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Forest Service Roadless Area Conservation

Final Environmental Impact Statement Volume 1

Acronyms and Abbreviations

ANILCA	Alaska National Interest Lands Conservation Act
ASQ	Allowable Sale Quantity
BBF	Billion board feet
BLM	Bureau of Land Management
BMP	Best Management Practices
CAET	Content Analysis Enterprise Team
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
DEIS	Draft Environmental Impact Statement
EPA	Environmental Protection Agency
ESA	Endangered Species Act
FEIS	Final Environmental Impact Statement
FEMAT	Forest Ecosystem Management Assessment Team
GIS	Geographic Information System
ICBEMP	Interior Columbia Basin Ecosystem Management Project
LUD	Land Use Designation (Tongass National Forest)
MMBF	Million board feet
NEPA	National Environmental Policy Act
NFMA	National Forest Management Act
NFS	National Forest System (includes national forests and grasslands)
NOI	Notice of Intent
NMFS	National Marine Fisheries Service
OHV	Off-highway Vehicle
RARE	Roadless Area Review and Evaluation
RARE II	Second Roadless Area Review and Evaluation
ROD	Record of Decision
ROS	Recreation Opportunity Spectrum
SAA	Southern Applachian Assessment
TEP	Threatened, Endangered, and Proposed
TEPS	Threatened, Endangered, Proposed, and Sensitive
TLMP	Tongass Land Management Plan
USC	United States Code
USDA	United States Department of Agriculture
USDI	United States Department of the Interior
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey

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Dear Citizen:

I am pleased to present the Roadless Area Conservation Final Environmental Impact Statement. These volumes describe a strategy for conserving National Forest System inventoried roadless areas and their important values. They contain an analysis of management options and the Forest Service's preferred alternative. I expect to render a final decision on this matter in no sooner than 30 days.

I want to thank all those who participated in this rulemaking. The wealth of insights and experience they provided contributed to improvements in development of the proposal and the analysis of social, economic, and environmental effects.

I remain confident that taking action now to conserve roadless areas through this national effort will result in these lands providing lasting values for future generations. I appreciate your participation in achieving this goal.

Sincerely,

MIKE DOMBECK
Chief

Forest Service Roadless Area Conservation
Final Environmental Impact Statement

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Abstract: The Forest Service is proposing new regulations to protect inventoried roadless areas within the National Forest System. This final environmental impact statement (FEIS) responds to strong public sentiment for protecting roadless areas and the clean water, biological diversity, dispersed recreational opportunities, wildlife habitat, forest health, and other public benefits provided by these areas. This action also responds to budgetary concerns and the need to balance management objectives with funding priorities. Public comments on the DEIS were considered in development of this FEIS in order to refine the scope of the decision to be made, verify significant issues, modify alternatives, identify possible mitigation measures, and direct the analysis of effects. The preferred alternative would prohibit road construction, reconstruction, and timber harvest except for stewardship purposes in all inventoried roadless areas. Implementation of the preferred alternative on the Tongass National Forest would begin in April 2004 to provide those communities in Southeast Alaska most impacted by the decision a transition period in which to adjust to possible economic changes that may result. Eight alternatives were fully developed and considered, including 4 sets of prohibited activities (including no action), and 4 alternative methods for applying the prohibitions to the Tongass. The procedural alternatives described in the DEIS are not included in this FEIS, since the decision was made to include procedures for roadless area conservation in the final rule for the Land and Resource Management Planning Regulations at 36 CFR 219.

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No Net Loss and Rotation of Roadless Areas

These alternatives would provide that the current amount of roadless acres be maintained. Existing roadless areas could be roaded provided new roadless areas are created through **decommissioning** or **obliteration** of temporary and classified roads. One approach would involve rotating the roaded and unroaded areas on different parts of each national forest in a one-for-one exchange to maintain the same amount of roadless areas. As an example, after timber harvest activities are completed and the area planted with trees, the roads in the area would be closed or decommissioned returning it to a roadless status. Roads would then be allowed for access to timber in other areas. In this manner, roadless areas would be restored, timber harvest from current roadless areas would continue at the current level, and overall road miles on NFS lands would neither increase or decrease.

These various alternatives were eliminated from detailed study, as they could have the same effects as the No Action Alternative. These options do not meet the purpose and need of the proposed action. The use of temporary roads may have the same long lasting and significant ecological effects as permanent roads, such as the introduction of non-native vegetation and degradation of stream channels. Vegetation recovery after timber harvest can take decades to restore **structure** and **composition**. These alternatives would postpone roaded entry to harvest unroaded areas until the vegetation in the in neighboring harvested areas was sufficiently recovered to mitigate anticipated effects caused by the new entry. Additionally, no-net-loss programs can lead to complicated systems of monitoring, excessive procedural requirements, and complex definitions and criteria.

Return Treaty-Ceded Lands

There was a request for alternatives to return treaty-ceded lands back to American Indian Tribes to be held in perpetuity as natural ecological and wildlife reserves. This is a legal matter that is outside the scope of this proposal.

Alternative Sets of Prohibitions Applicable To Inventoried Roadless Areas

A list of possible prohibitions could include off-highway vehicles (OHVs), rights-of-way, grazing, special uses, developed recreation, trails, mineral withdrawal, and other uses in addition to road construction, reconstruction, and timber harvesting. Another possibility is the closure or decommissioning of all roads in inventoried roadless areas.

The criteria used during RARE I and II allowed the presence of some roads in areas that were inventoried for Wilderness consideration (USDA Forest Service 1992). Subsequent roadless area inventories used the same criteria. Today, approximately 9,660 miles of roads currently exist on 5% of the land area in inventoried roadless areas. Some of these roads pre-date the inventories, while others have been constructed where land management plans have allowed development in inventoried roadless areas.

Alternative 1 – No Action

An estimated 1,160 miles of classified and temporary roads (including public roads not under Forest Service jurisdiction and private roads) are planned to be constructed or reconstructed in inventoried roadless areas over the years 2000 to 2004. Table 3-6 shows the miles of classified and temporary road construction and reconstruction in inventoried roadless areas, required to support the **timber offer** volume projected over the same years. The estimated percentage of the classified roads that would be closed after planned use is also displayed. Forty-two percent of the planned timber-related roads are single-purpose roads closed to traffic between uses or are short-term roads that would be decommissioned. In addition, all of the planned temporary roads would be decommissioned within 10 years after use. The Forest and Rangeland Renewable Resources Planning Act of 1974, generally requires temporary roads to be closed and revegetated after use. By closing or decommissioning roads after use, the long-term effects on the environment are reduced. On the other hand, while temporary road construction must comply with law, regulation, and policy, in general, temporary roads are not designed or constructed to the same standards as classified roads and are not intended to be part of the National Forest System Transportation System. The results can be a higher risk of environmental impacts over the short run. The effects of the road construction and reconstruction are described for the prohibition alternatives for each resource later in this chapter.

Table 3-6. Miles of planned timber-related road construction activities, 2000-2004.

Region	Classified road const	Classified road reconst	Temporary road const	Total all categories	Estimated closures of classified roads	Estimated closures of classified roads (%)
Northern (1)	12	33	7	52	26	58
Rocky Mountain (2)	16	25	18	59	31	76
Southwestern (3)	0	0	3	3	0	0
Intermountain (4)	73	15	28	116	49	56
Pacific Southwest (5)	4	3	4	11	4	57
Pacific Northwest (6)	16	1	2	19	17	100
Southern (8)	5	16	4	25	18	86
Eastern (9)	6	6	35	47	11	92
Alaska (10)	214	0	77	291	32	15
Total	**346**	**99**	**178**	**623**	**188**	**42**

Generally, the ecological benefits of protecting more inventoried roadless areas from development and roading include:

Physical Resources
- Conserving water, soil, and air resources
- Protecting aquatic ecosystems
- Ensuring that community drinking water sources are protected
- Protecting overall watershed health

Forest Health
- May reduce the occurrence of human-caused fires
- May reduce the spread of some damaging insects and diseases

Biological Diversity
- Increasing habitat protection
- Protecting areas from additional landscape fragmentation and further loss of connectivity
- Maintaining and/or enhancing native plant and animal communities and reducing opportunities for the spread of nonnative invasive species
- Increasing the protection of a diversity of habitats from low to high elevations
- Conserving habitat for threatened, endangered, proposed, and sensitive species (TEPS)
- Providing important habitat for populations of wide ranging animals that need large areas
- with low human activity levels

Physical Resources

Water, soil, and air resources have measurable characteristics that operate within naturally variable ranges of values. Water yield, timing, and quality, soil erosion, air quality, and other characteristics can vary widely, even in undisturbed situations. Land management practices, such as roading, timber harvest, **prescribed burning**, and other similar activities, can affect these values, and their variability. Sometimes the effects are within natural ranges; sometimes they are not. The most common effects of road construction and timber harvest activities on water, soil, and air resources are loss of ground cover vegetation, soil erosion and compaction, loss of soil productivity, increased potential for landslides, reduced transpiration (use of water by plants), increased water runoff, reduced water quality, and reduced air quality. In this analysis, the specific characteristics discussed are water quantity and timing, water quality, drinking water source areas, channel morphology, soil loss and sedimentation, site productivity, landslides, and air resources. Effects of fire on watersheds are discussed in the Forest Health and Fire Ecology section.

Roads have long been recognized as the primary human-caused source of soil and water disturbances in forested environments (Patric 1976; Egan and others 1996). Most impacts occur during initial road construction and then gradually decrease as roadside vegetation is reestablished and disturbed soil surfaces stabilize. Effects such as landslides persist when a road permanently undercuts unstable soils or landforms, or when roads are continually disturbed by road maintenance. Periodic maintenance activities can cause some of the impacts to briefly, but repeatedly, recur. Areas of particular concern are the road surface and associated drainage structures such as ditches and water crossings (bridges, culverts, and fords). Poorly maintained roads can result in greater impacts as surface water is diverted, culverts plug, and other road design characteristics are compromised. Lack of maintenance commonly has detrimental effects on water, soil, and air resources. Insufficient maintenance funding is a key reason for the lack of adequate road maintenance (USDA Forest Service 2000h).

Temporary road construction has most of the same effects as permanent road construction, but generally for a shorter term and for a more limited physical extent. Long-term effects can occur if temporary roads receive extended use, and they are not decommissioned. Generation of sediment within timber harvest units is most strongly related to roading and associated facilities (**skid roads and trails**, log landings, etc.) that are needed to remove logs, as opposed to tree cutting (Anderson and others 1976). Skid roads and trails, log landings, and similar disturbances within the sale area are the main cause of soil erosion and can contribute up to 90% of the sediment generated by timber sale activity (Patric 1976; Swift 1988).

Until recently, poorly managed timber harvest activities have been a major source of sediment from a timber sale area (Stone and others 1979; Martin and Hornbeck 1994). Generally, monitoring has shown compliance rates for implementing best management practices to be between 85% and 98%, with compliance rates increasing over time as awareness and training programs take effect (Stuart 1996, State of Oregon 1999, State of Montana 1998, Phillips and others 2000). Results vary between States and ownerships, with Federal lands and large forest industry entities showing highest compliance, but small non-industrial landowners with little access to professional forestry assistance falling behind. A recent report from Oregon found overall compliance rates of 98% to 99% across all ownership classes (State of Oregon 1999), while a study in Maine reported only 34% of best management practices with compliance rates grater than 80% (State of Montana 1998, University of Maine 1996).

Although, best management practices do not completely eliminate water quality impacts, they do reduce impacts to acceptable levels. “Best management practices may not be completely effective, but they do provide a level of protection that the states and the Environmental Protection Agency judged sufficient to meet the goals of the Clean Water Act” (Ice and others 1997). “Audit results showed that 96 percent of the individual practices audited were effective in protecting soil and water resources” (State of Montana 1998). “When used, the forestry BMPs work well” (University of Maine 1996). Concern remains in some aspects of BMP compliance, however. For example, reports from Montana and Oregon both cited below average compliance rates with road maintenance, road drainage, and temporary crossings (State of Montana 1998, University of Maine 1996, State of Oregon 1999). These aspects of best management practices compliance may require additional education and compliance reviews. Although some excellent work is under way on assessing the effectiveness of best management practices, additional work is need is this area (Seyedbagheri 1996).

Currently, all Forest Service permanent and temporary roads needed for timber sales are designed and constructed using water, soil, and air best management practices that meet or exceed those required by individual States under Environmental Protection Agency

Fire regimes have become altered in some vegetation types because of increasing fuel loads and flammability. These changes in vegetation have resulted in habitat losses for species using open old growth and early seral stages such as the flammulated owl and northern goshawk (Smith 2000). Conversely, multi-storied, late-successional forested habitats preferred by species such as the northern spotted owl, pileated woodpecker, and American marten, have been enhanced in some areas.

Response activities for fire suppression in inventoried roadless areas have likely been more limited in the past, due in part to a lower priority being placed on rapid suppression of fires in these areas, relative to fires in roaded and more developed areas. Many of these areas have also had lower levels of commodity timber harvest, which can remove larger and more fire resistant trees, leaving smaller diameter, less fire resistant stems. Stand conditions within these areas may lie within or closer to the historic range of variability, and they may have more normal levels of fuel loading and stand composition and structure. The precise condition of these areas relative to risk of uncharacteristic wildland fire effects has not been determined, but estimates made indicated that approximately 8 million acres, or 14%, of inventoried roadless areas in all fire regimes may be at high risk of uncharacteristic wildfire effects. This compares to an estimate of 38 million acres or 20% of all NFS lands estimated to be at high risk. Further discussion relative to regional levels of risk can be found in the Fuel Management section in this chapter.

Many inventoried roadless areas include plant associations (for example Rocky Mountain lodgepole pine, spruce/fir/whitebark pine and true fir/hemlock) where long fire intervals (70 to 400 years) and stand-replacement fires are consistent with the historic range of variability. In many cases, these are associated with upper elevation fire regimes that encompass a significant amount of inventoried roadless areas. For example, in the western United States 32% and 39% of inventoried roadless areas are > 9,000 feet and 8000-9000 feet in elevation respectively. As exemplified by the 1988 Yellowstone fires, both uniform stand-replacing fire events and mosaic mixed severity fire events are possible in these areas.

For many terrestrial ecosystems, fire has played an important role in creating and maintaining suitable habitat at varying temporal and spatial scales. Many species evolved under the influence of recurrent fire, including stand replacing events, and their long-term persistence relies heavily on the maintenance of important habitat components by these disturbance events. For example, wildland fires that create habitat mosaics can improve foraging habitat for lynx (USDA Forest Service and others 2000a), wild turkey, black bear, elk, and northern goshawk (Smith 2000).

Alternative 1 - No Action

Approximately 40% of the 58.5 million acres of inventoried roadless areas are covered by land management-plan prescriptions that currently prohibit road construction and reconstruction, while the other 60% does not. Projecting future roaded entry using historic levels of road construction, an additional 5% to 10% of inventoried roadless areas are likely to be entered within the next 20 years under Alternative 1. If this rate of entry continues, over the next century, this could equal 50% of inventoried roadless areas being affected by roaded entry. The actual amount, however, would probably be much lower due to rugged terrain in many of these areas, and public controversy over entry into inventoried roadless areas.

An estimated 1,160 miles of permanent and temporary road construction or reconstruction is planned through 2004. Table 3-32 displays total planned offer volumes and miles of road construction and reconstruction through 2004, by alternative, both with and without the Tongass exemption. Timber harvest under this alternative would occur on an estimated 18,000 acres of inventoried roadless areas per year initially, dropping to about 14,000 acres annually in the long term.

The type and extent of impacts to terrestrial species and habitats from this road construction would depend on road location and design, mitigation measures applied, the activities that are enabled, the amount and kinds of other activities occurring in adjacent areas, current condition of species populations, and the kinds and intensities of natural and human-induced disturbances in the area. With application of current design standards and best management practices, the effects of these kinds of activities have been mitigated or avoided in many situations. Some effects, however, cannot be mitigated, such as increased levels of habitat fragmentation.

Table 3-32. Total planned timber offer and miles of road construction and reconstruction for all activities through 2004, by alternative.

	Total planned offer (MMBF [a])		Total miles road construction/reconstruction	
Alternative	With Tongass National Forest exemption	Without Tongass National Forest exemption	With Tongass National Forest exemption	Without Tongass National Forest exemption
1	1,100	1,100	1,160	1,160
2	840	300	597	293
3	700	160	597	293
4	0	0	597	293

[a] Million board feet

Some of the potential direct and indirect adverse effects of road construction and timber harvest include:

- Increased fragmentation and loss of connectivity,
- Adverse edge effects for some species,
- Habitat loss, and losses of habitat suitability and effectiveness for some species,
- Increased risk of introduction and establishment of nonnative invasive species, and
- Increased potential for negative interactions with humans and illegal collection or over harvest of some species.

Some of the potential beneficial effects of road construction and timber harvest include:

- Enhanced access for some plant and wildlife management activities (for example, census survey and collection, and structure maintenance),

- Easier access for habitat restoration and enhancement for some species through stand manipulation,
- Creation of edge habitat and early successional habitat used by some species, and
- Easier access for hunting and wildlife viewing activities.

Almost all roads present some level of benefits and risks. These effects can vary greatly in degree (USDA Forest Service 2000h), and can shift over time. Some effects are immediately apparent, but others may require external events, such as a large storm, to become visible. Still other effects may be subtle, such as increased susceptibility to invasion by nonnative species or pathogens noticed only when they become widespread in the landscape, or with increased road use as recreation styles and motor vehicles change (USDA Forest Service 2000h). A road-related beneficial effect for one species, may, in fact, represent an adverse effect for another. For example, although forest edges, such as those created by road construction and timber harvest, may benefit some species, such as deer and bobwhite quail, they also provide access to interior forest patches for opportunistic or predator species (Norse and others 1986).

Beneficial effects to terrestrial species from timber harvest activities are often due to creating or maintaining some specific habitat condition. Timber harvest creates forest age-class diversity and mosaic habitats used by some species (Wisdom and others 2000; USDA and others 2000; Southern Appalachian Man and the Biosphere 1996c; USDA Forest Service 1995a; USDI Fish and Wildlife Service 1990; USDI Fish and Wildlife Service 1976). Some species require early seral or open-forest habitats that can be created and maintained by properly planned, restorative timber harvest. Timber harvest activities may also reduce the risk of uncharacteristic large stand-replacing insect and disease outbreaks and severe wildland fires. These disturbance events, can present both benefits and risks to some species (Wisdom and others 2000; USDI Fish and Wildlife Service 1995a; USDA and others 1993), at least at a local level. Some examples of timber harvest potential beneficial effects include the following:

- Timber harvest can be used to benefit species like the red-cockaded woodpecker (USDA Forest Service 1995a), Florida scrub jay (USDI Fish and Wildlife Service 1990), and Kirtland’s warbler (USDI Fish and Wildlife Service 1976) by creating and maintaining open forest or early seral conditions.
- The Mexican spotted owl may benefit from timber harvest activities that maintain and develop large old-growth pine habitats, and alleviate risk from wildland fire, insects, and disease (USDI Fish and Wildlife Service 1995a).
- The snowshoe hare, a primary lynx prey species, can benefit from properly planned regeneration harvests (USDA Forest Service and others 2000).
- Reynolds and others (1991) suggest that active management activities like tree thinning may be beneficial in producing and maintaining the desired conditions for sustaining goshawks and their prey species.

Fragmentation and Connectivity – Landscape fragmentation and loss of connectivity from road and timber harvest causes habitat loss, increases in edge effects, and increases in habitat isolation (British Columbia Ministry of Forest Research Program 1997). As described under the previous section on fragmentation, roads can increase forest fragmentation by breaking up large patches and converting interior forest into edge habitat (Reed and others 1996).

Forest fragmentation affects terrestrial species to different extents and at different scales. In studying fragmentation in Douglas fir forests in northwestern California, Rosenberg and Raphael (1986) found that species showing the most sensitivity to fragmentation included fisher, gray fox, spotted owl, and pileated woodpecker. As road construction, reconstruction, and timber harvest activities increase habitat fragmentation across large areas, populations of some species may become isolated into smaller groups, which increase the risk of local extirpations or extinctions (Noss and Cooperrider 1994). In examining the effects of road construction on wetland biodiversity, Findlay and Bourdages (2000) found increases in local extinction rates and decreases in re-colonization rates, with effects sometimes taking decades to be apparent.

Roads can fragment habitat for some invertebrates, particularly for less mobile, ground dwelling species. In the Klamath-Siskiyou province, researchers have identified habitat fragmentation for common land snails caused by roads and other land-disturbing activities (Frest personal communication). Reasons cited included microclimate changes on the road surface, loss of habitat complexity and structure, effective width of roads greater than actual width, and avoidance of exhaust residues, petroleum products, and other chemicals. Baur and Baur (1990) documented similar road avoidance findings for the land snail *Arianta arbustorum*, which avoids crossing even small, unpaved roads. Timber harvest, particularly where associated with extensive ground disturbance and canopy removal, may have adverse effects on some invertebrate populations (Frest 1993; Frest and Johannes 1995).

Edge Effects – Roads create environmental edges whose effects may extend well beyond the actual road. Loss of canopy along road corridors may result in greater temperature extremes, more exposure to winds, more direct sunlight within adjacent zones, and changes in relative humidity (Chen and others 1996; Chen and others 1993). The distance that this effect may extend is highly variable. The zone of disturbance related to road noise is estimated to be as great as one-half mile in forested areas (Forman and Deblinger 2000). Haskell (2000) found a large drop in abundance and diversity of macro invertebrate soil fauna close to NFS roads, with effects extending up to 100 meters into the forest.

Forest edges, such as those created by timber harvest and road construction, may benefit some species, such as deer and bobwhite quail. The close proximity of cover and forage areas at forest edges provides ideal habitat for many game species (see Game Species). However, edges also provide access to interior forest patches for opportunistic species, such as the brown-headed cowbird, with effects extending into forest interiors as far as 600 meters from an edge (Norse and others 1986). Cowbirds are implicated in the decline of certain songbirds in the Sierra Nevada, including the willow flycatcher, least Bell's vireo, yellow warbler, chipping sparrow, and song sparrow (Sierra Nevada Ecosystem Project 1996).

Habitat Suitability and Effectiveness – For some mammals, open road density has been shown to be indicative of habitat suitability, with increases in road density related to declines in habitat effectiveness and population viability (Noss and Cooperrider 1994). Some research has shown that the presence of a few large areas with low road density, even when found within an area with an overall high road density, is a key indicator of suitable habitat for large vertebrates (Rudis 1995). Unroaded areas may provide important security habitat for some species year round. Black bear population size was shown to be negatively associated with road density in the Adirondack Mountains (USDA Forest Service 2000h). Road density is a major determining factor for suitability of habitat for grizzly bear, a species with a home range size of 50 to 300 square miles for females and 200 to 500 square miles for males (USDI Fish and Wildlife Service 1993).

With an expected increase in roaded access into these areas, a corresponding increase in human disturbance is expected. Potential for harassment, disruption, and poaching of some species would increase. Species, such as forest carnivores, that require sites free from human disturbance are likely to be adversely affected. Habitat effectiveness for deer and elk has been shown to decrease with increases in open road density in some areas (Thomas and others 1979). Rowland and others, (in press) found that female elk in the Starkey Experimental Forest consistently used areas away from open roads in spring and summer, and that spatial distribution and distance to roads were more accurate predictors of habitat effectiveness than overall road density.

In their proposal to list the Canada lynx under the ESA, the U.S. Fish and Wildlife Service (USDI Fish and Wildlife Service 1998b) found that this species is threatened by human alteration of forests and by increased levels of human access into lynx habitats. Factors identified as threats to this species included timber management, forest and **backcountry** roads and trails, fragmentation and degradation of lynx **refugia**, and habitat degradation by nonnative invasive plant species. The lynx was listed as threatened on March 24, 2000.

In evaluating species-road relationships for 91 vertebrate species in the Interior Columbia River Basin, Wisdom and others (2000) found that more than 70% of those species could be negatively affected by one or more factors associated with roads. They concluded, from their review of scientific literature, that there are numerous potential adverse effects related to road construction and use. Some of their findings include:

- Road construction converts large areas of habitat to nonhabitat (Hann and others 1997; Reed and others 1996).
- Loss of large trees, snags, and logs in areas adjacent to roads through commercial harvest or firewood cutting has adverse effects on cavity dependent birds and mammals (Hann and others 1997).
- Roads facilitate poaching (Cole and others 1997) of many large mammals such as caribou, pronghorn, mountain goat, bighorn sheep, wolf, and grizzly bear (Dood and others 1985; Knight and others 1988; McLellan and Shackleton 1988; Mech 1970; Stelfox 1971; Yoakum 1978).
- Roads provide access for chronic, negative interactions of humans with wolves and grizzly bears (Mace and others 1996; Mattson and others 1992; Thiel 1985), which increases mortality of both species and often causes high-quality habitats near roads to serve as population sinks (Mattson and others 1996; Mech 1973).
- Reptiles seek roads for thermal cooling and heating and experience substantial mortality from motorized vehicles (Vestjens 1973). Roads facilitate human access into habitats for collection and killing of reptiles.

- Many species are sensitive to harassment or human presence during particular seasons, with potential reductions in productivity, increases in energy expenditures, or displacements in population distribution or habitat use (Bennett 1991; Mader 1984).
- Roads often restrict the movements of small mammals (Mader 1984; Merriam and others 1988; Swihart and Slade 1984) and function as barriers to population dispersal (Oxley and Fenton 1974).

Trombulak and Frissell (2000) drew similar conclusions in their review of scientific literature on the ecological effects of roads. They identified seven general, potential effects of roads: mortality related to construction, mortality from being hit by vehicles, behavioral modifications, changes in the physical environment, changes in the chemical environment, introduction and establishment of nonnative species, and increased human use of roaded areas. They concluded that, although not all species and ecosystems are affected to the same degree by roads, in general, the presence of roads in an area is associated with negative effects for both terrestrial and aquatic ecosystems. These effects included detrimental changes in species distribution, composition, and population size.

Although only used for relatively short periods, temporary roads present most of the same risks posed by permanent roads, although some may be of shorter duration. Many of these roads are designed to lower standards than permanent roads, are typically not maintained to the same standards, and are associated with additional ground disturbance during their removal. Also, use of temporary roads in an area to support timber harvest or other activities often involves construction of multiple roads over time, providing a more continuous disturbance to the area than a single, well-designed, maintained, and use-regulated road. While temporary roads may be used for periods ranging up to ten years, and are then decommissioned, their short- and long-term effects can be extensive to terrestrial species and habitats.

In addition to posing many of the same risks as road construction, road reconstruction could result in substantial changes in the kinds and amount of human uses in an area. Improvements such as realignment or improving road surfacing or gradient to provide easy access for low clearance vehicles may promote increases in the amount of human disturbances and disruptions to species and habitats, exceeding those previously experienced before reconstruction.

Early Successional Habitat – Although early successional habitat is well represented in many parts of the country, questions have been raised in some areas relative to the potential effects of the road and timber harvest prohibitions on the availability of this type of habitat, particularly in the Eastern and Southern Forest Service regions. Early successional communities are characterized and shaped by differences in structure, composition, and successional pathways. Such communities can include grasslands, shrublands, semi-forested habitat, and open land communities within larger forest patches.

Types of disturbance affecting the development, availability, and distribution of some early successional habitat include natural processes and events such as fire, wind, insect and disease, and management-induced disturbance associated with land use practices, significant ecological shifts in vegetation composition and structure, resulting in altered fire regimes by increasing fuel loads and flammability. As discussed under the Terrestrial Habitats and Species section, response activities for fire suppression in inventoried roadless areas have likely been more limited in the past due to a lower priority placed on rapid suppression of fires in these areas, relative to fires in roaded and more developed areas. When this is considered in conjunction with the lower level of past timber harvest activities in many of these areas, it is likely that stand conditions within these areas may lie within or closer to the historic range of variability, with more normal levels of fuel loading and stand composition and structure, as compared to conditions within roaded and more heavily timbered areas.

Alternative 1 - No Action

Alternative 1 would have the greatest potential for additional aquatic habitat loss, degradation, and disturbance associated with roads, timber harvest, and other activities. Approximately 40% of the 58.5 million acres of inventoried roadless areas are covered by land-management plan prescriptions that currently prohibit road construction and reconstruction. Projecting future roaded entry using historic levels of road construction, an additional 5% to 10% of inventoried roadless areas are likely to be entered within the next 20 years under Alternative 1, predominantly in those areas currently open to road construction. The planned timber harvest offer of 1.1 BBF through 2004 would occur on approximately 90,000 acres. Table 3-32 displays planned offer volumes and miles of road construction or reconstruction through 2004, both with and without the Tongass exemption, for each alternative.

Potential Effects from Roads – Road construction, maintenance, use, and even the presence of roads in a watershed, can have numerous adverse effects to aquatic systems and the species they support. Recent changes in road designs and application of best management practices have been effective in some instances at moderating or avoiding many adverse effects. The discussion in this section captures the principal effects that have been associated with roads, but these are potential effects, and not every road would necessarily exhibit each or even many of these effects. The Physical Resources section provides a full discussion of potential geomorphic and hydrologic effects of roads on watershed and stream channel conditions.

These effects can potentially include (Furniss and others 1991; USDA Forest Service 2000h):

- Increasing sediment loads in streams;
- Modifying watershed hydrology and stream flows;
- Altering stream channel morphology;
- Increasing habitat fragmentation and loss of connectivity;
- Degrading water quality, including increasing chance of chemical pollution;
- Altering water temperature regimes.

These physical alterations can potentially result in a variety of adverse effects to aquatic species including:

- Loss of spawning and rearing habitat, and deep pools, from excess sediment deposition;
- Increased mortality of eggs and young from lower levels of oxygen in stream gravels;
- Increased susceptibility to disease and predation;
- Increased reproductive failure;
- Shifts in macro invertebrate communities to those tolerating increased sediment or other types of diminished water quality;
- Increased susceptibility to over harvest and poaching;
- Loss of protective cover and resting habitat through changes in channel structure including large woody debris, overhanging banks, and deep pools;
- Competition from nonnative species;
- Loss of habitat caused by habitat degradation, barriers to passage, increased gradient, high temperatures, and other factors; and
- Increased vulnerability of subpopulations to catastrophic events and loss of genetic fitness, related to loss of habitat connectivity.

Trombulak and Frissell (2000) concluded that, although all species and ecosystems are not affected to the same degree by roads, in general, the presence of roads in an area is associated with negative effects for both terrestrial and aquatic ecosystems including changes in species composition and population size.

Temporary roads present most of the same risks posed by permanent roads, although some may be of shorter duration. Many of these roads are designed to lower standards than permanent roads, are typically not maintained to the same standards, and are associated with additional ground disturbance during their removal. Also, use of temporary roads in a watershed to support timber harvest or other activities often involves construction of multiple roads over time, providing a more continuous disturbance to the watershed than a single, well-designed, maintained, and use-regulated road. While temporary roads may be used temporarily, for periods ranging up to 10 years before decommissioning, their short- and long-term effects on aquatic species and habitats can be extensive.

Potential Effects of Timber Harvest - The effects of activities associated with timber harvesting (e.g., tree felling, yarding, landings, site preparation by burning or scarification, fuels reduction, brush removal and whip felling, and forest regeneration) are often difficult to separate from the effects of roads and road construction. The road systems developed to harvest timber are often a significant factor affecting aquatic habitats, as discussed above. Some of the potential effects to aquatic habitat from timber harvest can include the following (Chamberlin and others 1991, Hicks and others 1991, Beschta and others 1987):

- Increasing sediment supply and storage in channels,
- Modifying watershed hydrology and streamflow, including the timing or magnitude of runoff events,
- Decreasing stream bank stability, and altering stream channel morphology,
- Degrading water quality,
- Altering energy relationships involving water temperature, snowmelt and freezing,
- Diminishing habitat complexity, and
- Altering riparian composition and function