MM-3. Avoid locating waste dumps in Riparian Habitat Conservation Areas. If no other alternative exists, ensure that safeguards are in place to prevent release or drainage of toxic or other hazardous materials.

MM-4. For leasable minerals, prohibit surface occupancy within Riparian Habitat Conservation Areas for oil, gas, and geothermal exploration and development activities where contracts and leases do not already exist. Where contracts already exist, modify the operating plan to meet the Riparian Management Objectives.

MM-5. Prohibit common variety sand and gravel mining and extraction within Riparian Habitat Conservation Areas (subject to valid permitted rights), unless mining and extraction are consistent with Riparian Management Objectives and needed for restoration purposes.

Fire/Fuels Management

FM-1. Design fuel treatment and fire suppression strategies, practices, and activities to meet Riparian Management 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 management activities could damage long-term ecosystem health.

FM-2. Locate incident bases, camps, helibases, staging areas, helispots and other centers for incident activities outside of Riparian Habitat Conservation Areas. If the only suitable location for such activities is within the Riparian Habitat Conservation Area, 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. Use an interdisciplinary team to predetermine suitable incident base and helibase locations.

FM-3. Prohibit application of chemical retardant, foam, or additives in Riparian Habitat Conservation Areas. An exception may be warranted in situations where over-riding 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/prescriptions for areas next to Riparian Habitat Conservation Areas so that Riparian Habitat Conservation Areas are protected. Where riparian ecosystems would be enhanced by use of prescribed fire, clearly identify the specific objectives and risks.

FM-5. If Riparian Habitat Conservation Areas are significantly damaged by a wildfire or a prescribed fire burning out of prescription, establish an emergency interdisciplinary team to decide the rehabilitation treatments needed.

FM-6. Use minimum impact suppression methods in Riparian Habitat Conservation Areas. Consider potentially adverse effects of fire suppression effects and the potentially adverse effects of wildfire damage during initial fire size-up, initial suppression response, and in the development of the Escaped Fire Situation Analysis.

Lands

LH-1. For hydroelectric and other surface water development proposals, require instream flows and habitat conditions that maintain or restore riparian resources, channel conditions, and fish passage at levels that approximate favorable pre-project conditions. Coordinate this process with the appropriate state agencies. During relicensing of hydroelectric projects, make written and timely recommendations to Federal Energy Regulatory Commission 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 facilities that are not required within the Riparian Habitat Conservation Area (such as control rooms, housing, temporary construction buildings, etc.) outside the Riparian Habitat Conservation Area. Facilities within the Riparian Habitat Conservation Area will be located, operated, and maintained to minimize effects on riparian resources, including, for example, maintenance of upstream and downstream passages, and screening intakes and diversions.

LH-3. Review all Special Use Permits, rights-of-way, and easements affecting Riparian Habitat Conservation Areas. When Riparian Management Objectives are not being met, reduce impacts through education or modification of existing Special Use Permits. When granting easements or other rights-of-way across lands managed by the Forest Service to reach private lands, apply these standards and guidelines to provide the terms and conditions necessary to protect riparian resources on lands managed by the Forest Service.

LH-4. Use land acquisition and exchange to consolidate in-holdings, with the priority to protect and restore fish stocks and species at risk.

General Riparian Area Management

RA-1. Exclude heavy equipment from Riparian Habitat Conservation Areas, unless specifically approved for road construction and maintenance, or unless an interdisciplinary team finds that proposed activity is needed to meet the Riparian Management Objectives.

RA-2. Fell hazard trees only when they are found to pose an unacceptable safety risk. Such trees may be removed from Riparian Habitat Conservation Areas only when adequate sources of woody debris remain to meet Riparian Management Objectives. If long-term sources of woody debris are inadequate, and a tree is found to pose an unacceptable safety risk, that risk must be reduced in a way that contributes to woody debris objectives.

Watershed and Habitat Restoration

WR-1. A watershed analysis is a prerequisite to planning, implementing, and monitoring all restoration projects. A Level I watershed analysis (see Component 3) may be sufficient to identify the causes of riparian area degradation, to set priorities for watershed restoration measures, and initiate restoration projects in critical areas. A full watershed analysis (Level II) is required, however, to develop an integrated basin-wide strategy for restoration and monitoring. Priority should be given to restoring key watersheds supporting at-risk stocks and species.

WR-2. Control the causes of riparian area degradation before initiating restoration projects.

WR-3. Employ restoration methods that promote the long-term genetic and ecological integrity of restored ecosystems.

WR-4. Where mixed ownership exists, encourage the development of Coordinated Resource Management Plans or other cooperative agreements to meet Riparian Management Objectives.

WR-5. Do not use mitigation measures or planned restoration as a substitute for preventing habitat degradation.

Component 3 - Watershed Analysis - Watershed analysis is a systematic procedure for characterizing watershed history, processes, landforms, and conditions to meet specific objectives. It is a prerequisite for determining which processes and parts of the landscape affect fish and riparian habitat, and is essential for defining appropriate boundaries for Riparian Habitat Conservation Areas. Watershed analysis forms the basis for evaluating cumulative watershed effects, defining watershed restoration goals and objectives, implementing restoration strategies, and monitoring the results or effectiveness of all these measures. Watershed analysis employs the perspectives and tools of multiple disciplines, especially geomorphology, hydrology, geology, fish and terrestrial ecology, and soil science. It is the framework for understanding and implementing land use activities within a geomorphic context and is a major component of the evolving science of ecosystem analysis. A critical step in this process is monitoring and feedback. If monitoring reveals that Riparian Management Objectives are not being met, the sequence of determining processes, defining Riparian Habitat Conservation Area boundaries and standards and guides will be repeated.

Watershed analysis consists of a sequence of activities designed to identify and interpret the processes operating in a specific landscape. The overall goals of watershed analysis are to:

1. Characterize the geomorphic, ecologic, and hydrologic context of a specific watershed with respect to neighboring watersheds, and identified beneficial uses.

2. Determine the type, aerial 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 nutrients through a watershed.

3. Determine the distribution, abundance, life histories, habitat requirements, and limiting factors of fish and other riparian dependent species.

4. Identify parts of the landscape, including hillslopes and channels, that are either sensitive to specific disturbance processes or critical to beneficial uses, key fish stocks or species.

5. Interpret watershed history, including the effects of previous natural disturbances and land use activities on watershed processes.

6. Establish ecologically and geomorphically appropriate boundaries of Riparian Habitat Conservation Areas.

7. Design approaches to evaluate and monitor the reliability of the analysis procedure and the effectiveness of designated Riparian Habitat Conservation Areas to protect fish habitat.

8. Identify restoration objectives, strategies, and priorities.

The idea of watershed analysis is not new. Many National Forests have been conducting planning exercises that use elements of watershed analysis. However, few, if any, National Forests conduct a comprehensive watershed analysis. Furthermore, there is little consistency in objectives, methods, or results among Forests or ranger districts. Current efforts typically address only limited aspects of the problem (e.g., identifying unstable ground, or scheduling timber harvest to minimize the area in cutover or young stands at any given time). Little effort is made to identify effects of past practices or limiting factors for fish or other riparian dependent organisms. Watershed analysis falls between the scales of Forest and Project Planning; it is not a scale at which decisions are made. However, it is the critical scale for evaluating and making decisions about cumulative watershed effects.

In recent years, formal watershed analysis has begun to come to the forefront of forest land management and is now required by law on state and private forest lands in Washington (Washington State Forest Practice Board 1992). Within the Forest Service, an example of watershed analysis is the Draft Environmental Impact Statement for the Elk River Wild and Scenic River Plan, Siskiyou National Forest, Forest Service (USDA 1992b). An across-the-board requirement for watershed analysis does not exist, however, within the Forest Service.

Implementing watershed analysis will require major changes in Forest Service planning and management activities. To help with this transition, and to allow for planning and forest management activities to proceed in the face of the large task of performing watershed analysis in all National Forest watersheds in the owl region, two levels of analysis will be employed (Fig. 6-K-6):

Level I Analysis

Objectives: Level I analysis is less rigorous. It will assess current watershed conditions, identify watersheds currently providing or likely to provide high quality habitat, evaluate the ecologic and geomorphic processes critical for maintaining fish habitat, determine which watersheds require Level II analysis,and establish Riparian Habitat Conservation Area boundaries for watersheds not requiringLevel II analysis.

Scale: Level I analysis typically is conducted on watersheds from 10,000 to 100,000 acres (roughly 5th- to 6th-order).

Data used: Level I analysis typically relies on existing data, including topographic, geologic, soils, and vegetation maps; aerial photos; existing data on habitat and populations of fish and other riparian-dependent organisms; and existing mass movement inventories and streamflow records. Additional field work is required to set boundaries for watersheds not requiringLevel II analysis.

Products: Level I analysis assesses current watershed, riparian, and stream conditions and factors limiting fish habitat. Sequential aerial photos are examined to determine the frequency, magnitude, and spatial distribution of key disturbance processes within the watershed that influence fish habitat (e.g., landslides, debris flows, windthrow, fire). Streamflow records and channel inventories are used to determine if there is evidence for peak or low flow changes due to land management activities. Surveys of distribution and abundance or fish and other riparian-dependent species are used to determine if at-risk organisms are present. Past, ongoing, and foreseeable future projects are evaluated to determine their effects on disturbance regime and riparian habitat, and to determine if the Riparian Management Objectives are being met.

This information is used to determine whether past, present, or future management activities pose low, moderate, or high risk to riparian and stream habitat. For example, a watershed is classified as high or moderate risk if it has a history of slope instability, streamflow problems, threatened or endangered species or fish stocks, or management activities, either individually or collectively, that are likely to significantly change the disturbance regime contributing to fish habitat. Such a watershed requires a Level II analysis. For those watersheds where management activities pose a low risk to fish habitat, boundaries of Riparian Habitat Conservation Areas are delineated based on Level I analysis. These boundaries are established in the field using interim widths described in the previous section on Riparian Habitat Conservation Areas (Component 2) for different water bodies.

Time and personnel: Based on the time required to complete comparable efforts conducted by the Forest Service, Level I analysis should require approximately 5-7 weeks of a 4-person interdisciplinary team composed of a fish biologist, wildlife biologist, hydrologist, and geologist for a 50,000-acre watershed. This estimate assumes that topographic, geologic, soils, and vegetation map data and time-series aerial photographs are available.

<u>Level II Analysis</u>

Objectives: Level II analysis is more rigorous. It will establish ecologically appropriate boundaries of Riparian Habitat Conservation Areas, and identify restoration needs and priorities.

Scale: Level II analysis is carried out on watersheds of approximately 10,000 to 50,000 acres.

Data used: Level II analysis represents a refinement and extension of Level I analysis. Field maps of unstable areas, a road condition survey, inventory of riparian canopy conditions, intensive survey of channel conditions, and computer simulations of hillslope and channel processes would be used. Level II analysis typically involves additional field work to provide watershed-specific information on ecologic and geomorphic conditions.

Products: Level II analysis establishes operational boundaries of Riparian Habitat Conservation Areas to meet the Riparian Management Objectives, produces a transportation plan for the watershed, refine standards and guidelines to fit specific landscape conditions and limitations, establishes restoration goals, sets restoration priorities, and establishes a monitoring program to insure that Riparian Management Objectives are met.

Time and personnel: Level II analysis should require an additional 5-7 weeks of a 4-person interdisciplinary team for a 50,000-acre watershed. Total time to complete both Level I and II analysis of a 50,000-acre watershed should be approximately 40-56 person-weeks.

Because of their importance in providing high quality fish habitat and/or their high proportion of unstable landforms, all key watersheds (previously described) and inventoried roadless areas would require a Level II analysis.

Component 4 - Watershed Restoration - Watershed restoration addresses improving the current conditions of watersheds to restore degraded habitat and provide long-term protection to aquatic resources. To be effective in restoring salmonid habitats, a restoration strategy needs to incorporate:

- A regional strategy that looks across landscapes and ownerships to identify where restoration efforts are likely to be most effective;

- An explicit recognition of how differences in physiography and specific impacts on stream systems will require different restoration measures;

- A detailed watershed analysis (Component 3) to adapt restoration strategies to specific landscapes, taking into account unique watershed histories, conditions, and resources;

- A specific set of objectives for each watershed;

- An explicit role for research and monitoring in defining and refining restoration objectives and tracking the effectiveness of restoration measures.

Elements of a restoration program are:

a. Identification of Priority Watersheds - Priority watersheds for restoration should be those with high restoration potential. Prioritization is necessary because of the large number of watersheds in National Forests within the range of the northern spotted owl that are in poor condition. Additionally, funds for programs are currently lacking and probably never will be sufficient to deal with all watersheds. However, some watersheds have been altered so excessively that they have little potential of recovery. Candidate watersheds that have the best chance of benefiting from a restoration program have already been identified as part of the key watershed network of Johnson et al. (1991).

b. Distinguish Physiographic Regions - Physiographic regions vary considerably in both their intrinsic sensitivities to watershed disturbance and in the specific impacts involved. Restoration strategies need to be tailored to the specific processes and conditions occurring in different regions. Watershed analysis is the key to developing landscape-specific strategies.

c. Watershed Analysis - Before any restoration activities begin, the watershed analysis described in Component 3 is needed. It will identify: watershed disturbance processes and where they occur on the landscape; current conditions of hillslopes and channels; status of aquatic communities including threatened and endangered populations; limiting factors for riparian ecosystems; inventory of past land use practices, including roads, clearcuts, grazing allotments, and mining impacts.

d. Define Restoration Objectives and Strategies - The watershed analysis will provide a spatially explicit set of objectives for restoration activities. These objectives establish the framework for restoration work, including *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.

e. Research and Monitoring Included in Restoration Plans - There is limited experience and few successes in restoring watersheds and ecosystems. To learn from our actions, a research perspective needs to be utilized and monitoring built directly into the restoration strategy. Restoration needs to be based on scientifically credible concepts of how watersheds and their biota function. A research perspective considers replication, stratification, statistical design, sampling protocols, and responsibility for data management and analysis.

SUMMARY

This conservation strategy for habitat of at-risk stocks of anadromous salmonids and resident fish in the National Forests within the range of the northern spotted owl represents significant change from current management. It is a long-range program that maintains the existing balance of processes, functions, and habitat elements in intact aquatic and riparian ecosystems, and initiates the recovery of processes and functions in degraded systems. We believe that if this strategy is carried out in conjunction with other protection measures outlined in this plan, it will lead to a functioning landscape that buffers and absorbs disturbances to streams rather than amplifies them. In the long-term, we believe that if this conservation strategy is implemented, all streams in National Forests within the range of the northern spotted owl will eventually contain good fish habitat.

We reiterate that this fish habitat conservation strategy will not, by itself, prevent further declines or extirpation of at-risk stocks of anadromous salmonids. Reduction of the quantity and quality of freshwater habitat and disruption of ecological processes and functions are only one of the factors responsible for the decline of anadromous fish stocks. We believe that this strategy in combination with the other components proposed by the Scientific Analysis Team will accommodate the naturally dynamic nature of stream and riparian systems in the owl forests, help the recovery of degraded systems to more productive states, maintain options for future management, and sustain fish habitat and ecologically necessary riparian and watershed functions until additional knowledge allows us to implement new management measures.

Appendix 5-K
Strategy for Managing Habitat of At-Risk Fish Species

Tables

Table 5-K-1 At-Risk Species of Anadromous Salmonids and Resident Fish Found on National Forests Within the Range of the Northern Spotted Owl.

A. Anadromous Salmonids	
coho salmon	*Oncorhynchus kisutch*
chinook salmon	*O. tshawytscha*
sockeye salmon	*O. nerka*
chum salmon	*O. keta*
pink salmon	*O. gorbuscha*
steelhead trout	*O. mykiss*
sea-run cutthroat trout	*O. clarkii clarkii*
B. Resident Fish	
redband trout	*O. mykiss gibbsi*
bull trout	*Salvelinus confluentus*
Oregon chub	*Oregonichthys crameria*
Olympic mudminnow	*Novumbra hubbsi*

Appendix 5-K
Strategy for Managing Habitat of At-Risk Fish Species

Tables (continued)

Table 5-K-2 Changes in the Frequency of Large, Deep Pools (>50 yds^2 and >6 Feet Deep) Between 1935 and 1992 in Streams on National Forests 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	0.6	-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%

Appendix 5-K
Strategy for Managing Habitat of At-Risk Fish Species

Tables (continued)

Table 5-K-3 Spawning and Stream Rearing Habitat Factors That Potentially Limit natural Production of Coastal Oregon Anadromous Salmonids. Factors were assessed as: H = has high potential to limit natural production and M = has medium potential to limit natural production. A "?" indicates that insufficient information exists for making a professional judgement; A "*" indicates a priority for gathering new information to help in restoration of fish populations (from: Panel on Factors Potentially Limiting Natural Production, Oregon Governor's Coastal Salmonid Restoration Initiative, Oregon Department of Fish and Wildlife, Portland, Oregon).

FACTOR 1: SPAWNING HABITAT

	Holding Pools	Migration Barriers	Gravel Quantity/Quality	Water Quantity/Quality	Temperature
Coho	-	-	M	-	-
Chum	-	M	H	M	-
Fall Chinook	M	-	H	?	-
Spring Chinook	M	-	H	?	M
Summer Steelhead	-	-	-	?	-
Winter Steelhead	-	-	-	-	-
Sea-run Cutthroat	?	M	?	-	-

FACTOR 2: STREAM REARING HABITAT

	Channel Complexity	Streamflow	Temperature	Migration Barriers	Flood Plain and Wetland	Other
Coho	H	M	H	?*	H	
Chum[1]	-	-	-	?*	-	
Fall Chinook	M*	M*	M*	?*	?*	
Spring Chinook	H*	M*	M*	?*	?*	
Summer Steelhead	H	H	H	?*	H	
Winter Steelhead	H	H	H	?*	H	
Sea-run Cutthroat	H	H*	H*	?*	H	

[1]Potential limitation of chum salmon production during the free-swimming freshwater phase of life cycle is believed to be minor because chum fry move quickly downstream to the estuary soon after emergence and do not reside in streams.

Anadromous Stocks

Figure 5-K-1 Range and Status of At-Risk Anadromous Salmonid Stocks and Resident Fish Species in Washington, Oregon, Northern California, and Idaho (see facing page).

This map was produced from a 1:500,000 scale stream network developed by the Environmental Protection Agency. Due to the small scale of the map, streams smaller than 5th order are not displayed. The result is that some small coastal and headwater tributaries are not depicted. The map represents available data for all land ownerships, both public and private. In basins with more than one stock at risk, the highest risk code was assigned to the entire drainage.

Risk codes are those of Nehlsen et al. (1991) and are defined as follows:

Presently Listed: stocks currently listed under the Endangered Species Act.

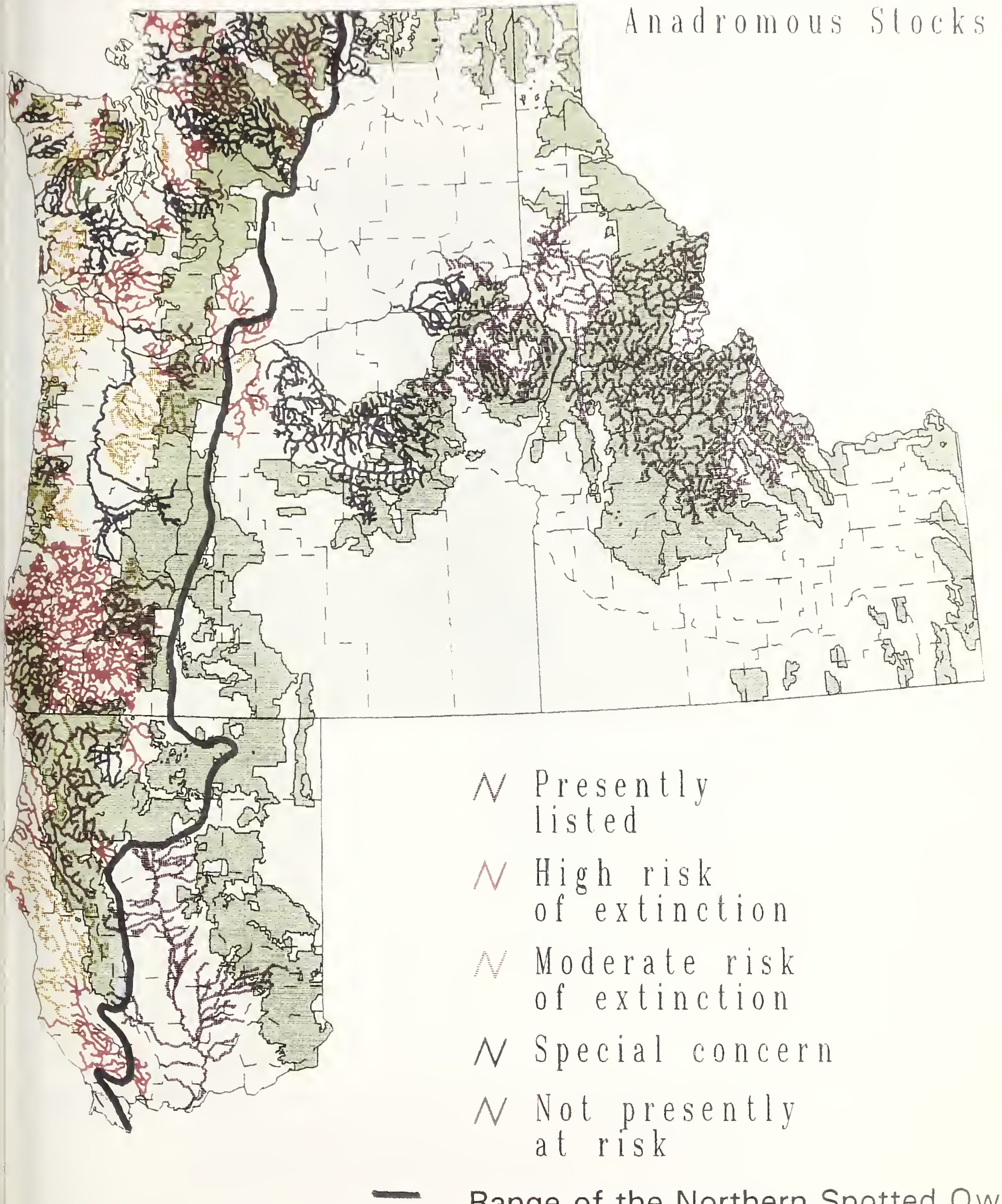
High Risk of Extinction: not self-sustaining (spawner:returning spawner ratio <1); continue to decline despite conservation efforts.

Moderate Risk of Extinction: presently self-sustaining (spawner:returning spawner ratio = 1 or slightly more) after previously declining more than natural variation would account for.

Special Concern: 1) relatively minor disturbances could make population not self-sustaining; 2) insufficient information on population trend, but available data suggests depletion; 3) relatively large ongoing release of non-native fish, the potential for inbreeding with the native population exists; 4) population is not presently depleted but requires attention because of a unique character.

Data for this map were derived from Nehlsen et al. 1991, and Johnson et al. 1991.

Anadromous Stocks



California Key Watersheds

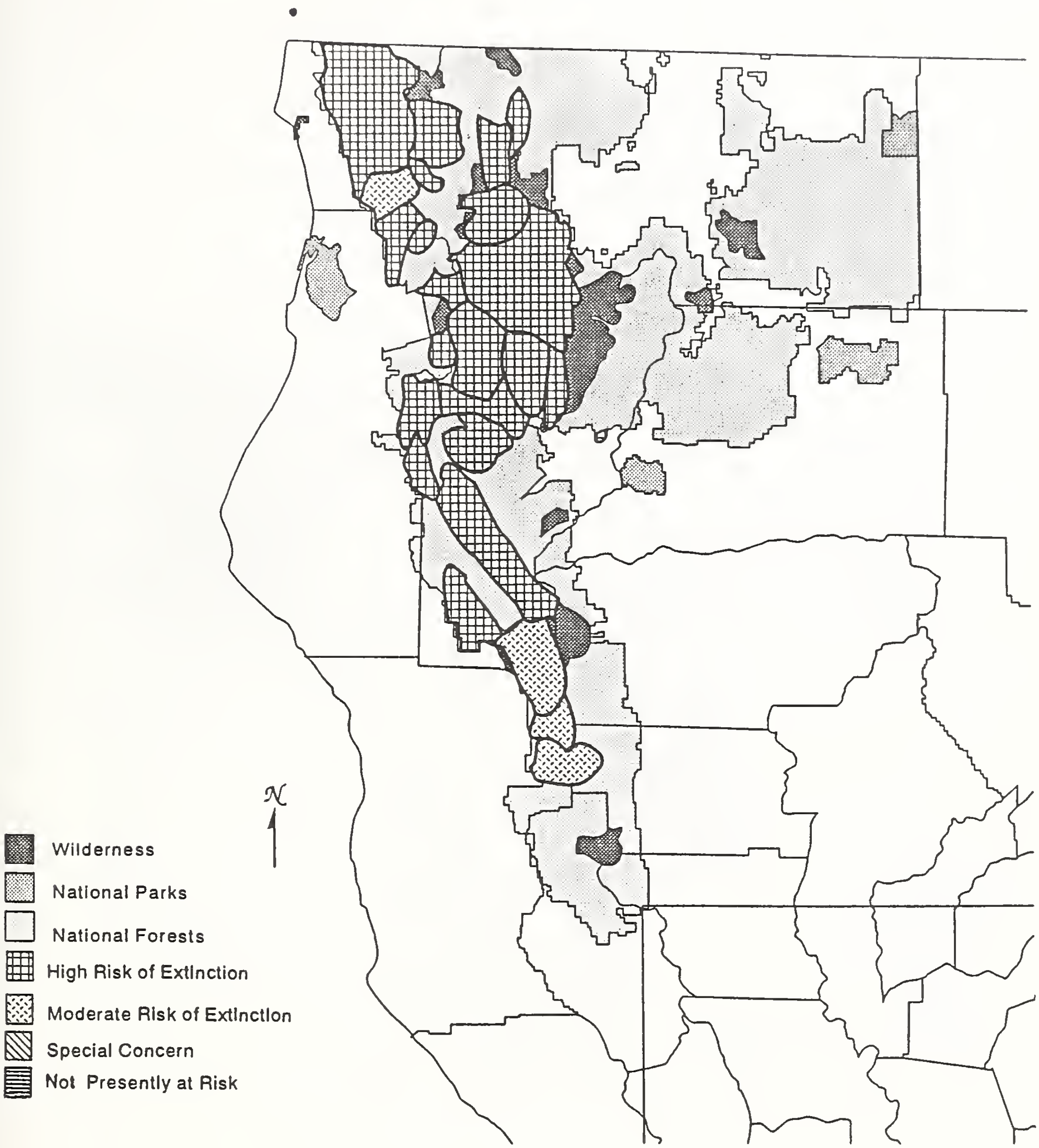


Figure 5-K-2 Location of Key Watersheds Which Could Serve as Aquatic Biodiversity Management Areas in California and Status of Anadromous Salmonid Stocks (as determined by Nehlsen et al. 1991) and Other Fish Species (as determined by Williams et al. 1989) Within Streams.

Oregon Key Watersheds

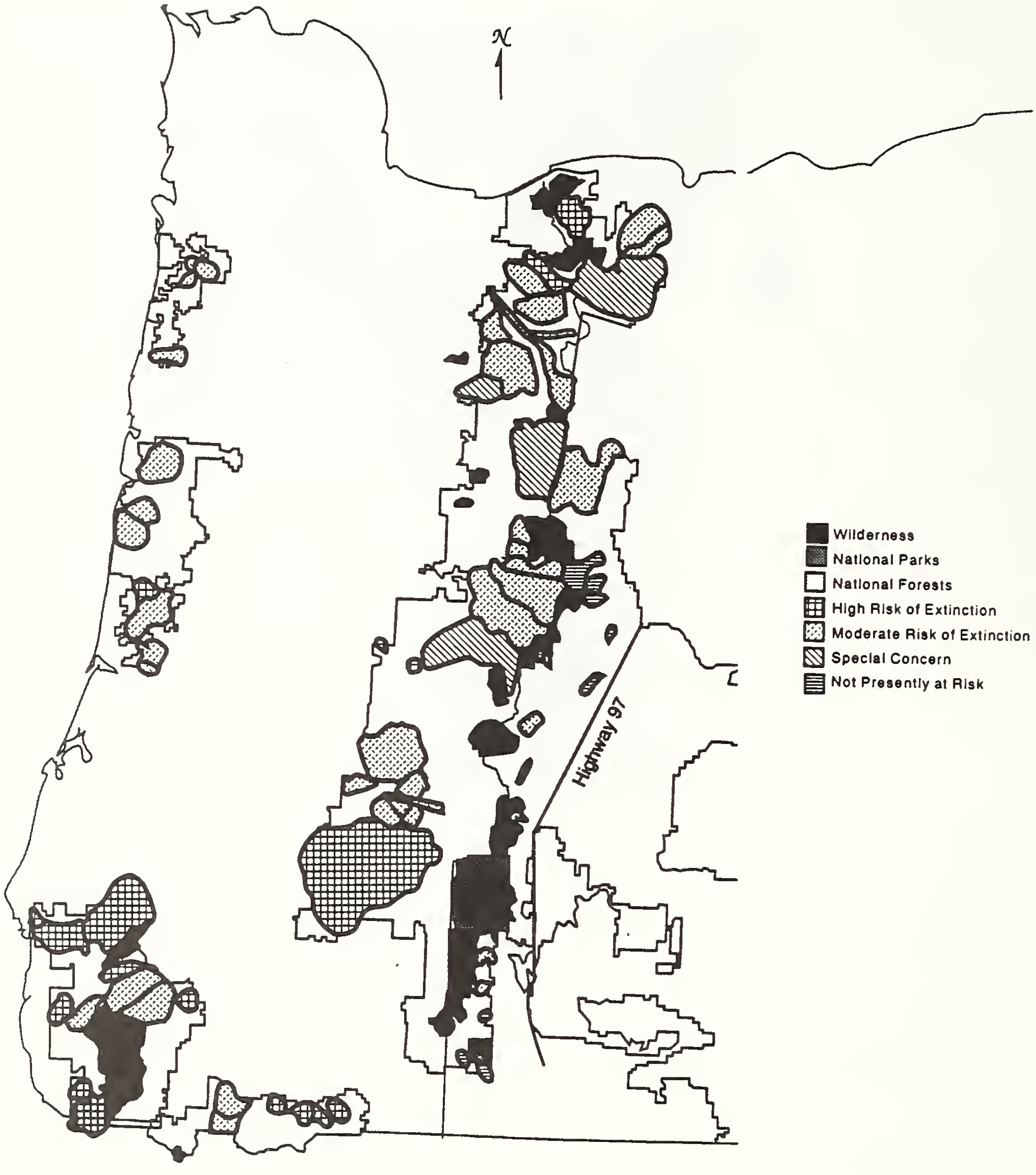


Figure 5-K-3 Location of Key Watersheds Which Could Serve as Aquatic Biodiversity Management Areas in Oregon and Status of Anadromous Salmonid Stocks (as determined by Nehlsen et al. 1991) and Other Fish Species (as determined by Williams et al. 1989) Within Streams.

Washington Key Watersheds

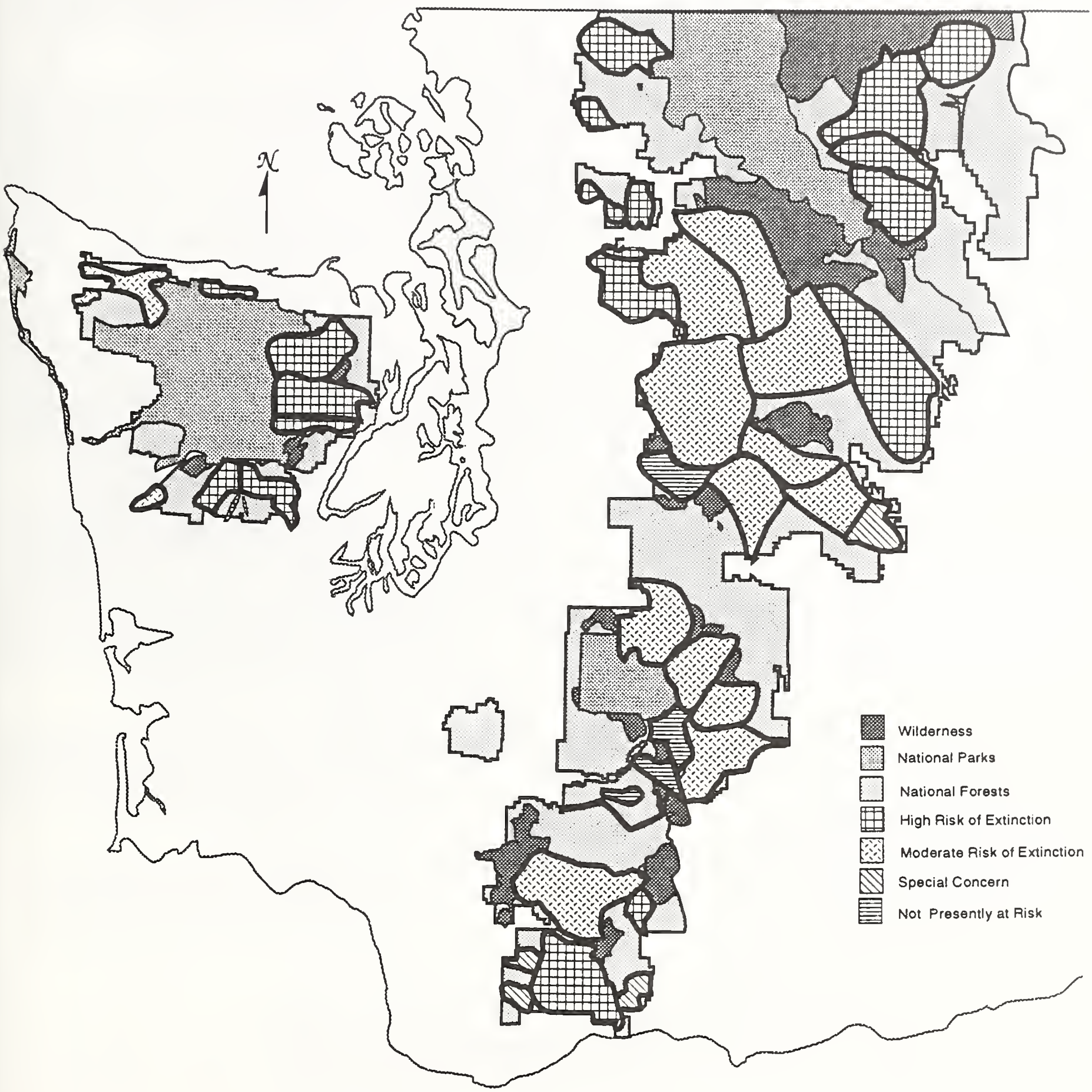


Figure 5-K-4 Location of Key Watersheds Which Could Serve as Aquatic Biodiversity Management Areas in Washington and Status of Anadromous Salmonid Stocks (as determined by Nehlsen et al. 1991) and Other Fish Species (as determined by Williams et al. 1989) Within Streams.

Schematic of a Riparian Habitat Conservation Area

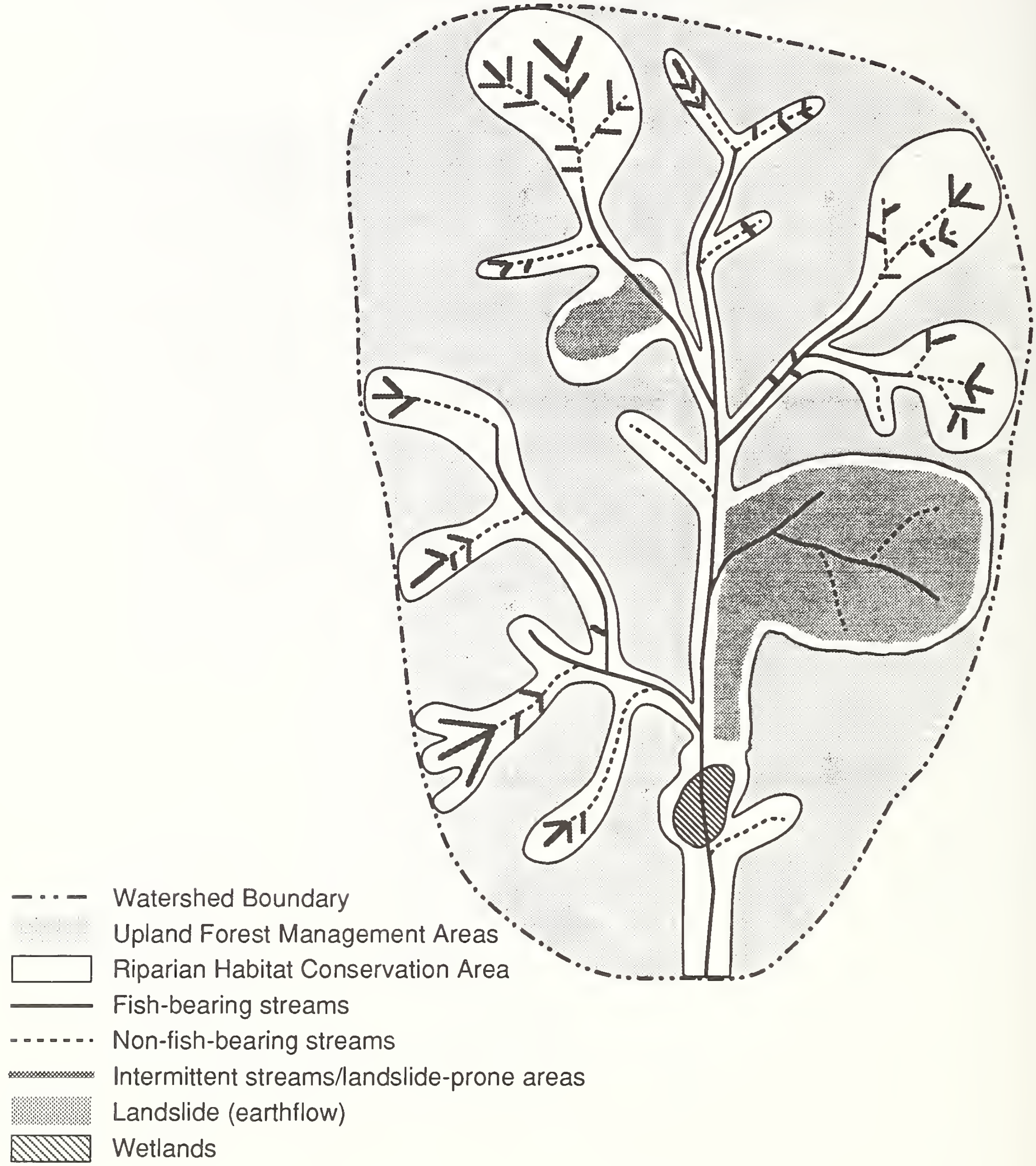


Figure 5-K-5 Schematic of a Riparian Habitat Conservation Area. Included within the Riparian Habitat Conservation Area are all seasonally flowing or intermittent streams, wetlands, landslides, and landslide-prone areas.

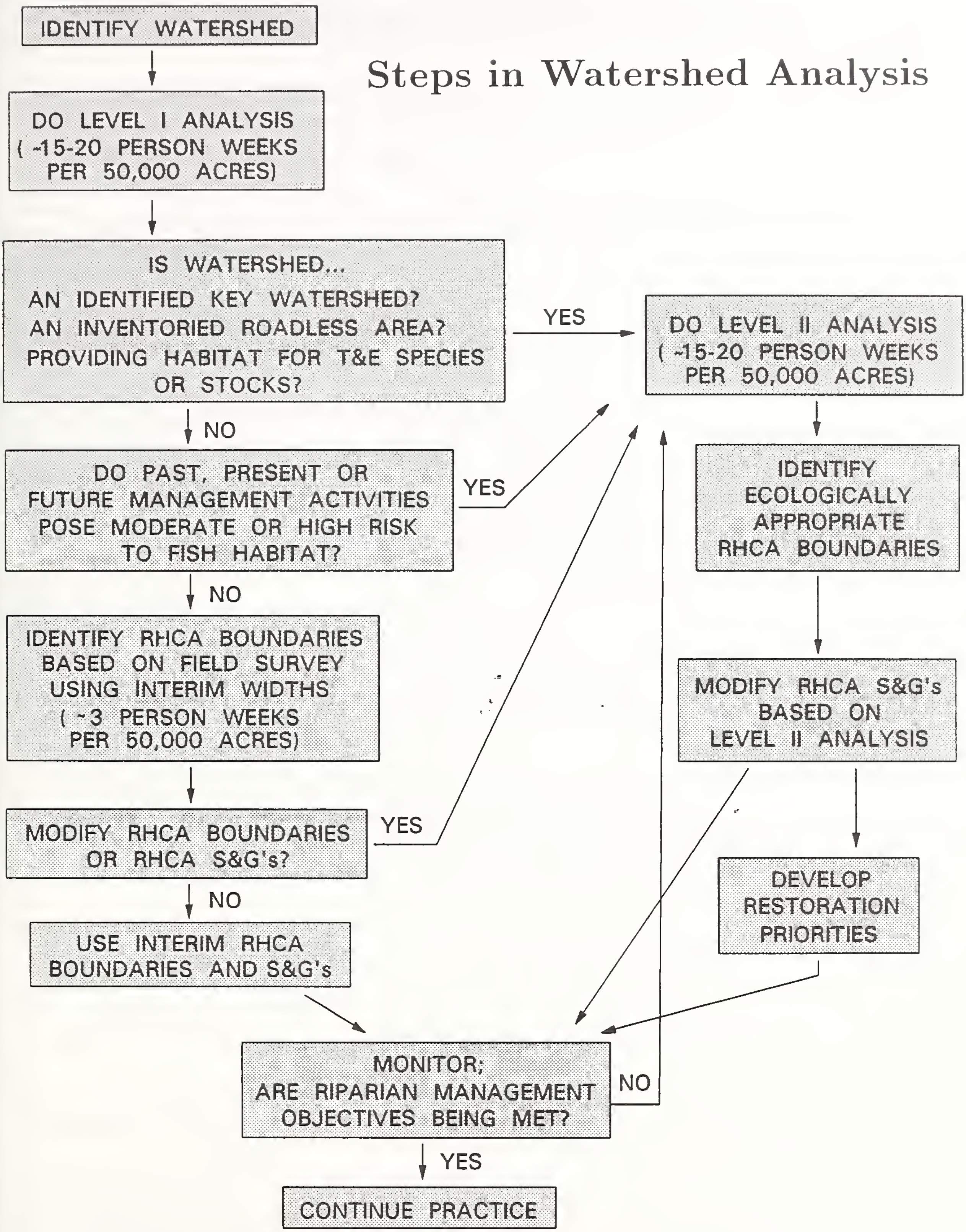


Figure 5-K-6 Flow Diagram of Proposed Watershed Analysis Procedure.

Appendix 5-K
Strategy for Managing Habitat of At-Risk Fish Species

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Chapter 6

Requirements for Successful Implementation

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Table of Contents

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INTRODUCTION

Our analyses focused on three aspects of the Forest Service's Final Environmental Impact Statement on Management for the Northern Spotted Owl in the National Forests (USDA 1992) (hereafter referred to as the Final Environmental Impact Statement, see Chapter 1) that were considered deficient by the United States District Court. In addressing these deficiencies we developed recommendations for needed mitigation measures as instructed by the Court and by the Chief of the Forest Service. Mitigation refers primarily to avoidance of adverse effects resulting from adoption of standards and guidelines recommended to provide mitigation measures for other species associated with late-successional or old-growth forests that were judged to be at risk under current Land and Resource Management Plans, plus the preferred alternative in the Final Environmental Impact Statement (the Interagency Scientific Committee's Conservation Strategy). However, mitigation also refers to measures or actions taken that would lessen adverse effects of management activities. Such activities would include recommended additions to the network of Habitat Conservation Areas in the Final Environmental Impact Statement preferred alternative to compensate for increased risk associated with Bureau of Land Management implementing their preferred alternative of their Draft Resource Management Plans.

SUMMARY OF MITIGATION STRATEGY

The Scientific Analysis Team's overall mitigation strategy follows a step-wise approach as described in Chapter 5. We developed and recommended mitigation actions (standards and guidelines) at each step in that process and each step built upon the preceding step(s). It must be understood that, although recommendations for each phase or step were developed individually, all recommendations must be viewed collectively and implemented as a complete package. Each step incrementally adds levels of habitat protection for distinct sets of species that are closely associated with old-growth forest (see Chapter 5 and its supporting appendices for full details). If some mitigation steps are not implemented, and alternate mitigation measures of equal effect are not implemented, all the species benefited by that mitigation measure will be compromised, as well as all other species benefited by the subsequent mitigation steps.

Key components of each step of our proposed strategy can be summarized as follows:

Step 1. Existing National Forest Land and Resource Management Plans–See Individual Forest Plans for specifics
- Land allocations that protect old-growth associated species including those in congressionally designated Wilderness
- Standards and guidelines that protect species closely associated with old-growth forest
- Protects habitat for 160 species or ranges

Step 2a. Interagency Scientific Committee's Strategy for Conservation of the Northern Spotted Owl (Thomas et al. 1990), or a similar plan that provides high viability for the northern spotted owl on all Federal lands

- Standards and guidelines from Step 1
- Addition of Habitat Conservation Areas
- Addition of 50-11-40 rule
- Standards and guidelines for conducting activities in Habitat Conservation Areas

– OR –

Step 2b. Interagency Scientific Committee's Conservation Strategy or an alternative that provides for a high probability of viable owl populations through additions to Habitat Conservation Areas to compensate for lower level of protection on lands administered by the Bureau of Land Management – see Chapter 3 for specifics

- Standards and guidelines from Steps 1 and 2a
- Addition of about 418,000 acres to the network of Habitat Conservation Areas on National Forests if Bureau of Land Management adopts the preferred alternatives of their Draft Resource Management Plans
- If Bureau of Land Management follows the Interagency Scientific Committee Strategy or adopts an alternative equal or superior to the Interagency Scientific Committee Strategy–no mitigation measure will be required and this step will not be adopted
- Protects habitat for 120 species or ranges (2a or 2b)

Step 3. Habitat Management for At-Risk Fish Species and Stocks – see Chapter 5, Appendix 5-K for specifics

- Standards and guidelines from Steps 1 and 2a or 2b
- Network of key watersheds containing at-risk fish species and stocks, good habitat, and/or high restoration potential
- Riparian Habitat Conservation Areas
  a) Establishment of interim buffer widths for Riparian Habitat Conservation Areas
  b) Standards and guidelines for operating within Riparian Habitat Conservation Areas
- Establishment of Watershed Analysis procedures to establish final boundaries and for conducting activities in key watersheds and Riparian Habitat Conservation Areas, and to establish restoration priorities
- Watershed Restoration of degraded habitat and for long-term habitat protection
- Protects habitat for 131 species or ranges

Step 4. Marbled Murrelet Standards–see Chapter 5 for specifics

- Standards and guidelines from Steps 1-3
- Interim standards and guidelines to conserve marbled murrelet habitat–applicable until adoption of a marbled murrelet recovery plan
  a) Protection of all suitable habitat within 35-50 miles of marine environments
  b) Protection of certain younger forest stands for habitat recruitment
  c) Designation and protection of buffers around occupied habitat where recruitment stands are unavailable

- Final standards and guidelines after adoption of recovery plan–evaluate whether final plans still meet viability requirements of other species protected within murrelet conservation areas
- Protects habitat for 24 species or ranges

Step 5. Protection of Rare and Locally Endemic Species–see Chapter 5 for specifics
- Standards and guidelines from Steps 1-4
- Identify and designate protection of known localities
- Addition of standards and guidelines to reduce habitat loss or conflicts
- Design and implement standardized survey protocol
- Conduct appropriate surveys to document species presence within proposed project areas. Surveys are required for 17 species: *Ptilidium californicum* (liverwort); *Ulota megalospora*, *brotherella roellii*, *Bauxbaumi piperi*, *B. viridus*, *Rhizumnium nudum*, *Schistostega pennata*, and *Tetraphis geniculata* (mosses); *Aleuria rehnana*, *Otidea leporina*, *O. onotica*, *O. smithii*, *Polyozellus multiplex*, and *Sarcosoma mexicana* (mushrooms); larch mountain salamander, siskiyou mountain salamander, and shasta salamander (amphibians).
- Protects habitat for 17 species or ranges

Step 6. Additional Mitigation Measures for Other Species in Upland Forest Matrix–see Chapter 5, for specifics
- Standards and guidelines from Steps 1-5
- Additional standards and guidelines to maintain critical components of habitat for particular species not provided for by Steps 1-5
- Design and implement standardized survey protocol for Del Norte salamander, lynx, and great gray owl
- Develop a standardized definition of hazard trees
- Protects habitat for 7 species or ranges

Provided that all the recommended mitigation steps and associated standards and guidelines are fully implemented, the Scientific Analysis Team believes this package will provide a high likelihood of the existence of well distributed populations of some 459 species closely associated with old-growth forests on the National Forests and located within the range of the northern spotted owl.

The Scientific Analysis Team identified 208 species for which we could not design specific mitigation options. We, therefore, tabulated a set of general ecological attributes of each of these species, including relative abundance, size of distributional range, endemism, association with old-growth components, specialization on specific substrates, elevation range, and overall distribution within the range of the northern spotted owl. We then evaluated whether any of the poorly known species would likely be protected by the Mitigation Steps above, considering this set of ecological conditions and the likelihood that mitigation measures will provide those conditions for the species in question. Through this process, we identified another 23 species that would likely be protected by mitigation measures designed for the better known species.

For the remaining old-growth associated species (185 species including 149 species of invertebrates, 19 nonvascular plants and fungi, 8 vascular plants, and 9 mammals), major uncertainties remain due to lack of scientific information about the distribution and habitat requirements of those species (see Chapter 5, Appendix 5-J). These uncertainties preclude definition of specific mitigation measures to assure viability of these poorly known species. The reservation of old-growth forests in National Parks, congressionally designated Wilderness, land use plans, and our additional mitigation measures (including implementing the Interagency Scientific Committee Strategy) should contribute to assuring viability of these species, but the state of knowledge is such that viability simply cannot be assessed. We strongly recommend processes be put in place to obtain and evaluate information necessary to evaluate viability of these species. However, we recognize that additional species can always be identified about which we know too little to evaluate their viability status. Many inconspicuous life forms have never been studied and many will likely not be studied in the foreseeable future.

FULL IMPLEMENTATION

Retention of Current Standards and Guidelines (Step 1)

Retention of current standards and guidelines for Management Indicator Species and Management Requirement Species (as described in approved National Forest Land and Resource Management Plans) is required outside the areas where the standards and guidelines prepared herein are applicable, that is, within the range of the northern spotted owl. Land allocations or standards and guidelines that reduce timber harvest, preclude scheduled timber harvest, or call for no timber harvest in the National Forest Land and Resource Management Plans, and thereby ensure habitat for species associated with old-growth forests, shall not be reduced or weakened. The first step in the Scientific Analysis Team's assessments of viability was to examine Forest Plans to evaluate how well they provided for species closely associated with old-growth forest. Other steps necessary to provide for species viability and ensure against extirpation were added. Alterations detracting from the value or amounts of these areas will increase risks to viability to some unknown degree for such species. Proposals for changes in the Land and Resource Management Plans that result in elimination or degradation of such habitat must be reviewed through an adaptive management process recommended and described below.

Implementation of the Interagency Scientific Committee's Conservation Strategy (Step 2a or 2b)

The Scientific Analysis Team's proposal depends upon implementation of the Interagency Scientific Committee Strategy or another strategy that provides for a high likelihood of viability for the northern spotted owl. This may include implementation of modifications necessary to compensate for adoption by the Bureau of Land Management of their preferred alternative of the Draft Resource Management Plans. If the Bureau of Land Management adopts a management strategy that provides for spotted owl viability at levels equal or superior to that afforded the spotted owl under the Interagency Scientific Committee's Strategy, no modification to the Interagency Scientific Committee's standards and guidelines on lands managed by the Forest Service are necessary.

Implementation of the Scientific Analysis Team's Recommended Standards and Guidelines (Steps 3-6)

Scientific Analysis Team recommended a set of standards and guidelines for other species that are closely associated with old-growth forests. The Scientific Analysis Team recognized that modifications to National Forest Land and Resource Management Plans cannot be instantly accomplished while complying with the requirements of the National Environmental Policy

Act and the National Forest Management Act. The Scientific Analysis Team believes that the suggested mitigation measures can best serve to enhance species viability only if they are implemented as soon as possible while complying in good faith with applicable laws and regulations.

Ongoing Activities

We recognized there are numerous ongoing activities on National Forests, some of which involve contracts, special-use permits, rights-of-way, leases, or other binding agreements. Some of the standards and guidelines, such as those for the Riparian Habitat Conservation Areas and marbled murrelets (Chapter 5), have specific language addressing some of these ongoing activities. For the most part, though, we have not offered such specific recommendations, and therefore offer the following:

1. Ongoing activities that do not involve contractual or otherwise binding agreements should be modified to be consistent with the standards and guidelines immediately upon implementation.

2. Ongoing activities that involve contractual or other binding agreements and where the Forest Service retains discretionary authority for alterations must be assessed to determine compatibility with the standards and guidelines. Where they conflict, consideration must be given to cancellation or modification.

3. Timber sales are recognized as a high-impact activity upon old-growth forests and associated species. Current, prolonged injunctions against entering into new timber sale contracts have reduced the number of sold and awarded sales located in late-successional old-growth habitats within the range of the northern spotted owl. We do not believe blanket cancellation of timber sales under contract is warranted. Each such activity should be individually evaluated. There are likely individual situations where cancellation and alteration may be appropriate–especially timber sales, that may affect Federally listed species such as the marbled murrelet. We note that there are several reviews by the Forest Service and the Fish and Wildlife Service of ongoing activities being conducted as part of the consultation process required by Section 7 of the Endangered Species Act. Such consultation should, if appropriately conducted, provide a rigorous examination of these ongoing activities by Fish and Wildlife Service personnel with suggested alterations where deemed appropriate.

Endangered Species Act regulations which require Federal agencies to avoid irretrievable or irreversible commitments of resources until consultation is concluded are an integral part of this assessment. Adherence to this provision in the regulations should allow adequate time for completion of the site-specific analyses necessary to determine whether such projects are in compliance with those regulations, and should proceed.

As discussed in Chapter 2, consultation as required by Section 7 will not result in "*de facto*" recovery plans or conservation strategies that have high probabilities of ensuring the viability of a threatened or endangered (i.e., "listed") species. To establish a standard higher than that of only avoiding jeopardy, the Scientific Analysis Team recommends, for Federally listed species for which a recovery plan or conservation strategy has not been implemented, that (1) not only the "Reasonable and Prudent Measures" or "Reasonable and Prudent Alternatives" presented in Biological Opinions by the Fish and Wildlife Service be followed as required by law, but that (2) the "Conservation Recommendations" made in such Biological Opinions by Fish and Wildlife Service be followed until the implementation of a recovery plan or conservation strategy for the species indicates they are not needed. Adoption of such conservation recommendations will likely result in interim protection levels adequate to ensure that ongoing agency activities will not seriously erode options essential to the development of credible recovery plans or conservation strategies.

Proposed or Planned Activities

Activities or projects that are in the proposal stage must be examined to see if modifications are necessary to comply with suggested mitigation measures. If so, these activities or projects must be modified to meet the mitigation standards regardless of the stage of the planning. Several species require surveys to designate and protect occupied sites. Survey protocols must be developed and implemented prior to project implementation.

Natural disturbances play a vital role in creating and maintaining structural and ecological characteristics of late-successional forests. Disturbances such as insect outbreaks, fire, windthrow, and disease will inevitably occur within designated areas managed primarily for spotted owl habitat and habitat for other species. The Scientific Analysis Team recommends development of a post-disturbance policy by the Forest Service that would set standards and guidelines for proposed activities within all conservation areas. Such standards and guidelines should build upon those standards that the Interagency Scientific Committee put in place for salvage and fuels management within Habitat Conservation Areas for spotted owls and for key watersheds and Riparian Habitat Conservation Areas (see Chapter 5, Appendix 5-K). Some guidelines for a general policy toward post-disturbance restoration activities are currently under development (S. Gregory, Oregon State University, pers. comm.). Guidelines must be developed with the overall objective that any proposed activities will be consistent with the goals and objectives for species closely associated with old-growth forests or fish stocks at risk for that site. They should be subject to review by appropriate interdisciplinary teams and the recommended oversight process. Policies should ensure that post-disturbance restoration activities do not decrease suitability of habitat conditions for species closely associated with old-growth forest.

Oversight Process

Consistent interpretation, application, and monitoring implementation of the Scientific Analysis Team's suggested standards and guidelines must be assured through a formally prescribed oversight process. This oversight process must be developed immediately by Forest Service management with involvement of other appropriate Federal and state agencies (Fish and Wildlife Service, National Marine Fisheries Service, and state fish and wildlife agencies).

Adaptive Management

The proposals we have offered as means to ensure against the loss of species viability or the extirpation of species are considered to be starting points. The Scientific Analysis Team based many recommendations on the best available information including the assistance of recognized experts and the professional judgments of team members. We believe that the mitigation measures suggested herein, if fully implemented, have a high probability of success in maintaining viable populations of old-growth associated species within the National Forests. We emphasize, however, that additional information will occasionally become available that may justify reexamination of suggested mitigation measures. When and where new information warrants, changes in the proposed management should be made–a process known as "adaptive management". We have based much of the following discussion of adaptive management on a similar discussion by the Northern Spotted Owl Recovery Team (USDI 1992). A key priority in the adaptive management process should be adequate and consistent funding of research and monitoring programs. Without such research and monitoring effort, it will not be possible to appropriately document changes that would indicate the need for, and the course of, adaptive management.

The idea of adaptive management seems straightforward and simple–that is, when better data become available, the standards and guidelines would be changed. However, such a process is, in reality, quite complex. There is often determined reluctance by organizations and individuals to alter decisions and practices that have become established. There may be uncertainty about the nature of the changes or about the consequences (biological, sociological, political, and economic) of change. Questions may also arise about the appropriate timing of indicated change.

Development of a well defined process of adaptive management can help alleviate some of these difficulties. Such a process provides a structure for dealing with new information in an orderly way and should produce rationally derived and well documented recommendations for adaptation. The following 13 steps represent one possible process.

1. Describe the aspect of the set of mitigation measures being addressed and the objective(s) that produced the original recommendation.

2. Describe the current standards and guidelines.

3. Describe the basis for the extant standards and guidelines–that is, the specific information that was used in development and how that information was synthesized. It is important to separately consider: (1) information derived from specific studies; (2) interpretations of that information; or (3) assumptions; and (4) professional judgements.

4. Provide some assessment of the reliability of the information used in developing the standards and guidelines. This should help in ascertaining if extant standards and guidelines should be changed. This process further suggests the types of information that should be collected in anticipation of changes.

5. Describe working hypotheses about how proposed changes in standards and guidelines will function to achieve objectives. This process may entail development of specific models for the elements being considered.

6. Clearly describe the anticipated outcomes if extant standards and guidelines are followed. These predictions should include ranges of possible outcomes based both on empirical observations, expert opinions, and the use of simulation models.

7. Describe possible outcomes if standards and guidelines do not function as expected. Such assessment should help establish the basis for identification of trigger points to determine when standards and guidelines should be reexamined.

7. Describe possible outcomes if standards and guidelines do not function as expected. Such assessment should help establish the basis for identification of trigger points to determine when standards and guidelines should be reexamined.

8. Describe potential changes to the standards and guidelines if outcomes are not as predicted. Identification of such potential changes early in the process will allow time to institute research and management experiments to focus on components of extant standards and guidelines deemed most critical. This action would allow assessment of future options and the likelihood that those options would be put in place at some future time.

9. Describe and implement the monitoring and research that should be collected in order to: (1) determine whether the standards and guidelines are being properly implemented; (2) determine if the standards and guidelines are producing expected results; (3) determine what changes to the standards and guidelines are appropriate; and (4) define responsibilities and establish funding and specific plans to reach objectives of the standards and guidelines.

10. Describe the conditions that set off reviews of, and changes in, standards and guidelines. There should be at least three types of such conditions: (1) passage of time–that is, regularly scheduled reviews; (2) outcomes are outside those parameters expected; and (3) new information becomes available that may be relevant to expected outcomes of application of the standards and guidelines.

11. When conditions identified in step 10 are reached, review monitoring and research data to determine if changes to the standards and guidelines are necessary. Risk assessment, focused on both the original decision and the forecast change, should be incorporated in making these decisions.

12. Make decisions and implement new standards and guidelines.

13. Initiate monitoring plans to assess whether the modification is achieving the desired results. Subject the new standards and guidelines to steps 1-12.

We recommend that an adaptive management process incorporating these, or some refinement of these steps be developed immediately upon implementation of new standards and guidelines for mitigation measures. Where appropriate, this process must include other agencies. Because we envision our proposal as a preliminary step, immediate attention must be given to assigning funds and staff to carry out necessary actions to implement adaptive management.

Research and Monitoring - Research and monitoring are essential components of adaptive management. It is likely that research results will add to the understanding of whether standards and guidelines are functioning as expected or whether change is warranted. Critical tasks required for research and monitoring include: (1) identifying critical monitoring or research questions for the species or standard and guideline in question (this includes implementation, effectiveness, and validation monitoring of standards and guidelines); (2) describing appropriate inventory standards and protocols for the species in question; (3) describing how variations in inventory standards will result in varying levels of reliability in estimates of population status or trend in habitat condition; (4) identifying and coordinating interactions between monitoring and research programs; and (5) providing adequate and continued funding and staff necessary to support research and monitoring activities.

Research activities can be designed to investigate a variety of the assumptions and components of the Scientific Analysis Team's strategy and proposals. Research can provide data to refine our understanding of the habitat relationships of old-growth associated species, to investigate whether proposed actions are achieving the desired effects, and to test assumptions about how old-growth ecosystems function. Manipulative experiments may be particularly important in testing hypotheses about effects of land management activity on species. Existing experimental forests such as the H.J. Andrews in Oregon and Wind River in Washington provide ideal locations for such studies and should be allowed to continue to support such work. The Scientific Analysis Team recommends that experimental forests in Washington, Oregon, and California be exempted from restrictions placed on manipulative experiments within spotted owl, riparian, and marbled murrelet habitat conservation areas, as long as those activities are motivated by legitimate scientific research questions (as determined by peer review). Because the key watersheds, Riparian Habitat Conservation Areas and marbled murrelet conservation areas cover wide geographic areas, the Scientific Analysis Team recommends development of an oversight and review process to evaluate, coordinate, and decide on suitability of planned research in riparian and murrelet habitat conservation areas outside of Habitat Conservation Areas. A technical committee such as that formed by Federal and state agencies under the Interagency Northern Spotted Owl Conservation Group would be an appropriate body to provide such oversight.

Our analyses revealed conspicuous gaps in knowledge about the fauna associated with old-growth forest. Perhaps chief among these is the paucity of information about the distribution and habitat requirements of invertebrates, "The little things that run the World" (Wilson 1987). Olson (1992) proposed a survey protocol to investigate the relationships of invertebrate populations to the kinds, amounts, and arrangement of forest conditions and to evaluate the use of invertebrate species as environmental indicators of biological diversity. Scientific Analysis Team recommends pursuit of these suggestions to help fill this information gap.

Ongoing Planning and Evaluations - The Forest Service, Bureau of Land Management, and the Fish and Wildlife Service have ongoing research, monitoring, planning and management activities that will produce new information on spotted owls and other species associated with old-growth forest. These efforts include: recovery planning by the Department of the Interior for the northern spotted owl, by the Fish and Wildlife Service for marbled murrelets, and by the National Marine Fisheries Service for various stocks of anadromous fish; Status Reviews conducted by the Fish and Wildlife Service under requirements of the Endangered Species Act; Bureau of Land Management Resource Management Planning; and the development of conservation strategies by the Forest Service for marbled murrelets, bull trout, forest owls, goshawk, furbearers, and Pacific anadromous fishes. Information from these and other efforts will need to be quickly and thoroughly processed through strict technical assessment and the adaptive management process to ascertain if and how the standards and guidelines put forth here should be modified.

INTERAGENCY COORDINATION

The Interagency Scientific Committee identified lack of interagency and intra-governmental cooperation as a longstanding, major obstacle of efforts to produce an effective, cost-efficient spotted owl habitat management plan. This obstacle obviously continues to exist. Added to the complexities of the management of habitat for northern spotted owls, marbled murrelets, and anadromous fish, are a myriad of other issues and considerations pertaining to the hundreds of other species associated with older forest conditions. In order to ensure the best chances of success, we believe it is essential that Federal and state agencies with responsibilities in this area, develop a unified management strategy to provide for species associated with old-growth forest. Efficiencies and opportunities not available to any single agency could be greatly enhanced by such an approach. Although institutional barriers make a unified approach difficult to achieve, we believe the biological, economic, political, and social complexities make the use of a unified approach increasingly difficult to overcome, justify, or tolerate. The Scientific Analysis Team's mitigation strategy applies only to lands managed by the Forest Service; however, population viability of the marbled murrelet and many fish stocks, for example, is a function of habitat conditions on all ownerships. Conservation of range-wide habitat conditions for such species simply cannot be accomplished by one agency acting alone or by involved agencies operating with conflicting purposes.

CONCLUSIONS

We emphasize the need to treat the proposed viability evaluations of old-growth associated species and the proposed mitigation options as management hypotheses. All species that we identified as closely associated with old growth, and particularly those identified as having a risk to their viability, are deserving of further research, monitoring of habitat amount and distribution and, in some cases, monitoring of specific population parameters such as distribution, size, and trend of population. However, it should be recognized that such broad range research efforts would be very expensive and, therefore, not likely to be funded. We recommend that Forest Service Research be commissioned to do an intensive problem analysis to identify the highest priority research and monitoring and suggest appropriate research for consideration by agency managers, the administration, and Congress.

Our analyses were hampered by the lack of spatially explicit resource inventories throughout the region. Better inventories are needed to facilitate future attempts to evaluate the effects of proposed land management actions and to design new conservation strategies for organisms or ecosystems.

Our effort is an initial step in a fuller process for providing underlying support to ecosystem management, planning, and evaluation. There is still much basic work required to support ecologically based land stewardship under a concept of ecosystem management. We evaluated a complex array of species–including vertebrate, vascular and nonvascular plants, and invertebrates. This lead to the proposal of a comprehensive management strategy that, in total, protects adequate habitat of all those species for which there is available information.

Our approach focused on the <u>composition</u> of old-growth forest ecosystems through an analysis on plant and animal species associated with such habitats. We anticipated that the next step toward ecosystem management would involve investigation and evaluation of ecological functions and processes as a means to understand, and perhaps design, management strategies to achieve desired objectives. Such an approach would lead away from a species-by-species management philosophy and toward a desired state of ecosystem function which might, in turn, lead to sustainability of ecosystems and their components. The Forest Service has adopted a new forest management policy called "ecosystem management". Our effort sheds some light on the early stages of implementing this policy, specifically for old-growth forest ecosystems of the Pacific Northwest. We believe our proposal is a link to future management directions in the Forest Service.

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Glossary

GLOSSARY

Most of the terms in this glossary were taken from the glossaries of the Interagency Scientific Committee's Conservation Strategy (ISC Report), the Final Environmental Impact Statement on Management for the Northern Spotted Owl in the National Forests (FEIS), the U.S. Fish and Wildlife Service's Draft Recovery Plan for the Northern Spotted Owl (Draft Recovery Plan), or Alternatives for Management of Late-Successional Forests of the Pacific Northwest (Late-Successional Forests Report). Any remaining terms have been defined by the Scientific Analysis Team. The source of each definition appears at the end of the definition.

50-11-40 rule - a guideline developed by ISC to provide habitat conditions to facilitate movement of juvenile and adult owls across the landscape. It requires that 50 percent of the forest within a quarter-township be maintained with an average tree dbh of at 11 inches and 40 percent canopy closure. (Draft Recovery Plan)

100-year floodplain - the area adjacent to a stream which is on average inundated once a century. (Scientific Analysis Team)

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. (Draft Recovery Plan)

Age specific birth rate - rate at which individuals of a particular age produce young. (Scientific Analysis Team)

Age specific survival rate - the average proportion of individuals in a particular age group that survive for a given time period. (Scientific Analysis Team)

Agreement areas - also BLM-ODFW agreement areas; spotted owl habitat areas protected by the BLM under a cooperative agreement with the ODFW. (ISC Report)

Allee effect - a depression in the encounter rate between males and females 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. (ISC Report)

Allowable sale quantity (ASQ) - the quantity of timber that may be sold from the area of suitable land covered by a Forest Plan for a time period specified by the Plan. This quantity is usually expressed on an annual basis as the "average annual allowable sale quantity." (FEIS)

Alternative - one of several policies, plans, or projects proposed for decision making. (FEIS)

Anadromous fish - fish that are born in freshwater, rear there as immature, move to the ocean to grow and mature, and return to freshwater to reproduce. (Scientific Analysis Team)

Aquatic ecosystem - any body of water, such as a stream, lake, or estuary, and all organisms and non-living components, functioning as a natural system. (Late-Successional Forests Report)

Arboreal - living in the canopies of trees. (FEIS)

Aspect - the direction a slope faces with respect to the cardinal compass points. (Draft Recovery Plan)

Associated species - a species found to be numerically more abundant in a particular forest successional stage as compared to other stages (Ruggiero et al. 1991). (FEIS)

Awarded sales - Federal timber sales that have been let to the successful bidder through a formal contract. (ISC Report)

b - the age-specific fecundity rate of adult females

B - the average annual number of new entries into the adult population (i.e., immigrants)

b(1) - the fecundity rate for one-year old females

b(2) - the fecundity rate for two-year old females

Biological diversity - the variety of life and its processes, including complexity of species, communities, gene pools, and ecological functions. (Draft Recovery Plan)

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. (Scientific Analysis Team)

Block (of forest, habitat) - geographical area of trees or vegetation that is distinct from surrounding conditions. Block size may vary greatly. (Late-Successional Forests Report)

BLM - Bureau of Land Management, U.S. Department of the Interior.

Blowdown - trees felled by high winds. (Draft Recovery Plan)

Breast height - a standard height from average ground level for recording diameter, girth, or basal area, generally 4.5 feet (1.37 meters). (Draft Recovery Plan)

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. (Draft Recovery Plan)

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. (Scientific Analysis Team)

Canopy - a layer of foliage in a forest stand. This most often refers to the uppermost layer of foliage. Here it is used to describe lower layers, but over one's head, in a multistoried stand. (Scientific Analysis Team)

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. (Scientific Analysis Team)

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. (Draft Recovery Plan)

Capture history - a record of the recaptures or resightings of a marked individual. Usually recorded as a string of 1's or 0's to indicate occasions when the individual was either recaptured or not recaptured. (Scientific Analysis Team)

Carrying capacity - the maximum number of organisms that can be supported in a given area of habitat at a given time. (FEIS)

Catastrophic event - a large-scale, high-intensity natural disturbance that occurs infrequently. (Late-Successional Forests Report)

Cavity nester - wildlife species, most frequently birds, that require cavities (holes) in trees for nesting and reproduction. (Late-Successional Forests Report)

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. (ISC Report)

Classic old growth - forest stands with unusually old and very large trees that also meet criteria for old-growth forests; stands that meet the definition in Forest Service publication PNW-447. (Late-Successional Forests Report)

Clear-cut - an area where the entire stand of trees has been removed in one cutting. (Draft Recovery Plan)

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 as 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. (FEIS)

Cluster - an area that contains habitat capable of supporting three or more breeding paris of spotted owls with overlapping or nearly overlapping home ranges. (Draft Recovery Plan)

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. (FEIS)

Cohort - individuals all resulting from the same birth-pulse, and thus all of the same age. (ISC Report)

Commercial forest land - land declared suitable for producing timber crops and not withdrawn from timber production for other reasons. (Late-Successional Forests Report)

Commercial thinning - the removal of generally merchantable trees from an even-aged stand, usually to encourage growth of the remaining trees. (Late-Successional Forests Report)

Community - pertaining plant or animal species living in close association and interacting as a unit. (Late-Successional Forests Report)

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. (Scientific Analysis Team)

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 scale-like leaves. (Draft Recovery Plan)

Connectivity - a measure of the extent to which intervening habitat truly connects species reserves for juvenile spotted owls or other species dispersing among them. (Scientific Analysis Team)

Conservation - the process or means of achieving recovery or viable populations. (Scientific Analysis Team)

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 of a proposed action on Federally listed threatened or endangered species or designated critical habitat. (Scientific Analysis Team)

Conservation strategy - a management plan for a species, group of species, or ecosystem that prescribes standards and guidelines which if implemented provide a high likelihood that the species, groups of species, or ecosystem, with its full compliment of species and processes, will continue to exist well-distributed throughout a planning area i.e., a viable population. (Scientific Analysis Team)

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. (Draft Recovery Plan)

Contiguous habitat - habitat suitable to support the life needs of species that is distributed continuously or nearly continuously across the landscape. (Draft Recovery Plan)

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. (ISC Report)

Critical habitat - Under the Endangered Species Act, critical habitat is defined as "the specific areas within the geographic area occupied by a Federally listed species...on which are found those physical and biological features essential to the conservation of the species, and that may require special management considerations or protection; and specific areas outside the geographic area occupied by a species at the time it is listed, upon determination that such areas are essential for the conservation of the species." (FEIS)

Critical link - In this report, geographical areas located between physiographic provinces that represent most likely avenues for dispersing spotted owls provided habitat conditions are favorable for such movement. (Scientific Analysis Team)

Crown - the upper part of a tree or other woody plant which carries the main system of branches and the foliage. (Draft Recovery Plan)

Crown cover - the degree to which the crowns of trees are nearing general contact with one another. Generally measured as the percent of the ground surface that would be covered by a downward vertical projection of foliage in the crowns of trees.

Crude density - the number of individuals in an area. (Scientific Analysis Team)

Cumulative effects - those effects on the environment which result from the incremental effect of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-federal) or person undertakes such other actions. Cumulative effects can result from individually minor but collectively significant actions taking place over a period of time. (FEIS)

CWD (coarse woody debris) - 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. (Draft Recovery Plan)

DBH - diameter at breast height. The diameter of a tree measured 4 feet 6 inches above the ground on the uphill side of the tree. (FEIS)

DCA - designated conservation area. (Draft Recovery Plan)

Debris torrent - rapid movement of a large quantity of materials (wood and sediment) down a stream channel during storms or floods; generally occurs in smaller streams and results in scouring of stream bed. (Late-Successional Forests Report)

Demographic stochasticity - random fluctuations in birth and death rates. (ISC Report)

Demography - the quantitative analysis of population structure and trends; population dynamics. (Draft Recovery Plan)

Density-dependent - a process, such as fecundity, whose value depends on the number of animals in the population per unit area. (ISC Report)

Density management - In Bureau of Land Management Draft planning documents of 1992–cutting trees for the primary purpose of widening their spacing so that growth of remaining trees can be accelerated. Density management is also planned to be used by BLM 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. (Scientific Analysis Team)

Density study area - an area in which the objective is to count all individuals that are present, thereby monitoring populations trends over time. (Scientific Analysis Team)

Designated conservation area (DCA) - a contiguous area of habitat to be managed and conserved for spotted owls under the Draft Recovery Plan for Northern Spotted Owl. This general description can be applied to two categories:

DCA 1 - category of DCA intended to support at least 20 pairs of spotted owls.

DCA 2 - category of DCA intended to support one to 19 paris of spotted owls. (Draft Recovery Plan)

Desired future conditions - an explicit description of the physical and biological characteristics of a habitat type believed necessary to meet objectives for a species. (Late-Successional Forests Report)

df - degrees of freedom, which is usually the sample, n, minus 1 (i.e., n-1)

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. (Late-Successional Forests Report)

Dispersal capability - the ability of members of a species to move from their area of birth to another suitable location and subsequently breed. (Draft Recovery Plan)

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. (ISC Report)

Dispersal habitat - habitat that supports the life needs of an individual animal during dispersal. Generally satisfies needs for foraging, roosting, and protection from predators. (Draft Recovery Plan)

Distribution (of a species) - the spatial arrangement of a species within its range. (Draft Recovery Plan)

Disturbance - a significant change in structure and/or composition caused by natural events such as fire and wind or human-caused events such as cutting. (Draft Recovery Plan)

Diversity - the variety, distribution, and abundance of different plant and animal communities and species within an area. See biological diversity. (FEIS)

Down log - portion of a tree that has fallen or been cut and left in the woods. (Draft Recovery Plan)

Draft Environmental Impact Statement (DEIS) - the draft statement of environmental effects which is required for major Federal action under Section 102 of the National Environmental Policy Act, and released to the public and other agencies for comment and review. (FEIS)

Drainage - a large area mostly bounded by ridges, encompassing part, most or all of a watershed and enclosing on the order of 5,000 acres. (Late-Successional Forests Report)

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. (Draft Recovery Plan)

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. (Draft Recovery Plan)

Ecological health - the state of an ecosystem in which processes and functions are adequate to maintain diversity of biotic communities commensurate with those initially found there. (Late-Successional Forests Report)

Ecosystem - an interacting system of organisms considered together with their environment; for example, marsh, watershed, and lake ecosystems. (Draft Recovery Plan)

Ecosystem approach - a strategy or plan to manage ecosystems to provide for all associated organisms, as opposed to a strategy or plan for managing individual species. (Late-Successional Forests Report)

Edge - where plant communities meet or where successional stages or vegetative condition with plant communities come together. (Draft Recovery Plan)

Edge effect - the effect of adjoining vegetative communities on the population structure along the margin, which often provides for greater number of species and higher population densities of some species than either adjoining community. Edge may result in negative effects as well; habitat along an edge is different than in the patch of habitat, reducing the effective area of the habitat patch. (FEIS)

Emigration - permanent movement of individuals of a species from a population. (ISC Report)

Empirical - derived from direct observation or experimentation. (Draft Recovery Plan)

Endangered species - any species of animal or plant that is in danger of extinction throughout all or a significant portion of its range; plant or animal species identified by the Secretary of the Interior as endangered in accordance with the 1973 Endangered Species Act. (Draft Recovery Plan)

Endemic - a species that is unique to a specific locality. (Draft Recovery Plan)

Environmental stochasticity - random variation in environmental attributes such as temperature, precipitation, and fire frequency. (Draft Recovery Plan)

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. (Draft Recovery Plan)

Even-aged forest - a forest stand composed if trees with less than a 20-year difference in age. (Draft Recovery Plan)

Even-aged management - the application of a combination of actions that result in the creation of stands in which trees of essentially the same age grow together. Managed even-aged forests are characterized by a distribution of stands of varying ages (and, therefore, tree sizes) throughout the forest area. The difference in age among trees forming the main canopy level of a stand usually does not exceed 20 percent of the age of the stand at harvest rotation age. 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. Clear-cut, shelterwood, or seed tree cutting methods produce even-aged stands. (Draft Recovery Plan)

Extended rotation - a period of years that is longer than the time necessary to grow timber crops to a specific condition of maturity. (Draft Recovery Plan)

Extinct - a species is extinct when it no longer exists. (Draft Recovery Plan)

Extirpation - the elimination of a species from a particular area. (Draft Recovery Plan)

Extirpation risk species - in this report, those species that were generally ranked as having a medium low or low viability over a 50-year period under one FEIS alternative. Extirpation related to local extinction of a species from one or more National Forests within the range of the northern spotted owl.

F1 cross - offspring resulting from a cross between two original parental stocks. (Scientific Analysis Team)

Fecundity - number of female young produced per female owl in the population of interest. (ISC Report)

Final Environmental Impact Statement (FEIS) - the final version of the of environmental effects 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. (FEIS)

Fire regime - the characteristic frequency, extent, intensity, severity, and seasonality of fires in an ecosystem. (Draft Recovery Plan)

Floaters - nonbreeding adults and subadults that move and live within a breeding population, often replacing breeding adults that die; nonterritorial individuals. (Draft Recovery Plan)

Forest or Forest land - lands currently supporting or capable of supporting forests at a density of 10 percent crown closure or better.

[Forest land - at least 10 percent land area covered by forest trees or formerly having had such tree cover and not currently developed for other use. (Late-Successional Forests Report)]

Forest fragmentation - the change in the forest landscape, from extensive and continuous forests of old-growth to a mosaic of younger stand conditions. (Draft Recovery Plan)

Forest landscape - land presently forested or formerly forested and not currently developed for nonforest use. (ISC Report)

Forest matrix - forest lands between designated areas managed primarily for spotted owl habitat. (FEIS)

Forest plan - a land management plan designed and adopted to guide forest management activities on a National Forest or BLM District. (Late-Successional Forests Report)

Fragmentation - the process of reducing size and connectivity of stands that comprise a forest. (FEIS)

FWS - Fish and Wildlife Service, U.S. Department of the Interior.

GIS - geographical information system. This is a computer system capable of storing and manipulating spatial (i.e., mapped) data. (Draft Recovery Plan)

Green tree - a live and growing tree. (Late-Successional Forests Report)

Green-tree retention - the silvicultural practice of retaining live, growing trees on a site during timber harvest as a future source of snags. (Late-Successional Forests Report)

Guideline - a policy statement that is not a mandatory requirement (as opposed to a standard, which is mandatory). (Draft Recovery Plan)

HA (hectare) - a measure of area in the metric system equal to approximately 2.5 acres. (Draft Recovery Plan)

Habitat - the place where a plant or animal naturally or normally lives and grows. (Draft Recovery Plan)

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 int he recovery plan, this means the same as capability to support spotted owl pairs. (Draft Recovery Plan)

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. (Late-Successional Forests Report)

Harvest cutting method - methods used to harvest trees. Harvest cutting methods are classified as even-aged and uneven-aged. (Draft Recovery Plan)

HCA (habitat conservation area) - 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. (Draft Recovery Plan)

Helicopter logging - use of helicopters to transport logs from where they are felled to a landing. (Scientific Analysis Team)

High-lead cable system - a harvest technology where cut logs are suspended above the ground and transported to a landing. (Scientific Analysis Team)

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 under at least one FEIS alternatives.

Home range - the area within which an animal conducts its activities during a defined period of time. (Draft Recovery Plan)

Home range of a pair - the sum of the home ranges of each member of a pair minus the area of home range overlap. (Draft Recovery Plan)

Hybrid - an offspring that results from the mating of individuals of different races or species. (Draft Recovery Plan)

Hybridization - the crossing or mating of two different varieties of plants or animals. (Draft Recovery Plan)

Immigration - movement of individuals into a population. (Draft Recovery Plan)

Inbreeding - mating or crossing of individuals more closely related than average pairs in the population. (FEIS)

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. (FEIS)

Ingrowth - the period in time after successional growth of a forest stand when it reaches a specified age or structure class, for instance, spotted owl foraging habitat. (FEIS)

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 Forests. (Draft Recovery Report)

Inner gorge - a stream reach bounded by steep valley walls which terminate upslope into a more gentle topography. Common in areas of rapid stream downcutting or uplift, such as northern California and southwestern Oregon. (Scientific Analysis Team)

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. (FEIS)

Interim (short-term) solution - a 2- to 4-year period. (Late-Successional Forests Report)

Interspecific - occurring among members of different species. (Draft Recovery Plan)

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. (Draft Recovery Plan)

Intraspecific - occurring among members of single species. (Draft Recovery Plan)

ISC (Interagency Scientific Committee) - a committee of scientists that was established by the U.S. Forest Service, U.S. Bureau of Land Management, U.S. Fish and Wildlife Service, and National Park Service, to develop a conservation strategy for northern spotted owls. (Draft Recovery Plan)

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. (Scientific Analysis Team)

Isolate - a population that is isolated. See isolation. (Draft Recovery Plan)

Isolation - absence of genetic crossing among populations because of distance or geographic barriers. (Draft Recovery Plan)

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. (Draft Recovery Plan)

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. (Scientific Analysis Team)

Juvenile - for spotted owls, a juvenile is normally considered to be any bird that is less than 1 year old. (Scientific Analysis Team)

Key watershed - as defined by National Forest and BLM 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. (Late-Successional Forests Report)

Lambda - the finite rate of population change (population size in year 2 divided by the population size in year 1). (ISC Report)

Land allocation - the specification in Forest Plans of where activities, including timber harvest, can occur on a National Forest or BLM District. (Late-Successional Forests Report)

Landsat - a satellite that produces imagery used in remote sensing of forests. Analysis of this imagery produces maps of vegetation condition. (Draft Recovery Plan)

Landsat Multispectral Scanner - a satellite borne sensor, first launched in 1972, capable of recording reflected energy from the surface of the 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 180x180 km scene which is useful for mapping natural resources. (Scientific Analysis Team)

Landsat Thematic Mapper - an improved version of the Landsat MSS satellite sensor capable of recording reflected and emitted energy from the surface of the 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. (Scientific Analysis Team)

Late-Successional Forests - Forest seral stages that include mature and old-growth age classes.

Leave strips - generally narrow bands of forest trees that are left along streams and rivers to buffer aquatic habitats from upslope forest management activities. (ISC Report)

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. (FEIS)

log (e) - the natural logarithm of a number

Long term - here, 50 to 100 years and sometimes beyond. (ISC Report)

Managed forest - forest land that is harvested on a scheduled basis and contributes to an allowable sale quantity. (ISC Report)

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. (Draft Recovery Plan)

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. (Scientific Analysis Team)

Matrix - land within the range of the northern spotted owl that lies outside of category 1 and 2 Habitat Conservation Areas. (Scientific Analysis Team))

Mature stand - a mappable stand of trees for which the annual net rate of growth has culminated. 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. (Draft Recovery Plan)

Maximum Likelihood Classification - A statistical classification technique which assigns reflectance values to groups based on the probability that an observation belongs to a particular class. (Scientific Analysis Team)

Mean - a central value of a series or set of observations obtained by dividing the sum of all observations by the number of observations. (Draft Recovery Plan)

Merchantable (trees, stands, timber) - trees or stands that people will buy for the wood they contain. (Late-Successional Forests Report)

Mesic - pertaining to or adapted to an area that has a balanced supply of water. Neither wet nor dry. (Draft Recovery Plan)

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. (Scientific Analysis Team)

Meta-population - a population comprised of a set of local populations that are linked by migrants, allowing for recolonization of unoccupied habitat patches after local extinction events. (ISC Report)

Microenvironment - the sum total of all the external conditions that may influence organisms and that come to bear in a small or restricted area. (ISC Report)

Microhabitats - a restricted set of distinctive environmental conditions that constitute a small habitat, such as the area under a log. (ISC Report)

Minimum viable population - the low end of the viable population range. (Draft Recovery Plan)

Mitigation - mitigation includes: (a) avoiding the impact altogether by not taking a certain action or parts of an action; (b) minimizing impacts by limiting the degree or magnitude of the action and its implementation; (c) rectifying the impact by repairing, rehabilitating, or restoring the affected environment; (d) reducing or eliminating the impact over time by preservation and maintenance operations during the life of the action; and (e) compensation for the impact by replacing or providing substitute resources or environments (40 CFR 1508.20). (FEIS)

Mixed conifer - as used in this document, the term "mixed conifer" refers to stands of trees, made up of pine, Douglas-fir, and true firs, that are generally found east of the Cascades. (Draft Recovery Plan)

Mixed-conifer forest - a forest community that is dominated by two or more coniferous species. (Draft Recovery Plan)

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. (Draft Recovery Plan)

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 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. (Draft Recovery Plan)

Monitoring - a process of collecting information to evaluate whether objectives of a management plan are being realized. (FEIS)

Monitoring program - see "monitoring;" the program used to monitor a population and its habitat. (ISC Report)

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. (FEIS)

Multiple use - the management of renewable resources so that they are utilized in the combination that will best meet the needs of people. (Draft Recovery Plan)

Multistoried - term applied to 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. (Draft Recovery Plan)

Natal area - the location where an animal was born. (Draft Recovery Plan)

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 which 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.). (FEIS)

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. (FEIS)

NEPA - National Environmental Policy Act of 1969. (ISC)

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. (FEIS)

NF - National Forest. (Draft Recovery Plan)

Nocturnal - referring to organisms that are active or functional at night. (Draft Recovery Plan)

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 which can be discerned from satellite imagery. (Scientific Analysis Team)

Northern spotted owl - one (*Strix occidentalis caurina*) of three subspecies of the spotted owl which 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. (Late-Successional Forests Report)

Occupancy rate - in reference to spotted owls, the percent of inventoried spotted owl habitat that is estimated to be occupied by breeding paris of spotted owls. (Draft Recovery Plan)

OGEA - In Bureau of Land Management Draft Planning Documents of 1992–Old Growth Emphasis Areas. 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. (Scientific Analysis Team)

Old-growth - a forest stand with moderate to high canopy closure; a multilayered, multispecies canopy dominated by large overstory trees; a high incidence of large trees with large, broken tops, and other indication of decadence; numerous large snags; and heavy accumulations of logs and other woody debris on the ground. (Draft Recovery Plan)

Old-growth associated species - plant and animal species that exhibit a strong association with old-growth forests. (Draft Recovery Plan)

Old-growth stand - a mappable area of old-growth forest. (Draft Recovery Plan)

Overstory - trees that provide the uppermost layer of foliage in a forest with more than one roughly horizontal layer of foliage. (Draft Recovery Plan)

Owl site - any site where there has been a recent or historic observation of a single spotted owl or a pair of owls. (Draft Recovery Plan)

P-value - the probability of finding a value of a test statistic larger than a given value

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. (FEIS)

Pair site - an amount of habitat that is considered capable of supporting one pair of spotted owls. (Draft Recovery Plan)

Patch - a small (20-60 acre) part of the forest. This term is often used to indicate a type of clearcutting (patch cuts) associated with the "staggered setting" approach to distributing harvest units across the landscape. (Late-Successional Forests Report)

Phi (Φ) - the annual probability of survival of adult females.

Physiographic province - a geographic region in which climate and geology have given rise to a distinct array of landforms. Biology and habitat relationships of spotted owls vary by physiographic province due to differences in climate, vegetation, and productivity of habitats. (Draft Recovery Plan)

Pixel - abbreviated form of "Picture Element", or the smallest division of a picture or image. (Scientific Analysis Team)

Planning area - in this document, the range of the northern spotted owl on National Forests. (FEIS)

Platform nest - a relatively flat nest constructed on a supporting structure such as a broad branch. (Draft Recovery Plan)

Population density - number of individuals of a species per unit area. (Draft Recovery Plan)

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, as well as the effects that any or all of these factors exert on the population. (Draft Recovery Plan)

Population viability - probability that a population will persist for a specified period of time across its range despite normal fluctuations in population and environmental conditions. (FEIS)

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. (Scientific Analysis Team)

Population viability models - a mathematical abstraction of a system that is designed to predict the likelihood of persistence of a population under different conditions. (Scientific Analysis Team)

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. (Draft Recovery Plan)

Precommercial thinning - the practice of removing some of the trees less than merchantable size from a stand so that remaining trees will grow faster. (Draft Recovery Plan)

Predator - any animal that preys externally on others, i.e., that hunts, kills, and generally feeds on a succession of hosts, i.e., the prey. (Draft Recovery Plan)

Prescribed burning - controlled fire deliberately set to meet various resource objectives. (Late-Successional Forests Report)

Prescribed fire - a fire burning under specified conditions that will accomplish certain planned objectives. The fire may result from planned or unplanned ignitions. (Draft Recovery Plan)

Presuppression - activities organized in advance of fire occurrence to ensure effective suppression action. (Draft Recovery Plan)

Protective management - measures taken by nonfederal entities to conserve spotted owls and or 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. (Draft Recovery Plan)

Province - see physiographic province. (Draft Recovery Plan)

Quarter-township - an area approximately 3 miles square containing nine sections of land. (Draft Recovery Plan)

R - the number of observations of banded spotted owls in year j that were last captured in year i.

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. (Draft Recovery Plan)

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. (Draft Recovery Plan)

Range (of a species) - the area or region over which an organism occurs. (Draft Recovery Plan)

Reasonable and prudent alternatives - alternative actions identified during formal consultation and communicated via a biological opinion, that can be implemented to avoid the likelihood of jeopardizing the continued existence of threatened or endangered species or destruction or adverse modification of critical habitat. (Scientific Analysis Team)

Reasonable and prudent measures - these actions the Fish and Wildlife Service or the National Marine Fisheries Service believe are necessary to appropriate to minimize the impacts i.e. amount or extent, of incidental take. These are communicated to a Federal agency in a biological opinion. (Scientific Analysis Team)

Record of Decision - a document separate from but associated with an environmental impact statement which 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. (FEIS)

Recovery - action that is necessary to reduce or resolve the threats that caused a species to be listed as threatened or endangered. (Draft Recovery Plan)

Recovery plan - a management plan developed under the authority of the Endangered Species Act which set 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. (Scientific Analysis Team)

Rectification - the process of making imagery conform to a map projection system, usually to assign real world coordinates to image data. (Scientific Analysis Team)

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. (Draft Recovery Plan)

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 recovery plan for marbled murrelets. (Scientific Analysis Team)

Reforestation - the natural or artificial restocking of an area with forest trees; most commonly used in reference to artificial restocking. (Draft Recovery Plan)

Refugia - havens of safety where populations have high probability of surviving periods of adversity. (ISC Report)

Regeneration - the actual seedlings and saplings existing in a stand; or the act of establishing young trees naturally or artificially. (Draft Recovery Plan)

Region - a Forest Service administrative unit. The two Regions affected by this proposed action are the Pacific Northwest Region (Region 6) which includes National Forests in Oregon and Washington, and the Pacific Southwest Region (Region 5) which includes National Forests in California. (FEIS)

Region 5 - the National Forests of California; the Forest Service's Pacific Southwest Region. (Late-Successional Forests Report)

Region 6 - the National Forests of Washington and Oregon; the Forest Service's Pacific Northwest Region. (Late-Successional Forests Report)

Regional Forester - the Forest Service official responsible for administering a single Region. (FEIS)

Regional Guide - the guide developed to meet the requirements of the Forest and Rangeland Renewable Resources Planning Act of 1974, as amended (NFMA). Regional Guides provide standards and guidelines for addressing major issues and management concerns which need to be considered at the regional level to facilitate Forest planning. (FEIS)

Regulations - generally refers to the Code of Federal Regulations. (Draft Recovery Plan)

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. (FEIS)

Reserved land - lands that have been removed from the acreage base used to calculate timber yields. These lands often have a preservation or protection status. Wildernesses, research natural areas, and national recreation areas are examples of reserved lands. (Draft Recovery Plan)

Residual stand - the trees that remain standing after some event such as selection cutting. (Draft Recovery Plan)

Riparian area - geographically delineated areas with distinctive resource values and characteristics that are comprised of aquatic ecosystems, and ecosystems influenced by adjacent bodies of water. (FEIS)

Riparian Habitat Conservation Area - portions of a watershed that contribute to the creation and maintenance of fish habitat. (Scientific Analysis Team)

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. (Late-Successional Forests Report)

Risk-analysis scale - a continuum of values (from low through high) describing the likelihood that habitat for associated wildlife species and fish will persist. (Late-Successional Forests Report)

Roost - the resting behavior of an animal. (Draft Recovery Plan)

Roost sites - a site where an animal roosts. Can refer to daytime and nighttime roosting. Sites often provide protection from environmental conditions and from predators. (Draft Recovery Plan)

Rotation - the planned number of years between the regeneration of an even-aged stand and its final cutting at a specified stage. (Draft Recovery Plan)

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 to promote forest health. (FEIS)

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 to 4 inches dbh, typically growing vigorously and without dead bark or more than an occasional dead branch. (Draft Recovery Plan)

Section 7 - the section of the Endangered Species Act that specifies the roles of interagency coordination in accomplishing the objective of species recovery. (Draft Recovery Plan)

Selection cutting - the annual or periodic removal of trees (particularly mature trees), individually or in small groups, from an uneven-aged forest, to realize yield and establish a new crop of irregular constitution. (FEIS)

Senescence - the process of aging. In demographic studies the usual concern is whether demographic rates change as organisms grow older. (Scientific Analysis Team)

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. (Late-Successional Forests Report)

Sensitive species - In Forest Service Policy, those plant and animal species identified by a Regional Forester for which population viability is a concern, as evidenced by: a significant current or predicted downward trend in population numbers or density; or a significant current or predicted downward trend in habitat capability that would reduce a species' existing distribution (FSM 2670.5(19)). (FEIS)

Seral - a biotic community that is a developmental, transitory stage in an ecological succession. (Draft Recovery Plan)

Seral species - species associated with an early stage in the development of a biotic community. (Draft Recovery Plan)

Shelterwood - an even-aged silvicultural system in which the old forest is removed in two or more successive cuttings. (Draft Recovery Plan)

Short term - here, 1 to 50 years. (Scientific Analysis Team)

Silvicultural practices (or treatments) - the set of field techniques and general methods used to modify and manage a forest stand over time to meet desired conditions and objectives. (Late-Successional Forests Report)

Silviculture - the science and practice of controlling the establishment, composition, and growth of forests. (Draft Recovery Plan)

Simulation - the use of a computer or mathematical model to examine how an estimate may vary given different sets of assumptions about population vital rates. (Scientific Analysis Team)

Site-potential tree - a tree that has attained the maximum height possible given site conditions where it occurs.

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. (Late-Successional Forests Report)

Slash - the residue left on the ground after timber cutting. It includes unused logs, uprooted stumps, broken or uprooted stems, branches, twigs, leaves, bark, and chips. (Draft Recovery Plan)

Snag - a standing dead tree. (Draft Recovery Plan)

SOHA (spotted owl habitat area) - a habitat area designated to support one pair of owls. Such areas were prescribed in some previous plans for northern spotted owl conservation. (Draft Recovery Plan)

Spatially explicit model - a model that predicts the future state of an animal population based on mapped locations of organisms and their habitat. (Scientific Analysis Team)

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. (Draft Recovery Plan)

Spectral Class - A statistical grouping of similar spectral reflectance values from a satellite sensor which can be associated with a specific land cover class (i.e., forest, agriculture, water). (Scientific Analysis Team)

Spectral signature - specific combination 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. (ISC Report)

Stage Classes - any distinguishable phase of growth or development of an organism. (FEIS)

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. (Late-Successional Forests Report)

Stand (tree stand) - an aggregation of trees occupying a specific area and sufficiently uniform in composition, age, arrangement, and condition as to be distinguishable from the forest in adjoining areas. (Draft Recovery Plan)

Stand condition - a description of the physical properties of a stand such as crown closure or diameters. (Draft Recovery Plan)

Stand-replacing event - a disturbance that is severe enough over a large enough area (for example, 10 acres) to virtually eliminate an existing stand of trees and initiate a new stand. (Draft Recovery Plan)

Standards and guidelines - principals specifying conditions or levels of environmental quality to be achieved. (FEIS)

Stochastic - random, uncertain; involving a random variable. (Draft Recovery Plan)

Stochastic model - a model that includes representation of random events. (Draft Recovery Plan)

Stocking - the degree of occupancy of an area of land by trees as measured by basal area or number of trees and as compared to stocking standard; that is, the basal area or number of trees required to fully use the growth potential of the land. (Draft Recovery Plan)

Structural diversity - the diversity of forest structure, both vertical and horizontal, which provides for a variety of forest habitats, such as logs and multilayered forest canopy, for plants and animals. (FEIS)

Structure - the various horizontal and vertical physical elements of the forest. (Late-Successional Forests Report)

Subadult - for spotted owls, a subadult is normally considered to be any individual that is 1-2 years old.

Subpopulation - a well-defined set of interacting individuals that comprise a proportion of a larger, interbreeding population. (ISC Report)

Subspecies - a population of species occupying a particular geographic area, or less commonly, a distinct habitat, capable of interbreeding with other populations of the same species. (Draft Recovery Plan)

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-for; shrub-seedling; pole-sapling; young; mature; old-growth. See also Seral. (Draft Recovery Plan)

Suitable habitat - the biological and physical components necessary to meet some or all the life needs of a species. (Draft Recovery Plan)

Suitable spotted owl habitat - See nesting, roosting, and foraging habitat. (Draft Recovery Plan)

Superspecies - two closely related species that are believed to have diverged relatively recently. (Scientific Analysis Team)

Superior habitat - habitat selected in excess of availability by the majority of individual northern spotted owls. (Draft Recovery Plan)

Suppression - the action of extinguishing or confining a fire. (Draft Recovery Plan)

Survival rate - the average proportion of individuals in a sample or a population that survive for a given time period. (Scientific Analysis Team)

T-test - a statistical test that compares the value of a test statistic, t-value, to the student's t distribution.

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. (Draft Recovery Plan)

Taking (Endangered Species Act, Section 7) - implementing an action that results in take. (Draft Recovery Plan)

Talus - broken rock forming a more or less continuous layer that may or may not be covered by duff and litter. (Scientific Analysis Team)

Taxon - a category in scientific classification system, such as class, family, or phylum. (Draft Recovery Plan)

Territorial single - an unpaired owl that is defending a territory. (Draft Recovery Plan)

Territory - the area that an animal defends, usually during breeding season, against intruders of its own species. (Draft Recovery Plan)

Texture of an ecosystem - relative surface smoothness of an ecosystem as determined by remote sensing technology, or the distinctiveness of the transition between two distinct ecosystems. (ISC Report)

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 as identified by the Secretary of Interior as threatened, in accordance with the 1973 Endangered Species Act. (Draft Recovery Plan)

Threshold phenomenon - pattern or trend in population growth rate that exhibits relatively long periods of slow change followed by precipitous increase or decrease in response to an environmental gradient. (ISC Report)

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 as is defined in the Endangered Species Act. (Draft Recovery Plan)

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. (Draft Recovery Plan)

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. (Draft Recovery Plan)

Transition period - a period of environmental change during which a population increases or decreases to a new stable equilibrium level. (Scientific Analysis Team)

Understory - the trees and other woody species growing under a more or less continuous cover of branches and foliage formed collectively by the upper portions of adjacent trees and other woody growth. (Draft Recovery Plan)

Uneven-aged management - the application of a combination of actions needed to simultaneously maintain 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. (Draft Recovery Plan)

Unsupervised Classification - a computer-automated technique of pattern recognition which attempts to find statistically similar groups of reflectance values in satellite image data. (Scientific Analysis Team)

USDA - U.S. Department of Agriculture. (Draft Recovery Plan)

USDI - U.S. Department of Interior. (Draft Recovery Plan)

Vagility - capacity of any organism to become widely dispersed. (ISC Report)

Viability - the ability of a 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. (Draft Recovery Plan)

Viable population - a population which has adequate numbers and dispersion of reproductive individuals to ensure the continued existence of the species population on the planning area (FSM 1905). (FEIS)

Vital rates - the rates of key demographic functions within a population, such as the birth rate and survival rate. (Draft Recovery Plan)

Watershed - the forested area contributing water and sediments to a stream or lake. (Scientific Analysis Team)

Watershed analysis - procedure used to identify ecologically important areas of a watershed that create and maintain fish habitat. (Scientific Analysis Team)

Watershed Restoration - improving current conditions of watersheds to restore degraded fish habitat and provide long term protection to aquatic and riparian resources (Scientific Analysis Team)

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. (Draft Recovery Plan)

West-side forests - the 11 National Forests with the range of the northern spotted owl in Washington, Oregon, and California that lie west of the Cascade Mountain Range crest. They are the Gifford Pinchot, Mendocino, Mt. Baker-Snoqualmie, Mt. Hood, Olympic, Rogue River, Siskiyou, Siuslaw, Six Rivers, Umpqua, and Willamette National Forests. (Draft Recovery Plan)

Wetlands - areas that are inundated by surface water or groundwater 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). (Draft Recovery Plan)
[Wetlands - areas inundated by surface water or groundwater frequently enough to support a prevalence of vegetative or aquatic life that requires saturated or seasonally saturated soils for growth and reproduction. (Late-Successional Forests Report)]

Wild and scenic rivers - those rivers or sections of rivers designated as such by congressional action under the 1968 Wild and Scenic Rivers Act, 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. Wild and scenic rivers may be classified and administered under one or more of the following categories:

1) Wild River Areas - those rivers or sections 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.

3. Recreational River Areas - those rivers or sections of rivers that are readily accessibly by road or railroad, that may have some development along their shorelines, and that may have undergone some impoundment or diversion in the past. (Draft Recovery Plan)

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. (Draft Recovery Plan)

Wildfire - any wildland fire that is not a prescribed fire. (Draft Recovery Plan)

Windfall - trees or parts of trees felled by high winds. See also blowdown and windthrow. (Draft Recovery Plan)

Windthrow - a tree or group of trees uprooted by the wind. (Draft Recovery Plan)

Young stands - forest stands not yet mature (generally, less than 50-80 years old; typically 20-40 years old). (Late-Successional Forests Report)

Z-test - a statistical test that compares the value of a test statistic. (z-value) to the standard normal distribution.

List of Common and Scientific Names

List of Common and Scientific Names

Common and scientific names of all vertebrate species listed in analyses and text, and of plant species as discussed by common name in the text. Scientific names of other species groups are presented in various appendices in Chapter 6. Species are listed here in alphabetical order by common name within each taxnomic class.

Nomenclature follows Hitchcock and Cronquist (1973) for plants, Williams et al. (1989) for fish, Nussbaum et al. (1983) for amphibians other than Olympic salamanders and for reptiles, Good et al. (1992) for Olympic salamanders, American Ornithologists' Union (1982) for birds, Jones et al. (1992) for mammals other than red tree voles, and Johnson and George (1991) for red tree vole.

Common name	Scientific name

Plants

Vascular plants

Douglas-fir	*Pseudotsuga menziesii*
Pacific yew	*Taxus brevifolia*
(Coast) Redwood	*Sequoia sempervirens*

Animals

Vertebrates

Fish species

(Also see Appendix 6-C for list of fish stocks)

Bull trout	*Salvelinus confluentus*
Chinook salmon	*Oncorhynchus tshawystcha*
Chum salmon	*Oncorhynchus keta*
Coho salmon	*Oncorhynchus kisutch*
Olympic mudminnow	*Novumbra hubbsi*
Oregon chub	*Oregonichthys crameria*
Pink salmon	*Oncorhynchus gorbuscha*
Redband trout	*Oncorhynchus mykiss gibbsi*
Redside shiner	*Richardsonius balteatus*
Sea-run cutthroat trout	*Oncorhynchus clarkii clarkii*
Sockeye salmon	*Oncorhynchus nerka*
Steelhead trout	*Oncorhynchus mykiss*

Amphibians

Arboreal salamander	*Aneides lugubris*
Black salamander	*Aneides flavipunctatus*
California slender salamander	*Batrachoseps attenuatus*
Cascade frog	*Rana cascadae*
Clouded salamander	*Aneides ferreus*
Cope's giant salamander	*Dicamptodon copei*
Del Norte salamander	*Plethodon elongatus*
Dunn's salamander	*Plethodon dunni*
Ensatina	*Ensatina eschscholtzi*
Foothill yellow-legged frog	*Rana boylei*
Larch Mt. salamander	*Plethodon larselli*
Mount Lyell salamander	*Hydromantes platycephalus*
Northern leopard frog	*Rana pipiens*
Northwestern salamander	*Ambystoma gracile*
Olympic salamanders:	
Olympic torrent salamander	*Rhyacotriton olympicus*
Columbia torrent salamander	*Rhyacotriton kezeri*
Cascade torrent salamander	*Rhyacotriton cascadae*
Southern torrent salamander	*Rhyacotriton variegatus*
Oregon Slender salamander	*Batrachoseps wrighti*
Pacific giant salamander	*Dicamptodon ensatus*
Pacific treefrog	*Hyla regilla*
Red-bellied newt	*Taricha rivularis*
Red-legged frog	*Rana aurora*
Roughskin newt	*Taricha granulosa*
Shasta salamander	*Hydromantes shastae*
Siskiyou Mt. salamander	*Plethodon stormi*
Tailed frog	*Ascaphus truei*
Van Dyke's salamander	*Plethodon vandykei*
Western red-backed salamander	*Plethodon vehiculum*
Western spotted frog	*Rana pretiosa*
Western Toad	*Bufo boreas*

Reptiles

Common garter snake	*Thamnophis sirtalis*
Gopher snake	*Pituophis melanoleucus*
Northern alligator lizard	*Elgaria coerulea*
Rubber boa	*Charina bottae*
Sharp-tailed snake	*Contia tenuis*
Western aquatic garter snake	*Thamnophis couchi*
Western fence lizard	*Sceloporus occidentalis*
Western pond turtle	*Clemmys marmorata*
Western rattlesnake	*Crotalus viridis*
Western terrestrial garter snake	*Thamnophis elegans*

Birds

Acorn woodpecker	*Melanerpes formicivorus*
Allen's hummingbird	*Selasphorus sasin*
American kestrel	*Falco sparverius*

American robin	*Turdus migratorius*
Bald eagle	*Haliaeetus leucocephalus*
Band-tailed pigeon	*Columba fasciata*
Barred owl	*Strix varia*
Barrow's goldeneye	*Bucephala islandica*
Belted kingfisher	*Ceryle alcyon*
Black swift	*Cypseloides niger*
Black-backed woodpecker	*Picoides arcticus*
Black-capped chickadee	*Parus atricapillus*
Black-headed grosbeak	*Pheucticus melanocephalus*
Black-throated gray warbler	*Dendroica nigrescens*
Blue grouse	*Dendragapus obscurus*
Brewer's blackbird	*Euphagus cyanocephalus*
Brown creeper	*Certhia americana*
Bufflehead	*Bucephala albeola*
California quail	*Callipepla californica*
Calliope hummingbird	*Stellula calliope*
Cassin's finch	*Carpodacus cassinii*
Cedar waxwing	*Bombycilla cedrorum*
Chestnut-backed chickadee	*Parus rufescens*
Chipping sparrow	*Spizella passerina*
Clark's nutcracker	*Nucifraga columbiana*
Common merganser	*Mergus merganser*
Common nighthawk	*Chordeiles minor*
Common raven	*Corvus corax*
Common redpoll	*Carduelis flammea*
Cooper's hawk	*Accipiter cooperii*
Dark-eyed junco	*Junco hyemalis*
Downy woodpecker	*Picoides pubescens*
Dusky flycatcher	*Empidonax oberholseri*
Evening grosbeak	*Coccothraustes vespertinus*
Flammulated owl	*Otus flammeolus*
Golden eagle	*Aquila chrysaetos*
Golden-crowned kinglet	*Regulus satrapa*
Gray jay	*Perisoreus canadensis*
Great blue heron	*Ardea herodias*
Great gray owl	*Strix nebulosa*
Great horned owl	*Bubo virginianus*
Hairy woodpecker	*Picoides villosus*
Hammond's flycatcher	*Empidonax hammondii*
Harlequin duck	*Histrionicus histrionicus*
Hermit thrush	*Catharus guttatus*
Hermit warbler	*Dendroica occidentalis*
Hooded merganser	*Lophodytes cucullatus*
House wren	*Troglodytes aedon*
Hutton's vireo	*Vireo huttoni*
Lewis woodpecker	*Melanerpes lewis*
Long-eared owl	*Asio otus*
MacGillivray's warbler	*Oporornis tolmiei*
Marbled murrelet	*Brachyramphus marmoratus*
Merlin	*Falco columbarius*
Merriam's turkey	*Meleagris merriami*
Mountain bluebird	*Sialia currucoides*
Mountain chickadee	*Parus gambeli*
Mountain quail	*Oreortyx pictus*
Mourning dove	*Zenaida macroura*
Nashville warbler	*Vermivora ruficapilla*
Northern flicker	*Colaptes auratus*
Northern goshawk	*Accipiter gentilis*
Northern pygmy-owl	*Glaucidium gnoma*
Northern saw-whet owl	*Aegolius acadicus*

Northern spotted owl	*Strix occidentalis caurina*
Nuttall's woodpecker	*Picoides nuttallii*
Olive-sided flycatcher	*Contopus borealis*
Orange-crowned warbler	*Vermivora celeta*
Osprey	*Pandion haliaetus*
Peregrine falcon	*Falco peregrinus*
Pileated woodpecker	*Dryocopus pileatus*
Pine grosbeak	*Pinicola enucleator*
Pine siskin	*Carduelis pinus*
Prairie falcon	*Falco mexicanus*
Purple finch	*Carpodacus purpureus*
Pygmy nuthatch	*Sitta pygmaea*
Red crossbill	*Loxia curvirostra*
Red-breasted nuthatch	*Sitta canadensis*
Red-breasted sapsucker	*Sphyrapicus ruber*
Red-tailed hawk	*Buteo jamaicensis*
Ruby-crowned kinglet	*Regulus calendula*
Ruffed grouse	*Bonasa umbellus*
Rufous hummingbird	*Selasphorus rufus*
Rufous-sided towhee	*Pipilo erythrophthalmus*
Sharp-shinned hawk	*Accipiter striatus*
Solitary vireo	*Vireo solitarius*
Song sparrow	*Melospiza melodia*
Spruce grouse	*Dendragapus canadensis*
Steller's jay	*Cyanocitta stelleri*
Swainson's thrush	*Catharus ustulatus*
Three-toed woodpecker	*Picoides tridactylus*
Townsend's solitaire	*Myadestes townsendi*
Townsend's warbler	*Dendroica townsendi*
Tree swallow	*Tachycineta bicolor*
Turkey vulture	*Cathartes aura*
Varied thrush	*Ixoreus naevius*
Vaux's swift	*Chaetura vauxi*
Violet-green swallow	*Tachycineta thalassina*
Warbling vireo	*Vireo gilvus*
Western bluebird	*Sialia mexicana*
Western flycatcher	*Empidonax difficilis*
Western screech owl	*Otus kennicottii*
Western tanager	*Piranga ludoviciana*
Western wood-peewee	*Contopus sordidulus*
Whip-poor-will	*Caprimulgus vociferus*
White-breasted nuthatch	*Sitta carolinensis*
White-headed woodpecker	*Picoides albolarvatus*
White-throated swift	*Aeronautes saxatalis*
White-winged crossbill	*Loxia leucoptera*
Wild turkey	*Meleagris gallopavo*
Williamson's sapsucker	*Sphyrapicus thyroideus*
Willow flycatcher	*Empidonax traillii*
Wilson's warbler	*Wilsonia pusilla*
Winter wren	*Troglodytes troglodytes*
Wood duck	*Aix sponsa*
Wrentit	*Chamaea fasciata*
Yellow warbler	*Dendroica petechia*
Yellow-rumped warbler	*Dendroica coronata*

Mammals

Allen's chipmunk	*Tamias senex*
American marten	*Martes americana*
Big brown bat	*Eptesicus fuscus*
Black bear	*Ursus americanus*
Brazilian free-tailed bat	*Tadarida brasiliensis*
Brush rabbit	*Sylvilagus bachmani*
Bushy-tailed woodrat	*Neotoma cinerea*
California chipmunk	*Tamias obscurus*
California myotis	*Myotis californicus*
Cascade golden-mantled ground squirrel	*Spermophilus saturatus*
Coast mole	*Scapanus orarius*
Columbian black-tailed deer	*Odocoileus hemionus columbianus*
Deer mouse	*Peromyscus maniculatus*
Douglas' squirrel	*Tamiasciurus douglasii*
Dusky shrew or Montane shrew	*Sorex monitcolus*
Dusky-footed woodrat	*Neotoma fuscipes*
Elk	*Cervus elaphus*
Ermine	*Mustela erminea*
Fisher	*Martes pennanti*
Forest deer mouse	*Peromyscus oreas*
Fringed myotis	*Myotis thysanodes*
Golden mantled ground squirrel	*Spermophilus lateralis*
Gray wolf	*Canis lupus*
Grizzly bear	*Ursus arctos*
Heather vole	*Phenacomys intermedius*
Hoary bat	*Lasiurus cinereus*
Keen's myotis	*Myotis keenii*
Little brown myotis	*Myotis lucifugus*
Long-eared myotis	*Myotis evotis*
Long-legged myotis	*Myotis volans*
Long-tailed weasel	*Mustela frenata*
Lynx	*Lynx canadensis*
Marsh shrew	*Sorex bendirii*
Masked shrew	*Sorex cinereus*
Mountain beaver	*Aplodontia rufa*
Mountain lion	*Felis concolor*
Mule deer	*Odocoileus hemionus*
Northern flying squirrel	*Glaucomys sabrinus*
Opposum	*Didelphis virginiana*
Pacific jumping mouse	*Zapus trinotatus*
Pacific shrew	*Sorex pacificus*
Pallid bat	*Antrozous pallidus*
Pinyon mouse	*Peromyscus truei*
Porcupine	*Erethizon dorsatum*
Raccoon	*Procyon lotor*
Red tree vole	*Arborimus longicaudus*
Red tree vole (California; Pomo tree vole)	*Arborimus pomo*
Ringtail	*Bassariscus astutus*
Shrew-mole	*Neurotrichus gibbsii*
Silver- haired bat	*Lasionycteris noctivagans*
Siskiyou chipmunk	*Tamias siskiyou*
Snowshoe hare	*Lepus americanus*
Southern red-backed vole	*Clethrionomys gapperi*
Townsend's chipmunk	*Tamias townsendii*
Trowbridge's shrew	*Sorex trowbridgii*
Vagrant shrew	*Sorex vagrans*
Western gray squirrel	*Sciurus griseus*
Western jumping mouse	*Zapus princeps*

Western red bat	*Lasiurus blossevillii*
Western red-backed vole	*Clethrionomys californicus*
Western small-footed myotis	*Myotis ciliolabrum*
Western (Townsend's) big-eared bat	*Plecotus townsendii*
White-footed vole	*Phenacomys albipes*
Wolverine	*Gulo gulo*
Yellow pine chipmunk	*Tamias amoenus*
Yellow-cheeked chipmunk	*Tamias ochrogenys*
Yuma myotis	*Myotis yumanensis*

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