United States
Department of
Agriculture

Forest Service

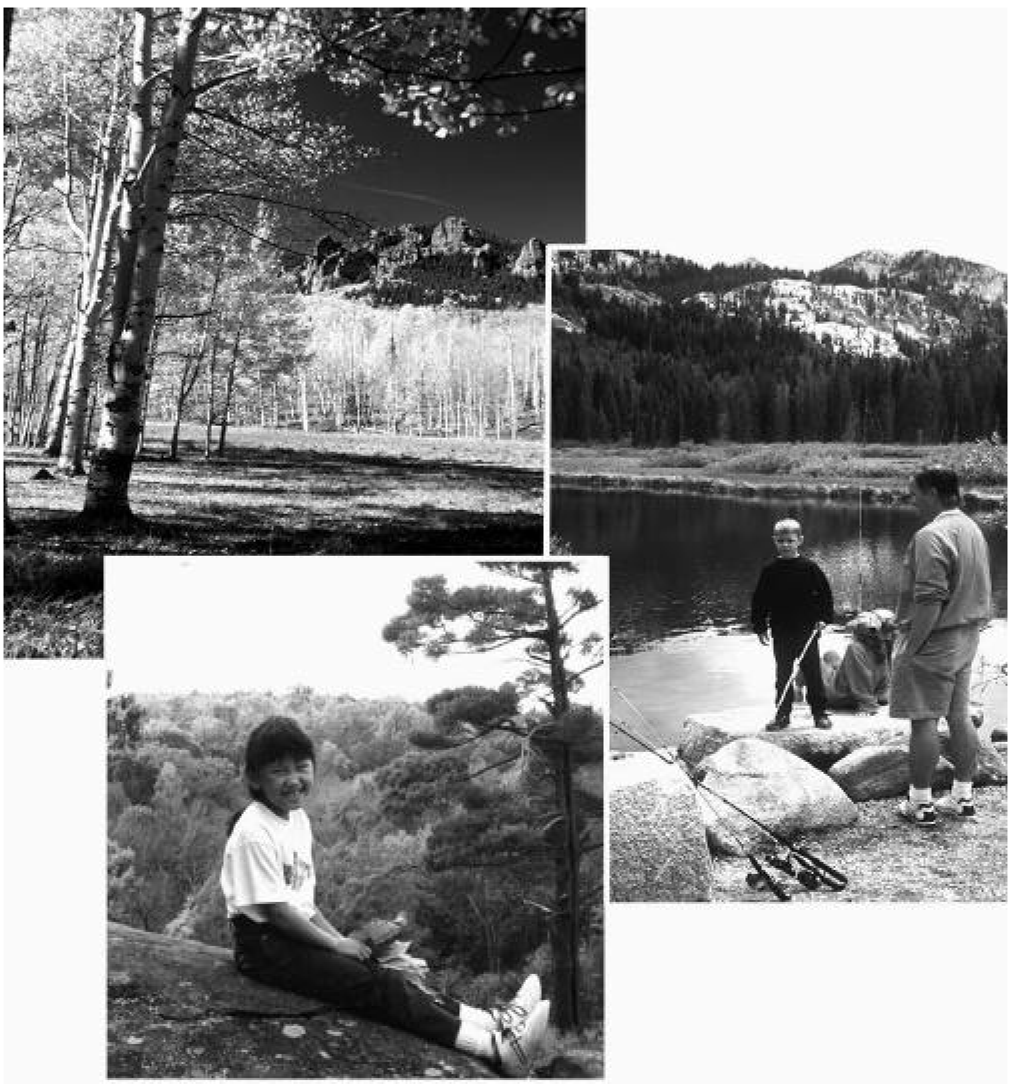
Washington
Office

November 2000

Forest Service
Roadless Area Conservation

Final Environmental Impact Statement

Specialist Report for
Terrestrial and Aquatic Habitats and Species



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Abstract

This specialist report provides the background and analysis for the affected environment and environmental consequences of the alternatives analyzed in detail for the Forest Service Roadless Area Conservation Final Environmental Impact Statement (FEIS), November 2000. It describes the assumptions, the information and data, and the methodology used in the analysis of effects to terrestrial and aquatic habitats and species and overall biodiversity which is summarized and disclosed in Chapter 3 of the FEIS.

Biodiversity is the variety and abundance of species, their genetic composition, their communities, and the ecosystems and landscapes of which they are a part (Wilson 1988; Adams and others 2000). The United States has a rich heritage of native biodiversity, due in large part to its great topographic and climatic diversity. Nearly 16,000 species of the world's vascular plants are found within the United States, as well as about 10% of freshwater fish species and 9% of mammal species (Adams and others 2000). Current rates and distributional patterns of species endangerment and extinction indicate that the biodiversity of the United States has been adversely impacted from human activities and is at risk of additional substantial loss in many parts of the country.

Potential effects to species and to overall biodiversity from this project were determined by considering the kinds and numbers of species potentially affected, identifying the important and sometimes unique characteristics of roadless areas that foster biodiversity, and evaluating the potential adverse and beneficial effects of road construction and timber harvest on those characteristics. These effects were analyzed for terrestrial animal species and habitats, aquatic animal species and habitats, terrestrial and aquatic plants, and threatened, endangered, proposed and sensitive (TEPS) species. Potential cumulative effects of the alternatives were addressed by considering land use and land conversion trends; laws, regulations, and policies that affect biodiversity; and invasion and establishment of nonnative species.

This analysis demonstrated that conservation of inventoried roadless areas through application of the prohibition alternatives would provide important protection of native biodiversity and overall ecosystem health. Many of these areas function as biological strongholds for terrestrial and aquatic species, including numerous threatened, endangered, proposed and sensitive (TEPS) species.

Changes between Draft and Final

- The procedural alternatives were removed since the final Planning Regulations incorporated similar analytical requirements relative to inventoried roadless areas and other unroaded areas.

- An exception to the prohibitions has been added to Alternative 4 that would allow timber harvest when necessary to protect or recover threatened, endangered, or proposed species.

- The stewardship provision under Alternative 3 has been more explicitly described.

- The effects of several potential social and economic mitigations measures have been analyzed, including potential exceptions to the prohibition of road construction for leasable minerals activities, road safety improvements, and Federal Aid highway projects.

- The discussion of the effects of wildfire on terrestrial and aquatic species and their habitats has been expanded.

- A discussion of the effects of temporary road construction, use, and decommissioning on aquatic and terrestrial species has been added.

- Additional discussion of the effects of the alternatives on game species has been added.

- The discussion on nonnative invasive plant species has been expanded.

- Additional discussion of the beneficial effects of timber harvest and road construction for some species has been included.

- The cumulative effects discussion has been expanded.

- Data updates between the DEIS and FEIS have been incoporated into the narrative and supporting lists, tables and other graphics.

Assumptions

Two of the key assumptions used in this analysis were that:

- Roaded entry and timber harvest trends would continue in these areas at rates approximating that occurring in the past 20 years.

- With approximately one-third of the native flora and fauna in the U.S. considered to be of conservation concern (Master and others 2000), and without significant increases in the success of conservation efforts, rates of species endangerment and extinction will continue to increase, and native biological diversity (biodiversity) will continue to diminish.

Consultation and Coordination

An integral part of the purpose and need identified for this project is the conservation of TEP plant and animal species and associated communities. Both the National Marine

Fisheries Service (NMFS) and the U. S. Fish and Wildlife Service (FWS), the agencies with oversight responsibilities for implementation of the Endangered Species Act (ESA), were extensively involved in the development and evaluation of alternatives. Although these agencies advised the Forest Service that a biological assessment is not required for ESA consultation on this kind of action, all pertinent and necessary supporting documentation, including a biological evaluation, was submitted to them as part of consultation prior to publication of a final rule. The biological evaluation submitted to NMFS and FWS on July 31, 2000 was updated with an amended BE, dated November 13, which incorporated all of the changes in alternatives between the DEIS and the FEIS. All action alternatives and potential mitigation measures from the FEIS were addressed in the BE and consultation.

In addition to meeting the consultation requirements of ESA Section 7(a)(2), the Forest Service also requested programmatic review of the project under ESA Section 7(a)(1), which enables Federal agencies to "utilize their authorities in furtherance of the purposes of this Act by carrying out programs for the conservation of endangered species and threatened species. . ." The level of discretionary review provided by these agencies will be commensurate with the programmatic nature and national scale of the project.

The NMFS also has oversight responsibilities for implementation of the Magnuson-Stevens Fishery Conservation Act. The Forest Service provided NMFS with written documentation that, as none of the alternatives would result in any kind of ground disturbing activity, and are therefore not likely to adversely affect designated Essential Fish Habitat, a need for further consultation under this Act was not anticipated.

Information and Methodology Overview

The analysis for this proposal was somewhat unique due to the nature of the proposal. Rather than authorizing any ground disturbing activities or uses, all of the prohibition action alternatives would prohibit certain activities. This means that the effects of these alternatives would depend on the kinds and amounts of activities precluded, and on how those activities or their absence would potentially influence species population status, habitat conditions, and overall biological diversity.

The No Action alternative provided the environmental baseline for the analysis, with the types and amounts of expected activities establishing likely future trends in habitat condition and overall levels of disturbance to inventoried roadless areas. Any road construction or timber harvest activities proposed for roadless areas under the No Action alternative would require site-specific NEPA analysis which has not yet been completed (in most cases), and which would likely include some site-specific design criteria to lessen adverse effects. The actual effects of the No Action Alternative, therefore, could vary from a "worst-case scenario" to one where many of the adverse effects were successfully mitigated, depending on project design and mitigation measures applied.

Given the national scale of this proposal, uncertainties related to specific future project locations and designs under the environmental baseline, and the non-ground disturbing nature of the action alternatives, a detailed site-specific or species-specific analysis was neither necessary or appropriate. The analysis, therefore, relied heavily on a comprehensive review of current scientific literature on the most common effects of roads, road construction, and timber harvest on species, their habitats, and overall native biological diversity, with potential effects described in terms of relative risks. By understanding how each of the alternatives and the potential social and economic mitigation measures would affect the agency's management of roadless areas, it was possible to draw conclusions about potential effects to key habitat attributes, to the kinds of species associated with those attributes, and to overall biological diversity. A list of the references used is included at the end of this report.

The principal sources of data used for this part of the analysis included the TEP and sensitive species databases developed for this project (see description below), large-scale assessments such as those conducted for the Interior Columbia Basin, the Northwest Forest Plan, the Sierra Nevada, and the Southern Appalachian, the Renewable Resources Planning Act Assessment, and U. S. Fish and Wildlife Service and National Marine Fisheries Service databases available on their internet websites and through some of their publications.

Data used in TEP and Sensitive species analyses were collected from each regional office and national forest. Descriptions of what data were collected and how they were compiled, validated, and analyzed follow:

Species List(s) Compilation (Database Items 2a and 3a)

In December 1999, data were requested from each national forest on threatened, endangered, and proposed (TEP) species and from each regional office on their Regional Forester designated sensitive species. The TEP information was requested at the National Forest level, and sensitive species information was requested at the regional level. These information requests are summarized below:

- **Threatened, Endangered or Proposed Species – Species listed as endangered, threatened or proposed under the Endangered Species Act (Database Item 2A).** Forests were asked to provide a complete list of endangered, threatened and proposed species by forest (i.e., the entire list for each forest) and to identify which of those species are likely to have habitat within inventoried roadless areas. For those species not likely to have habitat within inventoried roadless areas, they were asked to identify any that could be impacted by road construction or reconstruction in inventoried roadless areas, such as a fish species occupying habitat downstream of an inventoried roadless area. This information was used to establish a species list for ESA Section 7(a)(2) consultation, and to complete the analysis of effects and biological evaluation for the project. This request did not ask for determinations of effect, but only whether a species or its habitat could potentially be affected. Species were not linked with specific inventoried roadless areas.

- **Regional Forester-Designated Sensitive Species (Database Item 3A)**. Regions were asked to provide a complete list of sensitive species (i.e., the entire list for each region), and to identify which of those species are likely to have habitat within inventoried roadless areas. For those species not likely to have habitat within inventoried roadless areas, they were asked to identify any that could be impacted by road construction or reconstruction in inventoried roadless (for example, a sensitive fish species occurring downstream). This information was used to determine which species should be addressed in the project biological evaluation and to complete the analysis of effects for the project. This request did not ask for determinations of effect, but only whether a species or its habitat could potentially be affected. Species were not linked to specific inventoried roadless areas.

After extensive validation efforts (described below), four core spreadsheets were generated from the data submitted:

- **National Master Lists (NML)** - One NML was completed for TEP species and another for sensitive species. These lists represent the complete compilation of all entries submitted by the regions and/or forests. Many species are entered more than once in the NML because they occur on multiple forests or regions. For TEP species there are columns identifying species group (e.g. mammals, birds, plants, etc.), Region, and National Forest for each entry. The sensitive species lists contain the species group and Regional columns. These lists are included as appendices to the biological evaluation.

- **Unique Species Occurrence Lists (USO)** - One USO list was completed for TEP species and another for sensitive species. These lists were generated from the NMLs, and are consolidated lists of each species that occurs at least once on the NML. There are no species duplications on the USO lists. For sensitive species, a column identifies which sensitive species are also federally listed candidate species. These lists are included as appendices to the biological evaluation.

These four core spreadsheets were used to complete regional and species groups sorts and baseline queries. The queries included determining the number of NML species entries in each species group potentially impacted by inventoried roadless areas; the number of NML species entries impacted by region; and the total number of USO species impacted by inventoried roadless areas.

Five species list validation efforts were completed between February 2000 and July 2000. Beginning in early January 2000, the initial species lists were checked for data entry errors and spelling errors. The federal listing status provided by the regions was checked against: (1) federal listings published in the Federal Register (*www.eswr.com*), and (2) the U.S. Fish and Wildlife Service and National Marine Fisheries Service TEP species list (*endangered.fws.gov*). U.S. Fish and Wildlife Service representative John Fay assisted with the federal listing status review. Alice Berg from the National Marine Fisheries Service reviewed the accuracy of salmon listings provided by the regions. She also reviewed the Evolutionary Significant Unit designations.

In late January, Forest Service Regional Office and National Forest personnel were contacted via e-mail and telephone to share the results of the early January validation effort. The errors identified from the preliminary submissions included misspellings, changes in TEP federal listing status (e.g., proposed to endangered or threatened), or species given an incorrect federal listing status. Some forests and regions had incorrectly interpreted the instructions. Instead of submitting a "complete list of all proposed, threatened and endangered and sensitive species", some forests/regions only submitted species that were affected by inventoried roadless areas. Other forests submitted a complete regional TEP list even though some species or their habitat did not occur on that forest. As a result, a number of changes were made to the initial species lists. All corrections were made and revised Item 2a and Item 3a species lists were prepared in February 2000.

The edited species lists were placed on the *Roadless.fs.fed.us* web page in early March 2000. Shortly afterwards, several regional offices noticed errors in the web page species lists. The web page was immediately closed until corrections could be made. A second validation effort began in late March.

To check for other possible errors, the Regional Roadless Contacts were called and asked to again review Items 2a and 3a. The Regions were asked to check the web page information against their existing Regional Forest Sensitive Species lists (including any recent updates or revisions). As a result of that review, some minor spelling and duplication errors were found in the February 15 species lists. Changes were made to capture additional TEP federal listings (such as from proposed status to endangered or threatened) occurring since February. Corrections were made because a few forests had submitted only those species that were affected by inventoried areas. Region 9 revised their Regional Foresters Sensitive Species List adding approximately 400 new sensitive species to Item 3a. All the corrections were made and revised Item 2a and Item 3a species lists were prepared on April 5, 2000.

In April, the Regional TES Program leaders, Regional Roadless contacts and the National TES Program Leader were sent copies of the revised Item 2a and Item 3a lists. This was followed up with a brief presentation during a regional coordinators conference call. The importance of the species lists and the primary ways the lists would be used were discussed. The Regions were asked to give the lists another review. Few corrections were needed to the species lists from this review. The majority of corrections made to Item 3a were due to the previous omission of some Region 8 sensitive species. An additional 44 sensitive species were added.

The Roadless web page was updated with the following proposed, threatened, endangered, and sensitive species information: (1) National Master lists, (2) Unique Species Occurrence Lists, (3) A list of species with at least one "yes" response to one of the four inventoried roadless areas questions, and (4) summary counts of TEPS species potentially impacted by inventoried roadless areas nationally, regionally, and for TEP species, each National Forest and National Grassland.

As part of the analysis for the biological evaluation, the regions were asked in May to review the species lists and to identify any species that could potentially be adversely affected by the prohibition of road construction and reconstruction or timber harvest in inventoried roadless areas. Their findings were discussed in a series of conference calls during the weeks of June 5 and June 12. The principal concern for those few species identified as potentially adversely affected was based on the total prohibition of timber harvest under Alternative 4. As a result of those concerns, Alternative 4 was subsequently modified to provide an exception when needed for protection or recovery of TEP species. There was some additional validation of the species lists at that time.

The biological evaluation completed for the project utilized a coarse filter approach, in combination with some supplemental species-specific information gathered from each region, to make a final determination of effects to TEP and sensitive species. This biological evaluation supplements the specialist report and can be accessed at the project website.

Supporting information for this analysis is contained in the landscape ecology, physical resources, fire and fuels management, and forest health specialist reports. The physical resources specialist report contains a thorough discussion of the effects of road construction and timber harvest on watershed condition, providing much of the basis for the analysis of effects to biological diversity, particularly for aquatic ecosystem components.

This report is separated into the following sections: alternatives analyzed, terrestrial animal habitat and species, aquatic animal habitat and species, terrestrial and aquatic plants, and threatened, endangered, proposed and sensitive species. Each of these sections describes the affected environment and results. Separate sections are also included which describe the effects of potential social and economic mitigation measures, and the potential cumulative effects.

Alternatives Analyzed

A full description of the alternatives analyzed is included in Chapter 2 of the FEIS. These alternatives describe the activities that would not be allowed on approximately 58.5 million acres of inventoried roadless areas (fewer acres, if the Tongass National Forest is not included in the final rule), identified in the FEIS Volume 2 maps. The detailed analysis of the alternatives specific to the Tongass National Forest is described in the Tongass Biological Resources Specialist Report.

Depending on which alternative is selected, the prohibitions would apply to the entire area within the boundaries of inventoried roadless areas, including portions that contain existing roads. Some otherwise prohibited projects or activities may be allowed within those boundaries, if they qualify under one of the exceptions. The alternatives for the DEIS excluded the roaded portions of inventoried roadless areas.

Alternative 1

No Action; No Prohibitions

Alternative 2

*Prohibit Road Construction and
Reconstruction Within Inventoried Roadless Areas*

Alternative 3

*Prohibit Road Construction, Reconstruction,
and Timber Harvest Except for Stewardship
Purposes Within Inventoried Roadless Areas*

Stewardship purpose timber harvest could only be used where it maintains or improves roadless characteristics and:

- Improves threatened, endangered, proposed or sensitive species habitat;
- Reduces the risk of uncharacteristically intense fire; or
- Restores ecological structure, function, processes, or composition.

Limited tree cutting could occur incidental to other management activities, such as trail construction or maintenance, hazard tree removal adjacent to classified roads for public health and safety reasons, fire line construction for wildland fire suppression or control of prescribed fire, or survey and maintenance of property boundaries.

Alternative 4

*Prohibit Road Construction, Reconstruction and
All Timber Cutting Within Inventoried Roadless Areas*

Limited tree cutting could occur incidental to other management activities, such as trail construction or maintenance, hazard tree removal adjacent to classified roads for public health and safety reasons, fire line construction for wildland fire suppression or control of prescribed fire, or survey and maintenance of property boundaries. Mechanical fuel treatments, such as crushing, piling, or limbing, would be permitted, but under this alternative, area-wide tree cutting for fuel reduction purposes would be prohibited.

The responsible official may authorize an exception to the prohibition on timber harvest if it is determined that such harvest is necessary: 1) to prevent degradation or loss of habitat, to the extent that such loss or degradation would increase the risk of extinction for a threatened or endangered species, or for a species that has been proposed for listing as threatened or endangered under the Endangered Species Act; or 2) to promote recovery of a threatened or endangered species. In all cases, agreement that the proposed action is warranted must be obtained from the National Marine Fisheries Service or United States Fish and Wildlife Service, as applicable.

Social and Economic Mitigation Measures

Several new exceptions were developed as the result of public comment on the DEIS. While similar to the exceptions proposed in the DEIS (see p. 2-4 in the FEIS), their purpose is to mitigate some potential social and economic impacts the various alternatives may cause. The final rule may or may not include some or all of these mitigation measures. These exceptions, outlined below, are more fully described in Chapter 2 of the FEIS.

- Reconstruction is needed to implement road safety improvement projects on roads determined to be hazardous on the basis of accident experience or accident potential;
- The Secretary of Agriculture determines that a Federal Aid Highway project authorized pursuant to Title 23 of the United States Code is in the public interest or is consistent with the purposes for which the land was reserved or acquired, and no other feasible alternative exists; or
- A road is needed for prospective mineral leasing activities in inventoried roadless areas.

Results

Terrestrial Animal Habitat and Species

Affected Environment

Inventoried roadless areas encompass a range of habitat types including grass and shrublands, young forested stands, and old-growth forests. The character, distribution, and extent of habitats are affected by the size of an area, the kinds, intensity and timing of management-induced and natural disturbances that have occurred, and the landscape context in which they are found. Inventoried roadless areas provide large, relatively undisturbed blocks of important habitat for terrestrial animal species and communities. In addition to supplying or influencing habitat for more than 300 TEPS terrestrial animal species, these areas support numerous other game and non-game vertebrate and invertebrate species.

Many of these inventoried roadless areas function as biological strongholds and places of refuge for many species, covering the spectrum from wide-ranging carnivores to narrowly distributed endemic snails (that is, restricted to a specific location). Some of these areas may play an increasing role in supporting species viability and overall native biodiversity than in the past, due to the cumulative degradation and loss of other habitat in adjacent landscapes.

In general, the composition of, and relationships between native plant and animal communities in inventoried roadless areas may be less disrupted than in roaded areas of similar size. Species richness and native biodiversity are more likely to be effectively conserved in inventoried roadless areas, particularly in areas large enough to offer a shifting mosaic of habitat patches in various stages of recovery from disturbance (Noss and Cooperrider 1994). For example, in comparing the distribution of inventoried roadless areas with centers of biodiversity identified in the Interior Columbia Basin Ecosystem Management Project (ICBEMP) (Quigley and Arbelbide 1997a), these areas cover approximately 21% (1,650,000 acres) of the identified acreage in centers of biodiversity for animals. In addition, almost 10% (2,780,000 acres) of the acreage identified in the ICBEMP as centers of endemism for animals is contained in inventoried roadless areas.

Habitat in these areas is likely to be less fragmented from human activities and more likely to be better connected than in roaded areas of similar size. This is important to a number of species, as the following examples illustrate:

- Fisher, marten, and lynx populations have been negatively affected by habitat fragmentation and loss of connectivity due to timber harvest (Ruggiero and others 1994) and roads in forested areas (USDI Fish and Wildlife Service 1998b).

- Hargis and others (1999) documented an adverse response by American martens even to low levels of habitat fragmentation in the Uinta Mountains and determined that martens also respond negatively to increased size and proximity of open areas such as clearcuts.

- Analyses done in the northern Rocky Mountains illustrate the value of inventoried roadless areas in supporting connectivity between large core areas of quality habitat for grizzly bear, mountain lion, and elk, and in providing important contributions of core habitat (American Wildlands, 2000). Figure 3-29 illustrates the contribution made by inventoried roadless areas in providing important grizzly bear habitat.

- Smaller habitat patch size and loss of interior forest habitat has adverse effects on numerous species dependent on such habitat including some neotropical migratory bird species such as the cerulean warbler, hooded warbler, and wood thrush (Southern Appalachian Man and the Biosphere 1996a).

Inventoried roadless areas may provide important habitat to species that are sensitive to human disturbance. Such disturbance can disrupt species migration, reproduction, and rearing of young, and can increase physiological stress. The importance of this type of habitat has been identified in a number of studies:

- Isolated forest habitat has been shown to be essential for wolverine presence (Ruggiero and others 1994).

- In some areas, large mammals, such as elk, bighorn sheep, grizzly bear and wolf, exhibit strong road avoidance (Trombulak and Frissell 2000).

- The recovery plan for the grizzly bear acknowledges that increases in bear-human conflicts or adverse changes in the quality and security of habitat can affect population viability (USDI Fish and Wildlife Service 1993).

- Remoteness from human activity is a key characteristic of black bear habitat (Southern Appalachian Man and the Biosphere 1996c).

- In selection of nest sites, some bird species, including bald eagles, golden eagles, and sandhill cranes, may avoid areas close to roads (Anthony and Isaacs 1989; Fernandez 1993; Norling and others 1992).

It has become increasingly apparent that in certain parts of the country some types of past timber harvest, combined with the effectiveness of wildland fire suppression over the past century, have caused significant ecological shifts in vegetation composition and structure. 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 Chapter 3 of the FEIS.

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 2000), wild turkey, black bear, elk, and northern goshawk (Smith 2000). Attachment 1 provides supplemental information on the effects of fire on terrestrial and aquatic species and their habitats.

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 1 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 1. 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,
- 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, such as timber harvest, road construction, and prescribed fire (USDA Forest Service 1999e; Southern Appalachian Man and the Biosphere 1996c). When human-induced disturbances reset the successional clock to an earlier stage, they frequently affect larger areas and result in increased mean patch size, with adverse effects on habitat suitability for many species (Verner 1986). Natural disturbances, such as wildland fires, can also affect large areas of land and modify habitat suitability. In many cases, wildland fires blend into larger landscapes, and the adverse impacts are less severe or negligible.

In the United States, the abundance and distribution of many early-successional species before European settlement is unknown. It is estimated that by 1820 in New England, less than 25% of the original forest was left on land that was suitable for agriculture. By the middle of the 19^{th} Century, New England was experiencing wood shortages. This sizeable increase in early successional habitat was likely followed by corresponding increases of populations and distributions of species using such habitat. As forested habitats have become reestablished in this century in some areas, there has been a corresponding decline in some species directly or indirectly dependent on early successional habitat. For example, as forest cover increased in New Hampshire by 40% between 1880 and 1980, New England cottontail populations decreased from a continuous distribution throughout 60% of the State, to a fragmented distribution covering less than 20%; bobcat populations were affected by this decrease in available prey (Trani-Griep 1999; Martin 1999).

Information in the Southern Appalachian Assessment (Southern Appalachian Man and the Biosphere 1996c) indicates that as of 1995, NFS timberlands within the approximately 37 million acre assessment area provided about 11% of the habitat in the grass/seedling/shrub successional stage. Non-industrial private lands at that time provided approximately 69% of this stage. Examples of species within the Southern Appalachian Assessment area using early successional habitat include bobwhite quail, ruffed grouse, Bachman's sparrow, and prairie warbler. The Southern Appalachian Assessment identified no T&E species that were principally associated with early successional habitat in the assessment area. A comparison of the habitat information from the Southern Appalachian Assessment with the distribution of inventoried roadless areas shows that less than .09% (approximately 1,380 acres out of 1,570,000 acres) of early successional grass shrub habitat are currently provided by inventoried roadless areas in the assessment area.

Game species **–** These species are wild animals that people hunt or fish for food or recreation according to prescribed seasons and limits (USDA Forest Service 1999u; USDA Forest Service and USDI Bureau of Land Mangement 2000). They are generally described in terms of either big game (including white-tailed deer, mule deer, elk, bear, wild boar, and turkey) or small game (including ruffed grouse, blue grouse, hare, cottontail rabbits, gray squirrel and quail).

Game species are generally associated with mixed habitat mosaics or patterns that include a variety of habitat types and age classes. In forested areas, early seral patches, natural openings, and open woodlands are important habitat components. Many game species are habitat generalists (for example deer, elk and ruffed grouse,) using a variety of habitats and therefore, cannot be easily associated with a single habitat type (Southern Appalachian Man and the Biosphere 1996c).

In many areas of the United States, NFS lands, including inventoried roadless areas, are a significant source of high quality game species habitat, given the influences of private land conversions, including urbanization, agriculture, and development. In some cases, NFS lands are strongholds for some game species. For example, black bear populations are increasing in some areas of the Eastern United States in part because of security within NFS lands (Vaughan and Pelton 1995). Lands outside of inventoried roadless areas have important influences on game species populations. As an example, deer and elk winter ranges on many non-NFS lands are critical in maintaining stable populations.

The public interest in providing and maintaining game species habitat on NFS lands is evidenced by the various program initiatives that focus on these species. The Forest Service has partnered with a number of organizations (for example Wild Turkey Federation, Rocky Mountain Elk Foundation, Quail Unlimited) to implement wildlife program initiatives such as: "Answer the Call," "Elk Country", "Dancers in the Forest", "A Million Bucks", and "Making Tracks." These initiatives have resulted in substantial amounts of game species-habitat improvement, including the creation and maintenance of early seral habitats in some areas.

A number of factors can influence game populations. For example, State harvest strategies and regulations are an important management tool for achieving desired population levels, especially in big game management (Flather and others 1999). In addition, other factors like predation and disease can influence some game species populations. In recent years, game species population trends have varied, with some species exhibiting declines, while others have increased or remained stable (Flather and others 1999). It is reasonable to assume that many of these game species-population trends are substantially influenced by changes in their habitat.

Flather and others (1999) in *Wildlife Resource Trends in the United States* concluded that a nation-wide (but most evident in the 20 northern States) decrease in species that are associated with early seral stages (and grasslands) could be expected in the next 20 years. However, this conclusion is not necessarily indicative of what would happen to game species populations. In fact, Flather and others (1999) predict that many game species populations are expected to remain relatively stable to the year 2045 (the 50 year outer benchmark for their long-term population projections), including black bear, wild turkey, pronghorn, and deer. Elk are expected to decrease slightly after recent population increases and range expansion (Flather and others 1999). Many small game species like ruffed grouse and bobwhite quail appear to be declining in some parts of the country (USDA Forest Service 1999u; Southern Appalachian Man and the Biosphere 1996c).

These declines in part may be due to reductions in the amount of early seral and shrub dominated sites.

Roads can serve a number of purposes relative to game management. They can provide access for timber harvest activities that can improve or enhance game species habitats. Some roads provide access for other kinds of game species-habitat improvements, including, construction and maintenance of water developments (for example guzzlers, ponds and spring boxes). In addition, roads are often used to facilitate the maintenance of natural and created openings.

Timber harvest activities can fundamentally change the composition and configuration of game species habitats. These changes can alter and modify animal behavior, causing changes in population numbers and distribution. Whether the impacts are adverse or beneficial depends on species needs, and the extent, duration, timing and intensity of timber harvest activities and associated roads.

Timber harvest activities that create, restore, and maintain a mixture of habitats and a variety of age classes are generally beneficial to most game species. Thus, timber harvest activities can be designed to meet specific game species habitat needs, and have positive impacts (Brown 1985; Hoover and Wills 1984; Thomas 1979). For example, timber harvest designs that create and maintain edge, early seral patches, natural openings, and open woodland habitats, are beneficial for most game species (Southern Appalachian Man and the Biosphere 1996c; USDA 1999u; Flather and others 1999; USDA Forest Service and USDI Bureau of Land Management 2000). In some managed forest areas, deer and elk populations have benefited from improved forage conditions created by some timber harvest activities (USDA Forest Service and USDI Bureau of Land Management 2000). Turkey (Dickson 1992), forest grouse, and quail have benefited from openings and saplings created by some timber management activities. Generally, timber harvest activities in combination with access management strategies that reduce road densities are more effective at providing high quality game species habitats.

Conversely, when timber activities are poorly placed on the landscape, and road densities are not managed, game populations can decline due to poaching, concentrated legal hunting (USDA Forest Service 1999p), reduced habitat quality or habitat loss (Brown 1985; Hoover and Wills 1984; Thomas 1979). There is evidence that inventoried roadless areas are important security areas and linkages for some game species.

Late Successional Habitat – Inventoried roadless areas encompass a variety of cover types and age classes, including late successional habitats. Late successional or old-growth forest has been defined as forest stands that are greater than 100 years old (Southern Appalachian Man and the Biosphere 1996c; USDA 1999u). They are also defined as the later stages of stand development with large trees, large-size dead trees standing and on the ground, multiple canopy layers, canopy gaps and decadence in the form of broken or deformed tree tops, boles and root decays (USDA Forest Service and USDI Bureau of Land Management 2000). The Forest Ecosystem Management Assessment Team (USDA and others 1993) defined late successional habitats as "forests older than 80 years." Some late successional habitats have developed with frequent disturbances (such as fires) resulting in large tree single story structure.

Various efforts at defining and delineating late successional habitats have occurred for NFS lands. For example, the Forest Ecosystem Management Assessment Team (USDA and others 1993) estimated that approximately 4.5 million acres of medium/large multistoried conifer late successional habitat occurred within the 57 million acre range of the northern spotted owl. The Southern Appalachian Assessment (Southern Appalachian Man and the Biosphere 1996c) estimated that approximately 1.1 million acres of late successional habitat occurred in the assessment area in 1995. Some late successional habitats are considered critically endangered, such as Eastern deciduous and Western ponderosa pine forests (Noss and others 1994).

Much of the late successional habitat remaining on NFS lands is highly fragmented and poorly connected because of past management activities and natural disturbances. Late successional habitats associated with inventoried roadless areas are often better connected than those found in roaded areas, and are often linked to larger intact forests in Wilderness and other protected areas. This connectivity provides benefits for a number of late successional associated species such as the northern spotted owl, marbled murrelet, fisher, white-headed woodpecker, and American marten.

Timber harvest to improve late successional habitat could be implemented under Alternatives 2 and 3. Alternative 4 prohibits timber harvest activities, but provides an exception for timber harvest activities needed for the protection or recovery of T&E species. In addition, prescribed fire continues to be an acceptable management tool for maintaining some single-storied late successional habitats.

Summary of Effects – Relative to Alternatives 2, 3, and 4, the No Action Alternative would result in a greater likelihood of measurable losses of habitat quality and quantity in inventoried roadless areas. Assuming that roaded entry and timber harvest would continue in these areas at rates approximating that occurring in the past 20 years and given the risks associated with timber harvest and other road-dependent activities, the No Action Alternative would have the greatest potential for adverse effects to some species and to overall biodiversity,

Mitigation measures offsetting some adverse effects would undoubtedly be identified as part of site-specific NEPA decisions and ESA consultations. However, some adverse effect, such as increased habitat fragmentation and loss of connectivity, cannot be effectively mitigated.

Alternative 2

With a prohibition on road construction and reconstruction in inventoried roadless areas, the potential for increased levels of human-caused disturbance and degradation of terrestrial habitat quality, quantity and distribution would be substantially reduced relative to Alternative 1, particularly in those inventoried roadless areas currently open to road construction. A description of the potential adverse effects of road construction is provided under Alternative 1. This alternative does not prohibit any type of timber harvest, but the overall level of timber harvest would be reduced by a prohibition on road construction and reconstruction.

Alternative 2 would offer a greater degree of assurance than Alternative 1 that current biodiversity would be maintained. Based on estimates provided by each national forest, there would be approximately a 75% reduction in the total miles of road that would be constructed or reconstructed in inventoried roadless areas through 2004 under Alternatives 2, 3, and 4. Under the exceptions common to all action alternatives (as described in Chapter 2 of the FEIS), approximately 300 miles of road would be constructed or reconstructed. See Table 1 for a comparison of planned timber offer volume and miles of road construction and reconstruction by alternative both with and without the Tongass National Forest exemption.

Even though there could continue to be stewardship and commodity-purpose timber-harvest activities in inventoried roadless areas, information collected from the forests indicates that much of the timber harvest currently planned in these areas would require road construction and reconstruction and hence, would not occur under this alternative, as shown in Table 1. The remaining timber harvest in inventoried roadless areas would potentially occur on an estimated 8,000 acres per year, dropping to half that level in the long term. Approximately 2.8 million acres of inventoried roadless areas have had classified roads constructed since the time of inventory, under land management plan prescriptions that allowed road construction. In addition, in some areas, one or more roads were present at the time of inventory. Prohibiting further road construction in these areas would provide some level of benefits to the overall area, by avoiding the additional risks inherent with new road construction or reconstruction, such as additional landscape fragmentation and loss of connectivity, increased levels of human activities, and nonnative species introductions.

Wildlife management activities that are not dependent on new or reconstructed road access would be feasible under this alternative. Information submitted by each national forest on terrestrial wildlife projects that would potentially be precluded if road construction and reconstruction were prohibited in inventoried roadless areas indicates that, within the next 5 years, seven projects are planned nationwide that, as currently designed, could not be implemented. Almost 15 miles of road construction or reconstruction would be associated with these projects. Types of projects identified include thinning and fuels management in late successional reserves, aspen regeneration, other stewardship timber harvest for habitat improvement, and prescribed fire. It is likely that at least some of these projects could be redesigned so that they could proceed without road construction or reconstruction in inventoried roadless areas.

Nationally, the average number of wildlife projects precluded per year by this alternative is less than 2, which is estimated to be substantially less than 1% of the overall national program, based on the 1999 Wildlife, Fish and Rare Plants reporting system database (USDA Forest Service 2000d). It appears that few roads are built into inventoried roadless areas to support wildlife management activities. As a result, this alternative would not limit the current overall ability of the Agency to manage wildlife habitat in inventoried roadless areas, including the ability to maintain or enhance early or late successional habitat or create and maintain mixed habitat mosaics where such need is demonstrated or to implement other stewardship-timber harvest activities.

The prohibition on road construction and reconstruction under Alternative 2 would have a negligible effect on management of game species and their habitats. While this alternative would prohibit new roads, it would not affect existing transportation systems. Existing access for wildlife management activities would not be affected. The current capabilities and tools to design and implement habitat-improvement methods and techniques would be retained under Alternative 2, although alternative means of access may be needed for implementation. In addition, other timber harvest projects planned and implemented in inventoried roadless areas, but not necessarily driven by game species objectives (for example threatened, endangered, and proposed (TEP) species objectives, forest health or fuels management objectives) may also benefit some game species.

Summary of Effects **–** The prohibition on road construction and reconstruction would avoid many of the potential adverse affects of roads to terrestrial animal species and habitats, as described under Alternative 1. This includes habitat loss and fragmentation, negative edge effects, increased fire risk, access for poaching, increased potential for excessive hunting pressure, harassment and disturbance, movement barriers, displacement or avoidance behavior, increased potential for establishment of nonnative invasive species, and greater risk of chronic negative interactions with people (Wisdom and others 2000; USDA Forest Service 2000h). No adverse effects to terrestrial animal species and habitats would be expected, as this alternative does not directly authorize any ground disturbing activities, nor does it preclude any activities essential for management of these species or their habitats by this Agency or other government agencies with jurisdictional responsibilities. Overall, beneficial effects to conservation of biological diversity would be expected.

Alternative 3

By prohibiting road construction and reconstruction and non-stewardship timber harvest, Alternative 3 would provide a greater likelihood that terrestrial habitats, species, and their associated plant and animal communities, would be maintained at current levels, relative to Alternative 1. A description of the potential adverse effects of road construction and timber harvest is provided under Alternative 1. Table 1 displays planned offer volumes and miles of road construction or reconstruction, both with and without the Tongass exemption, for each alternative. An estimated 4,400 acres per year would be harvested under this alternative, dropping to about 1,300 acres per year in the long term.

Relative to Alternative 2, the additional prohibition of non-stewardship timber harvest would further reduce the potential for adverse effects to species and habitats. Over time, this additional prohibition could provide important cumulative beneficial effects relative to conservation of terrestrial species and habitats, beyond those described under Alternative 2.

By retaining the ability to harvest timber for stewardship purposes, the Agency's capability to enhance habitat directly and indirectly would be maintained, making this alternative potentially somewhat more ecologically beneficial compared to Alternative 4. Most projects where the primary objective would be restoring wildlife habitat would be included in this category. This could potentially have beneficial effects for some species on a site-specific basis. An example of stewardship timber harvest beneficial to a species would be mid-story vegetation removal for enhancement of foraging habitat for red-cockaded woodpecker (USDA Forest Service 1995a).

Summary of Effects – This alternative would not affect the current overall ability of the Agency to manage wildlife habitat on NFS lands including the ability to maintain or enhance early or late successional habitat, create, or maintain mixed habitat patches, where such need is demonstrated. No adverse environmental effects to terrestrial species would be expected from this alternative, as it would not directly authorize any ground-disturbing activities, nor would it preclude activities essential for management of these species, and their habitats, by this or other government agencies with jurisdictional responsibility. The overall ability of the Agency to implement management actions for conservation of terrestrial animal communities would not be affected.

Alternative 4

This alternative would prohibit road construction, reconstruction, and all timber harvest except for that needed for protection or recovery of TEP species. Alternative 4 would provide a greater likelihood that terrestrial habitats, species and their associated communities, would be maintained at current levels, relative to Alternative 1. A description of the potential adverse effects of road construction and timber harvest that could be avoided is provided under Alternative 1. Table 1 displays planned offer volumes and miles of road construction or reconstruction, both with and without the Tongass exemption, for each alternative.

Overall, the current need for timber harvest specifically to manage terrestrial wildlife habitat within inventoried roadless area appears to be minimal. In fiscal year 1997, approximately 15% of the total volume harvested for stewardship purposes on all NFS lands was for wildlife or TEP species habitat management objectives (USDA Forest Service 1998b). The current national capability of the Agency to manage such habitat would not be measurably affected by a prohibition on timber harvest. Alternative 4 does not preclude use of other restorative tools like prescribed fire, which under some conditions can be used without prior timber removal, to benefit early seral and open forest species.

Timber Harvest to Reduce Fuels – Timber harvest to reduce fuel loading may be desirable in some areas where there is an abnormally high risk of high intensity, large-scale fires. Uncertainties about the magnitude and extent of beneficial effects of such activities have to be carefully weighed against the well-documented risks of adverse effects associated with timber harvest and associated road construction. Even though some timber harvest activities are intended to mimic the effects of natural disturbance processes such as fire, there is little known about the long term ecological legacies of such treatments. It is not clear how those legacies would compare to areas where natural disturbance processes have played a more dominant role in controlling successional pathways, landscape mosaics, and ecosystem composition. Analysis conducted by the fire specialist on the FEIS team showed minimal landscape level differences between Alternatives 2 through 4 and Alternative 1, relative to the likelihood of timber harvest providing significant reductions in the risk of uncharacteristic wildfire effects in inventoried roadless areas.

Regardless of the alternative selected, wildland fires will continue to play a dominant role in shaping terrestrial species habitats in many areas, including many fires that are of a much higher intensity and greater size than those historically occurring within an area. Many terrestrial and aquatic 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. While wildland fires may negatively affect individuals of some species, the overall effects on species populations are less likely to be adverse in nature.

Game Species – The prohibition of timber harvest would probably have limited local impacts on the ability of the Agency to actively manage for the mixed pattern habitats used by game species, although other tools, such as prescribed fire, would continue to be feasible in many areas. Natural disturbances are likely to continue creating and maintaining mixed pattern habitats in inventoried roadless areas for a number of game species. Additional background information relative to the effects of timber harvest on game species is included in Attachment 2.

The prohibitions on timber harvest are not likely to detrimentally impact mule deer, white-tailed deer, and elk populations. Elk populations have been increasing across the west and are expected to continue to increase for the next four decades. In the east, white-tailed deer density information for the Southern Appalachian Assessment (Southern Appalachian Man and the Biosphere 1996c) indicates that the highest densities of deer in the Southern Appalachian Assessment area are found in association with private croplands and agricultural lands. Because of poaching (USDA 1999p), increased hunting pressure (Flather and others 1999), and continuing land use development in many areas, deer and elk populations may benefit from the security and isolation provided by inventoried roadless area protection.

Black bears are habitat generalists utilizing early seral patches, edge, and open forested habitats (Hoover and Wills 1984; Wisdom and others 2000; USDA Forest Service 1999u) in juxtaposition with mid to late seral-forested habitats. Black bears tend to be absent for portions of the Southern Appalachians where large amounts of nonforested habitat and limited forested habitat occur. Dense forest cover and security areas, and remoteness provide protection from poaching and hunting and are a key habitat parameter (Southern Appalachian Man and the Biosphere 1996c).

Timber harvest prohibitions would likely benefit bear populations. In the east where poaching, intense hunting pressure and land development are threatening bear populations, one of the primary limiting factors for bears is availability of relatively undisturbed tracts of land habitats. The remaining large tracts of roadless area in the east are important strongholds for bear populations, and may help stabilize bear populations over the long term. In the West, bear populations are expected to remain stable in the

Rocky Mountains and increase along the Pacific coast. Eliminating timber harvest and associated new road construction in inventoried roadless areas would avoid habitat modifications and changes in animal behavior that can detrimentally impact large mammals like bears (USDA and USDI 2000c, USDA 1999p, Fredrick 1991). While early seral habitats are important components of bear habitat, the security and isolation provided by inventoried roadless areas are likely more significant at maintaining stable bear populations than are the potential forage opportunities created by timber harvest activities.

Turkeys prefer habitat where openings are interspersed with mature forests (Dickson 1992; USDA Forest Service 1999u). The inventoried roadless areas likely have only a minor influence on changes in turkey populations in the Southern and Northeast regions. Only 6% (1.6 million out of almost 25 million acres) of NFS lands in Regions 8 and 9 are in inventoried roadless areas, therefore the management of areas outside of inventoried roadless areas would likely have the most significant impact on turkey populations. In addition, the prohibitions would likely maintain important security areas, and minimize potential increases in illegal hunting.

It is unlikely that a timber harvest prohibition on the 6% of NFS lands in inventoried roadless areas in Regions 8 and 9 would have an adverse impact on small game populations. The management of NFS and other lands outside of inventoried roadless area would likely have the most significant impact on these populations. Grouse populations have declined since the 1970s possibly due to regional decreases in the amount of sapling/pole seral stages, which grouse favor (Flather and others 1999; Southern Appalachian Man and the Biosphere 1996c; Hoover and Wills 1982; Wisdom and others 2000) or to a decline in winter range higher elevation coniferous forests. Some grouse populations would benefit from protection of upper elevation winter-range habitats. For ruffed grouse in the east, NFS lands provide a significant amount of habitat (Southern Appalachian Man and the Biosphere 1996c), but only about 6% of Region 8 and 9 NFS lands are in inventoried roadless areas.

Squirrel numbers show steady but slight gains in the North, declines in the Rocky Mountains, and declines since 1985 in the South. Gray squirrel populations in the Southern Appalachian Assessment area (Southern Appalachian Man and the Biosphere 1996c) have remained stable and have benefited from increased acorn production from maturation of oak forests. In the West, gray squirrels have declined as interior ponderosa pine and Oregon white oak habitats are converted to human uses (Wisdom and others 2000). Other small game species (e.g., sharp-tailed grouse, bobwhite quail and cottontail rabbits) are found in heavily fragmented forested habitats, but are more closely associated with rangelands, highly interspersed forests, and agricultural and/or croplands (Wisdom and others 2000; Klimstra and Roseberry 1975; Flather and others 1999); these species therefore are not likely to be impacted by the prohibitions.

Summary of Effects **–** By eliminating the ability to harvest timber for stewardship purposes except when needed for protection or recovery of TEP species, the current capability of the Agency to enhance habitat directly and indirectly would potentially be impaired at the stand level, but it is unlikely to have much impact at larger scales. This would hinder the Agency's ability to use timber harvest to manage for early successional or other structural stages in some areas, where such a need is identified, although prescribed fire is an effective tool under certain conditions. In fiscal year 1997, approximately 15% of the total volume harvested for stewardship purposes on NFS lands was for wildlife or TEP species habitat-management objectives (USDA Forest Service 1998b). Although adverse effects associated with timber harvest would not occur, this limitation of the Agency's ability to manipulate stand structure and successional stage for habitat improvement would make this alternative potentially less ecologically beneficial compared to Alternative 3.

Aquatic Animal Habitat and Species

Affected Environment

Inventoried roadless areas support a diversity of aquatic habitats and communities, providing or affecting habitat for more than 280 TEPS species, and numerous other aquatic species. Without the disturbances caused by roads and the activities that they enable, stream channel characteristics are less likely to be adversely altered compared with stream channel conditions in roaded areas. Important characteristics that influence habitat quality for aquatic species include channel and floodplain configuration, amount of fine sediment in stream substrate, riparian condition, amount and distribution of woody debris, streamflow, water quality, and temperature regime (Furniss and others 1991). Smaller streams, such as many of those found in inventoried roadless areas, provide important habitat for resident and migratory aquatic species and also influence the quality of habitat in larger, downstream reaches (Chamberlin and others 1991).

Illegal introduction and harvest of aquatic species is less likely to occur in these areas due to lack of ready access. Poaching of large, migratory bull trout, a native char found in the Northwest, has been described as an important cause of mortality (Lee and others 1997). Illegal introduction of nonnative fish species has had measurable effects on native aquatic communities in many parts of the country. For example, the Sierra Nevada Ecosystem Project (SNEP) report (Moyle and others 1996) identified illegal introductions of predatory fish, such as northern pike and white bass, and other nonnative fish, as important causes of disruptions in native fish communities in Sierran waters.

The nonnative fish most commonly established through bait bucket introductions in Sierra Nevada waters was the golden shiner, a species able to survive in many high elevation lakes. Thirty species of nonnative fish have been introduced (both legally and illegally) or have invaded most waters in the Sierra Nevada Range. The SNEP determined that less than half of the 40 fish species native to those waters seem to have stable or expanding populations. Adverse effects to native species included hybridization, increased predation, and competition (Moyle and others 1996.)

Waters in inventoried roadless areas have been shown to function as biological strongholds and refuges for many fish species. The size of an area, kinds and intensity of management-induced and natural disturbances that have occurred, and the landscape context in which it is found, all affect the quality, distribution, and extent of these habitats. Some of these waters may now play a relatively much greater role in supporting aquatic species viability and biodiversity than in the past due to cumulative degradation and loss of other, potentially more biologically rich habitat within associated drainages.

The Nature Conservancy and the Association for Biodiversity Information identified the United States as a global center of freshwater biodiversity (Chaplin and others 2000). In examining the distribution of 307 fish species and 158 mussel species that are imperiled or vulnerable, they identified 87 watersheds as aquatic biodiversity hotspots, supporting 10 or more vulnerable or imperiled species. The majority of these watersheds are in the Southeastern United States, with one occurring west of the 100th meridian. Inventoried roadless areas are found within 29 of these watersheds, and likely play a role in supporting the continued survival of these species either directly through providing habitat or indirectly by contributing to water quality within the drainage.

Analysis done for the ICBEMP (Lee and others 1997) indicates that strong fish populations are often associated with areas of low road density. That analysis showed that increasing road densities (miles of road per square mile) and their attendant effects were associated with declines in the status of bull trout, westslope cutthroat trout, yellowstone cutthroat trout, and redband trout. Approximately 60% of unroaded or very low road density subwatersheds within the assessment area supported strong salmonid populations. In contrast, less than 25% of subwatersheds with moderate and 18% with high road densities supported strong populations (Quigley and others 1996).

As shown in Table 2, approximately 2 million acres of inventoried roadless areas contain high priority watersheds identified in the ICBEMP for conservation of threatened Snake River Chinook, with about half of those acres falling in inventoried roadless areas where road construction is not prohibited by current management direction. An additional 5 million acres of inventoried roadless areas contain identified priority watersheds[1] for conservation of bull trout and other species. Cumulatively, the data indicate that more than 30% of the acreage in designated priority and high priority watersheds for aquatic species are in inventoried roadless areas.

[1] Priority Watersheds were identified in the ICBEMP (Quigley and Arbelbide 1997a) as those important for conservation of bull trout (from the Inland Fish Strategy), or with potentially "critical habitat" for anadromous species not listed as threatened or endangered under the Endangered Species Act as of March 1996 (from PACFISH); or as watersheds containing high quality habitat but no listed species as of March 1996.

Table 2. Inventoried roadless areas (in thousand acres) in ICBEMP [a] priority and high-priority watersheds.

State	Inventoried roadless areas in ICBEMP priority watersheds	Inventoried roadless areas in ICBEMP high-priority watersheds
Idaho	2,952	1,937
Montana	1,527	Not Applicable
Nevada	10	Not Applicable
Oregon	429	92
Washington	174	45
Total	**5,092**	**2,074**

[a] Interior Columbia Basin Ecosystem Management Project
(Roadless Database 2000)

A substantial amount of inventoried roadless areas provide important habitat for Pacific anadromous fish species. Table 3 shows the acreage of inventoried roadless areas that lie within the habitat range of Pacific salmonids including those for chinook, chum, coho, and sockeye salmon, as well as steelhead and coastal cutthroat trout. This table also shows acreages of inventoried roadless areas specific to federally listed Pacific salmonids.

Table 3. Pacific anadromous fish habitat in inventoried roadless areas (in thousand acres).

Species	Inventoried roadless areas within the range of Pacific salmonids	Inventoried roadless areas within the range of threatened and endangered Pacific salmonids
Chinook Salmon	8,869	6,314
Chum Salmon	1,401	95
Coho Salmon	1,823	1,175
Sockeye Salmon	258	179
Steelhead	7,593	6,033
Coastal Cutthroat Trout	1,884	156

(National Marine Fisheries Service [NMFS]; Roadless Database 2000)

In considering the contributions of large unroaded areas for conservation of aquatic habitats and species, comparisons can be drawn from research in other areas lacking roads and with minimal levels of human disturbance. For example, in evaluating the role of Wilderness Areas in conserving aquatic biological integrity in Western Montana, Hitt and Frissell (1999) concluded that, although the presence of designated Wilderness does not guarantee aquatic biological integrity due to factors such as fish stocking practices and impacts from adjacent roads, “the importance of Wilderness in aquatic conservation is extraordinary.” Their analysis showed that more than 65% of waters that were rated as having high aquatic biological integrity were found within subwatersheds containing Wilderness. They also concluded that, given the relative rarity of unprotected areas that support a relatively greater degree of aquatic biological integrity, undisturbed areas warrant permanent protection.

For many aquatic 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 kinds of disturbance events. For example, fire-killed trees provide an important and continuing supply of large woody debris to many aquatic systems, an important habitat attribute essential for many salmonid and other aquatic species.

In certain parts of the country, some types of past timber harvest combined with the effectiveness of past wildland fire suppression over the past century, have caused 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. Additional discussion of the effects of fire on aquatic and terrestrial species is presented in Attachment 1.

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 1 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

If present, these physical changes in habitat would have may of the same biological effects as previously listed under the effects of roads, above. With the recent increased emphasis on use of best management practices and other protective measures in the design and implementation of timber harvest activities, the effects can often be mitigated to some extent. Cumulatively, however, timber harvest activities within a watershed can have pronounced and lasting effects to aquatic habitat (Chamberlin and others 1991).

Extent and Duration of Effects **–** For aquatic habitats, the indirect effects of disturbances associated with road construction and timber harvest could extend well beyond those areas directly impacted, given the influence that upslope areas and upstream reaches have on the condition of downstream habitat (Chamberlin and others 1991). The types and extent of impacts on aquatic habitats would depend on road location and design, proximity to accessible habitat, mitigation measures applied, and the activities enabled. For fish populations, habitat alterations can adversely affect all life-stages, from egg to adult, and habitat essential for migration, spawning, incubation, emergence, rearing, feeding, and security (Furniss and others 1991).

The duration of effects, or recovery time, is dependent on a variety of factors. Site productivity, rainfall, and length of growing season influence the rate and success of vegetation regrowth. The type, location, extent and duration of an activity, magnitude of adverse effects, dominant hydrologic and geomorphic processes within the watershed, overall watershed condition, and the effectiveness of mitigation and reclamation activities are some of the other factors influencing the duration of physical effects on a watershed and associated stream channels. The duration of biological effects can extend beyond the recovery time for the physical environment, and can be irreversible if a species is extirpated from the watershed.

Sedimentation **–** Roads can cause direct and indirect effects to important habitat factors for fish and other aquatic species. They contribute more sediment to streams than any other land management activity. The majority of sediment from timber harvest is related to road construction and use. Roads also increase the potential for erosion and slope failure in many areas. This can increase sedimentation of aquatic systems and adversely affect aquatic communities (Furniss and others 1991). Past timber harvest and road construction on unstable slopes in the South Fork Salmon River watershed in Idaho resulted in massive amounts of sediment being heavily deposited in spawning gravels during the 1960s, which substantially impacted spawning success for anadromous and resident fish populations (Platts and Megahan 1975).

Sediment entering stream channels can clog streambed gravels, reducing oxygen concentrations critical to incubating eggs, young fish, and macro invertebrates, fill deep pools, and change channel shape and form, all of which can have adverse effects on aquatic species (Bjornn and Reiser 1991; Hicks and others 1991; Furniss and others 1991). Populations of tailed frogs can be severely reduced or eliminated by increased sedimentation (Corn and Bury 1989; Welsh 1990). In the Clearwater Basin of Washington, the amount of fine sediment from roads was equal to that contributed by landslides and cumulatively resulted in degraded spawning habitat for coho salmon (Chamberlin and others 1991).

A general picture of the effects of sedimentation on aquatic populations like salmon can be constructed from investigations in the Pacific Northwest. Fine sediment can directly reduce egg-to-fry survival, food production, summer rearing area, and winter survival; it can also change the morphology and stability of stream channels, causing long-term reductions in the carrying capacity and the survival of salmon in the stream (Murphy 1995). Holtby and Scrivener (1989) concluded that increased sedimentation following timber harvest reduced escapement by chum salmon (*Oncorhynchus keta*) by 25% in a stream in British Columbia. Scrivener (1991) concluded that sedimentation associated with logging over a 40-year period contributed to the decline of the chum salmon population on Western Vancouver Island. Cederholm and Reid (1987; cited in Murphy 1995) found that sediment from a debris torrent and a streamside salvage operation caused a stream in Washington to aggrade to the point at which the stream dried up during the summer. The yield of coho salmon smolt in that stream declined 60% to 80%.

Increases in turbidity from suspended fine sediment can cause direct mortality to aquatic species, reduce growth and feeding activity (Nelson and others 1991), and can affect the abundance and diversity of benthic invertebrates (Lee and others, 1997).

Habitat Fragmentation and Loss of Connectivity **–** Large blocks of unroaded areas, such as inventoried roadless areas, while having relatively more intact aquatic habitat, may still support isolated aquatic populations because of road-related effects and other causes of habitat alteration in adjacent areas. Ground-disturbing activities, including timber harvest, can result in further loss of habitat connectivity. Improperly placed culverts can result in migration barriers. Gucinski and Furniss (USDA Forest Service 2000h) cited studies showing that:

- Thirteen percent of the historical coho habitat in a large river basin in Washington
- was lost because of improper culvert barriers (Beechie and others 1994);
- Total taxa richness and some species-specific richness were negatively related to the number of stream crossings (Hawkins and others in press); and
- There were significant differences between macroinvertebrate assemblages above and below road stream crossings (Newbold and others 1980).

Areas where changes in riparian vegetation have reduced shading may present thermal barriers to movement of aquatic species (Furniss and others 1991) including many salmonid species such as bull trout.

When habitat connectivity is lost, sub-populations lose the ability to interact, making these species more vulnerable to local extirpations and extinction from any cause. The lack of genetic interchange in an isolated subpopulation or in one with severely restricted size can lower its ability to adapt or respond to changing environmental conditions, resulting in an increased long-term risk to species viability (Gilpin and Soule 1986; Lee and others 1997). While the localized effect of an individual road-stream crossing may not have a substantial adverse effect, the cumulative effect of road networks and multiple crossings increases the potential for major adverse effects to aquatic habitats.

Watershed Hydrology and Stream Channel Morphology **–** Accelerated changes in stream channel morphology and alterations in flow can adversely affect aquatic species by causing a loss of important habitat attributes such as overhanging banks, spawning substrate, deep pools and riffles, winter refugia, and suitable water temperature and volume, affecting virtually all life stages and the overall quality of habitat.

Timber harvest activities can have significant effects on the hydrologic processes that determine streamflow. Increased peak flow can be detrimental to aquatic species, including salmon, because the resulting bedload overturn can scour stream channels, kill incubating eggs, and displace juvenile salmon from winter cover (McNeil 1964; Tschaplinski and Hartman 1983).

Timber harvest can weaken channel banks by removing the source of large woody debris, altering the frequency of channel modifying flows, and changing sediment supply. Riparian tree roots provide bank stability. Streambank instability often increases when these trees are removed, leading to loss of overhanging banks, which is an important habitat attribute for rearing Pacific salmonids (Murphy 1995) and other aquatic species. Streambank destabilization from vegetation removal adds to sediment supply and causes a loss of the channel structures that provide the habitat diversity needed to support healthy fish populations (Harris 1984; Scrivener 1988).

Habitat Complexity **–** Hicks and others (1991) found that a primary consequence of past timber harvest activities was the simplification of fish habitat. Example of such activity included changes in stream flow velocities and depth (Kaufmann 1987), reductions in large wood (Bisson and others 1987; Bilby and Ward 1989), changes in stream and floodplain interaction (Naiman and others 1992), and loss of habitat types and certain substrates (Sullivan and others 1987). The consequence of these changes has been a reduction in the diversity and quality of habitats. In Pacific Northwest streams, habitat simplification resulting from timber harvest and associated activities has diminished diversity of the anadromous salmonid complex (Bisson and Sedell 1984; Hicks 1990).

Water Quality – Road construction and timber harvest can result in measurable reductions of water quality by introducing sediment, nutrients, and chemical pollutants, and by causing abnormal temperature fluctuations. Some pollutants are from road construction and maintenance equipment, or are brought into the watershed through public road use.

Road construction and timber harvest may cause water temperature to change where groundwater is intercepted and brought to the surface or where loss of tree cover in riparian areas reduces shading (Hornbeck and Leak 1992). Removal of riparian canopy associated with road construction and maintenance can elevate stream temperatures to levels that have adverse physiological effects on aquatic species, and can result in increased mortality rates and lowered reproductive success. Elevated temperatures can inhibit upstream migrations, increase disease susceptibility, reduce metabolic efficiency, and shift species assemblages (Beschta and others 1987; Hicks and others 1991).

Pools – In the broad scale assessment of aquatic species and habitats in the Columbia River Basin (Lee and others 1997), sizeable losses of large pools, critical habitat features for many fish species, and deep pools were found in streams in managed areas (multiple-use, roaded areas) over the last 50 to 60 years, compared with streams in unmanaged areas. This analysis showed that streams in 20 managed watersheds in the Central Idaho Mountains ecological reporting unit (ERU) had a 40% decrease in the frequency of large pools, whereas large pools in 11 unmanaged streams in the same ERU showed no noteworthy change. A substantial decrease was also found in the frequency of deep pools in managed streams, in contrast to a considerable increase in streams in unmanaged areas. Pools showed a clear decline in size and frequency with increasing road density.

Riparian Vegetation – Timber harvest and road construction can affect riparian vegetation through removal, soil compaction, changes in drainage pattern and floodplain function, and introduction of nonnative invasive plant species. Riparian vegetation is a controlling factor of stream habitat quality, particularly in smaller streams. It contributes organic materials that supply nutrients and affects productivity, insects that serve as a food source, and logs and branches that affect channel morphology and habitat complexity. Riparian vegetation retains organic matter and provides cover for fish. Roots stabilize stream banks and maintain undercut banks. The protective canopy provided by riparian vegetation helps to regulate temperature by shading the channel in summer and insulating from heat loss in winter (Murphy and Meehan 1991).

Introduction of Nonnative Species and Diseases – Introductions of nonnative fishes and other aquatic species, whether authorized or unauthorized, have the potential to affect the distribution and abundance of native fishes, amphibians, and other aquatic organisms through competition, hybridization, predation, and introduction of parasites and diseases. Nonnative aquatic plants may also be inadvertently introduced to lakes and streams from boats and boat trailers. Unauthorized releases of aquarium fishes, bait fishes, nonnative amphibians and reptiles, and nonnative plants to streams and lakes are strongly influenced by the presence of roads (USDA Forest Service 1999p; Lee and others 1997; Allan and Flecker 1993).

Over Harvest and Illegal Introduction – The presence of a road system and associated facilities accessing streams, lakes, and wetlands can contribute substantially to declines in rare and unique native vertebrate populations (USDA Forest Service 1999p) due to over harvest and illegal collection. Increased access can increase the likelihood of disruption of aquatic native communities with illegal or inadvertent introductions of nonnative species, as discussed under the affected environment section.

Recent Studies – Analysis done for the Interior Columbia Basin Ecosystem Management Project (Lee and others 1997) indicates that strong fish populations are often associated with low road density. The Sierra Nevada Ecosystem Project documented a negative correlation between the abundance of roads in a watershed and the integrity of native stream biota (Moyle and Randall 1996).

The U.S. Fish and Wildlife Service (USDI Fish and Wildlife Service 1998a) found that bull trout are exceptionally sensitive to the direct, indirect, and cumulative effects of roads. Dunham and Rieman (1999) demonstrated that disturbance from roads was associated with reduced bull trout occurrence. They concluded that conservation of bull trout should involve protection of larger, less fragmented, and less disturbed (lower road density) habitats to maintain important strongholds and sources for naturally recolonizing areas where populations have been lost.

Road construction and timber harvest were identified as important factors in the regional decline and loss of populations of some inland cutthroat trout subspecies (Young 1995; Duff 1996). Adverse effects related to roads were identified for Colorado River, westslope, Bonneville, and Yellowstone cutthroat. Timber harvest was identified as a cause of habitat degradation for westslope, Rio Grande, Bonneville, and Yellowstone cutthroat trout.

The biological opinion issued by the National Marine Fisheries Service for PACFISH[2] (USDA Forest Service and USDI Bureau of Land Management 1995) identified roads as a primary cause of salmonid decline, and indicated that roads may have unavoidable effects on streams, regardless of how well they are located, designed, or maintained. In discussing the effects of management activities in inventoried roadless areas in the Pacific Northwest, the scientific analysis team headed by Jack Ward Thomas (Thomas and others 1993) concluded that such activities would increase the risk of damage to aquatic and riparian habitat and could potentially reduce the capacity and capability of key watersheds important for maintaining salmonid populations.

Beneficial Effects of Roads and Timber Harvest – Provided a road is located, designed, constructed, and maintained to the standards needed to protect aquatic habitat, roads can have positive aspects for a fisheries management program for a particular stream or lake (Furniss and others 1991). Roads provide access to lakes and streams, facilitating both

[2] Implementation of Interim Strategies for Managing Anadromous Fish-producing Watersheds in Eastern Oregon and Washington, Idaho, and portions of California

fishing and law enforcement. They also provide easier access for inventory and assessment of stream habitat and populations, for habitat improvement and enhancement projects, and for State stocking and population management activities.

Stewardship timber harvest may provide some potential beneficial effects to some aquatic species. For example, careful thinning to reduce fuel loading in some areas where there is an abnormally high risk of high intensity, large-scale fires, may lower the risk of extirpation of an isolated fish population from a watershed, particularly where habitat complexity and spatial diversity have already been diminished, and where recolonization would not be possible due to a lack of habitat connectivity.

Summary of Effects – With the expectation that roaded entry and timber harvest will continue in these areas at rates approximating those in the past, and given the numerous negative direct, indirect, and cumulative effects identified in the literature associated with these activities, the No Action Alternative has the greatest potential for increased risk of adverse effects to aquatic and riparian habitat and species, relative to Alternatives 2, 3, and 4.

Alternative 2

This alternative offers a greater degree of assurance than Alternative 1 that current aquatic biodiversity would be maintained, due to the prohibition on road construction and reconstruction. Based on estimates provided by each national forest, there would be approximately a 75% reduction in the total miles of road that would be constructed or reconstructed in inventoried roadless areas through 2004 under this alternative. Under the exceptions common to all action alternatives (as described in Chapter 2 of the FEIS), about 300 miles of road could be constructed or reconstructed. Table 1 displays planned offer volumes and miles of road construction or reconstruction, both with and without the Tongass exemption, for each alternative.

Even though timber harvest activities could continue in inventoried roadless areas, information collected from the forests indicates that much of the timber harvest currently planned in these areas would require road construction and reconstruction and hence, would not occur under this alternative as shown on Table 1. Therefore, much of the potential adverse effects associated with road construction would be avoided, and a lower level of risk associated with less timber harvest would be expected, compared to Alternative 1.

Aquatic habitat management activities that are not dependent on new or reconstructed road access could be implemented under this alternative. Forests identified approximately 4 miles of road construction or reconstruction in inventoried roadless areas associated with fisheries habitat improvement projects within the next 5 years. These projects included limestone applications in two streams in Region 8 to reduce acidic conditions, road reconstruction in Region 6 to reduce sedimentation, mine reclamation in Region 8 to reduce stream sedimentation, and stream barrier construction in Region 3 to prevent movement of nonnative fish species into habitat occupied by threatened loach minnow and Apache trout, as well as other native fish species.

These projects represent substantially less than 1% of the annual national program (USDA Forest Service 2000d). One or more of them could likely be redesigned so that road construction or reconstruction would not be necessary in inventoried roadless areas by using aerial access or by walking heavy equipment into the site. For instance, the Region 3 project-feasibility study presented two alternatives that would not require road construction – using a site 8 miles upstream with current road access at a 20% cost savings, or using helicopter access to a site about 3 miles upstream at an 18% increased cost (USDI Bureau of Reclamation 1998).

All action alternatives offer an exception to prohibitions for situations where an existing road needs to be realigned to prevent resource damage, caused by the road itself. For example, this exception could be invoked to prevent substantial adverse effects to aquatic habitat caused by excessive sedimentation from an adjacent road. The Region 6 road reconstruction project listed above could potentially fall under this exception.

Overall, the need for additional road access to manage aquatic habitat within inventoried roadless area appears to be minimal. The current national capability of the Agency to manage aquatic habitat would not be measurably affected.

Summary of Effects **–** No adverse environmental effects to aquatic animal species would be expected from this alternative, since it does not directly authorize any ground disturbing activities, and this and other government agencies with jurisdictional responsibilities would retain the tools necessary to manage these resources. Overall effects to aquatic species and biodiversity would be beneficial.

Alternative 3

With the added prohibition against non-stewardship timber harvest, this alternative presents a lower risk than Alternatives 1 and 2 of additional degradation or loss of aquatic habitat quality, quantity, and distribution resulting from timber harvest, particularly in those inventoried roadless areas that are currently open to road construction. A description of the potential adverse effects of road construction and timber harvest is provided under Alternative 1.

As discussed under Alternative 2, a reduction of approximately 75% in the total miles of road that could be constructed or reconstructed in inventoried roadless areas through 2004 would be expected under this alternative. Table 1 displays planned offer volumes and miles of road construction or reconstruction, both with and without the Tongass exemption, for each alternative.

By restricting timber harvest to activities necessary for resource stewardship, many of the adverse effects of timber harvest would be minimized, while maintaining a management tool potentially needed for ecological restoration. Mechanical vegetation manipulation to reduce fuel loading may be desirable in some areas where there is an abnormally high risk of high intensity, large-scale fires. Fuels reduction stewardship activities may be indirectly beneficial to some aquatic populations, if such activities are implemented with minimal impacts to aquatic habitats. Other types of stewardship timber harvest to meet objectives for aquatic habitat could include watershed restoration and enhancement of riparian vegetation (USDA Forest Service and USDI Bureau of Land Management 1995).

As described under Alternative 2, aquatic habitat management activities that are not dependent on new or reconstructed road access could be implemented under this alternative. Overall, the need for additional road access to manage aquatic habitat within inventoried roadless area appears to be minimal. This alternative would not measurably affect the current ability of the Agency to manage aquatic habitat.

Summary of Effects – No adverse environmental effects to aquatic animal species would be expected from this alternative, since it does not directly authorize any ground disturbing activities. This Agency and other government agencies with jurisdictional responsibilities would retain the tools necessary to manage these resources. Overall, the effects on biodiversity would be beneficial.

Alternative 4

The potential beneficial effects of this alternative on aquatic communities would be similar to those described in Alternatives 2 and 3, but potentially somewhat greater. By prohibiting all timber harvest, except for that needed for protection or recovery of TEP species, this alternative would provide the greatest assurance that these areas would not experience increased levels of human-caused disturbance and associated degradation of aquatic habitat quality, quantity, and distribution, associated with road construction and timber harvest.

However, by prohibiting all timber harvest, the Agency would loose a management tool that may be desirable for ecological restoration in some areas. Vegetation manipulation using mechanical means to reduce fuel loading may be desirable where there is an abnormally high risk of high intensity, large-scale fires, but could not be implemented under this alternative.

Whereas the benefits of less ground disturbance from road construction and timber harvest are well documented in the literature, it is less clear whether failure to reduce fuel loading would constitute a substantially increased level of risk to aquatic communities. Even though some timber harvest activities are intended to mimic the effects of natural disturbance processes such as fire, there is little known about the long term ecological legacies of such treatments. It is not clear how those legacies would compare with areas where natural disturbance processes have played a more dominant role in controlling successional pathways, landscape mosaics, and ecosystem composition.

Although Rieman and others (1997) documented that large fires can adversely affect aquatic systems, and can result in fish mortality and even extirpation, they concluded that the resilience and persistence of salmonid populations are heavily influenced by the complexity and spatial diversity of habitats. A complex, well-dispersed network of habitats is likely to be an important element in the persistence of fish populations during and after large fires. They concluded that some aquatic species, such as bull trout and redband trout, appear to be well-adapted to "pulsed" disturbances, such as fire and its associated hydrologic effects, as opposed to more continual or "press" effects linked to roads and extended timber harvest. They recommended that where small or isolated sensitive fish populations occur in watersheds at high risk of uncharacteristic wildland fire, management actions should be implemented only after careful site-specific risk evaluation. When a need to reduce fuel loading is identified, silvicultural prescriptions emphasizing low-impact logging and yarding and prescribed fire would be preferable.

Research on the Boise National Forest after large intense fires in 1994 showed rapid recolonization of reaches by bull trout (Rieman and others 1997). Burns (2000a) found that risks to fish populations from prescribed fire or wildland fire are low where fish populations can freely migrate and ecosystems are not severely fragmented. Research on fish recolonization after large disturbances or experimental removal indicates that full population recovery can occur quickly, often within a few years (Niemi and others 1990; Detenbeck and others 1992) or even in much shorter periods (Sheldon and Meffe 1995; Peterson and Bayley 1993). These studies support a determination that, provided aquatic populations are not functionally isolated, this alternative would not result in a greater risk of adverse effects to aquatic communities from prescribed or wildland fire.

Overall, the need for additional road access and timber harvest to manage aquatic habitat within inventoried roadless area appears to be minimal. Although there may be some local limitations, this alternative would not affect the overall current ability of this Agency or other Federal, State, or local government agencies with jurisdictional responsibility to manage aquatic species and habitat. Existing access would not be affected by this or the other prohibition alternatives.

Summary of Effects **–** No adverse environmental effects to aquatic animal species would be expected from this alternative, since it does not directly authorize any ground disturbing activities. This Agency and other agencies with jurisdictional responsibilities would retain the tools necessary to manage these resources. Overall effects relative to conservation of aquatic species and biodiversity would be beneficial.

Terrestrial and Aquatic Plant Species

Affected Environment

Inventoried roadless areas provide large, relatively undisturbed blocks of important habitat for a wide variety of native terrestrial and aquatic plants including, more than 1,400 sensitive and almost 100 TEP plant species. Many of these are endemic species, with narrowly limited geographical ranges determined by soil types, climatic conditions, and other environmental conditions. Endemic species, due to their limited distribution, are often at a relatively higher risk of extinction from either natural or human-induced causes. Areas in the United States with sizeable numbers of endemic plant species include California, Texas, Alaska, the Pacific Northwest, the Southwest, the Intermountain West, and the South (Gentry 1986). Appendix C of the FEIS includes a list of TEP plant species found on NFS lands and identifies which species may be affected by inventoried roadless areas. Lists of both TEP and sensitive species potentially affected by the project can be found in the biological evaluation or at the project website (**roadless.fs.fed.us)**.

These inventoried roadless areas may provide important biological strongholds for native plant species and communities. In comparing the distribution of these inventoried roadless areas with centers of biodiversity identified in the Interior Columbia Basin Ecosystem Management Project (ICBEMP) (Lee and others 1997), inventoried roadless areas cover approximately 10% (2,810,000 acres) of the identified acreage for centers of biodiversity for plants. In addition, almost 10% (1,370,000) of the acreage identified in ICBEMP as centers of endemism for plants is contained in inventoried roadless areas.

Because access to many inventoried roadless areas is relatively difficult, and there are typically fewer projects and activities requiring rare-plant inventories, areas that are more accessible are often better surveyed than inventoried roadless areas. Therefore, inventoried roadless areas are more likely to yield new distributional records and even previously unknown species.

Compared to roaded areas, plants in inventoried roadless areas are less likely to be exposed to disruption from a variety of human activities such as collection, trampling, and other surface disturbance. This lower level of disruption may make inventoried roadless areas important references for understanding the natural composition and dynamics of native plant communities.

Roads are also avenues for invasion by nonnative invasive plant species that frequently compete with or displace native vegetation. Competition by nonnative invasive species is one of the leading causes for plant species being listed as T&E (Pimental and others 1999; Fay personal communication). More than 3,700 nonnative plant species have become established in the United States (Williams and Meffee 1998). Table 4 shows the estimated numbers of established nonnative species in this country, providing an indication of the magnitude of this issue. Areas subjected to intense and wide spread natural disturbances, such as high intensity stand-replacing wildland fire, can be susceptible to nonnative plant invasions for a period. However, the risk is significantly less than in roaded areas where human activities and disturbances associated with roads can exacerbate the problem. Lacking roads and many of the disturbances associated with them, inventoried roadless areas are less likely to experience problems with nonnative invasive species and are more likely to be able to maintain intact native plant communities.

Table 4. Estimated number of established nonnative species in the United States.

Species group	Number
Plants	3,723
Terrestrial vertebrates	142
Insects and arachnids	>2,000
Fishes	76
Mollusks	91
Plant pathogens	239
Total	**>6,200**

(Williams and Meffe 1998)

Alternative 1 - No Action

This alternative would have the greatest potential for additional ground disturbance associated with roads, timber harvest, and other management activities. Approximately 40% of the 58.5 million acres of inventoried roadless areas are currently covered by land management-plan prescriptions that 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 areas currently open to road construction. The type and extent of impacts to native plant species and communities from this road construction would depend on road location and design, mitigation measures applied, and the activities that occur. Approximately 90,000 acres (18,000 acres per year) would be directly impacted by the planned level of timber harvest offer of 1.1 BBF through 2004. Over the long term, the average annual acreage affected is expected to drop to about 14,000. Table 1 displays planned offer volumes and miles of road construction or reconstruction, both with and without the Tongass exemption, for each alternative.

Nonnative Invasive Plants – With the expectation that roaded entry would continue at approximately the same rate in inventoried roadless areas and given the disturbances and uses associated with roads, this alternative poses the greatest degree of risk for increased introduction and spread nonnative invasive species, with a corresponding increase in risk of all of the adverse ecological effects associated with establishment of such species. Roads serve as a means of entry for many nonnative invasive plant species, with seeds or plant parts inadvertently transported into previously unaffected areas. Ground disturbance associated with roads and with other road activities provides additional opportunity for establishment or expansion of nonnative invasive plant populations (Parendes and Jones 2000).

A recent survey conducted by the U.S. Department of the Interior found that nonnative invasive plants have invaded more than 17 million acres of public rangelands within the Western United States, more than quadrupling their range from 1985 to 1995. At this rate of expansion, Western wildlands are being lost at a rate of 4,600 acres per day to invasive plants such as leafy spurge and yellow starthistle (Westbrooks 1998). The source of many of these infestations has been traced to roads, trails, railroads, and other travel corridors. When vehicles are driven through a **noxious weed**-infested area, seeds from these plants may become lodged in tire treads, in a winch, and in other cracks and crevices on the chassis of a vehicle. Such seeds may become dislodged hundreds of miles away, infesting new areas (Westbrooks 1998). Many nonnative invasive plants are dispersed through transportation of contaminated hay or seed along roads. Spotted knapweed and yellow starthistle are just two examples of plants that are dispersed throughout roadways by the transportation of contaminated alfalfa and clover seed.

Site disturbance by road construction and the transport of contaminated soil and gravel have been identified as a major contributors to long distance seed dispersal for yellow starthistle (Thomsen and others 1996). Additionally, within California, scotch broom has been found to be dispersed by vehicles through the transportation of seed in mud and debris (USDI 1994). Routine roadside mowing aids in the elimination of some noxious weeds, but can accidentally spread the seeds of others, like knapweed in the Midwest and the dust-like seeds of parasitic weeds such as small broomrape in South Georgia (Westbrooks 1998). Gorse has been recognized as a significant nonnative invasive plant occurring within Oregon and California (Amme 1983). Subsequent use of roadways in close proximity to gorse facilitates its spread by serving as a mechanism for seed dispersal (Hill 1949). Now widely distributed throughout North America (Whitson and others 1991; Young 1991), cheatgrass has been identified as a common species along many roadsides. The highly flammable cheatgrass alters the frequency and intensity of fires on Western rangelands, and therefore alters vegetative communities important for many big game species.

Aggressive nonnative invasive plant species generally undermine native plant diversity through competition and habitat alteration. For example, the Sierra Nevada, an area historically rich in plant diversity with more than 3,500 native species, now supports hundreds of nonnative species, many of which have had considerable detrimental ecological effects (Sierra Nevada Ecosystem Project 1996). Other parts of the country show similar situations. Areas infested with invasive species, such as spotted knapweed and leafy spurge, can have low grass productivity (Hillis 1999) affecting the quality and amount of forage available to many species. Once established, many of these nonnative species are extremely difficult or impossible to eradicate. The use of herbicides in eradication or control efforts can have unintended adverse effects to populations of other terrestrial and aquatic species (Norris and others 1991).

Fragmentation – While most studies of forest fragmentation have focused on animal species, some research has addressed plants. In studying the effects of forest fragmentation from timber harvest clearcuts on trillium (*Trillium ovatum),* a common herbaceous understory plant, Jules (1998) documented continuing adverse effects (high mortality during initial disturbance and a continuing lack of new plants) even in sites that had been clearcut more than 30 years ago. Although he found individual plants as old as 72 years, study areas showed few plants younger than the age of the clearcut. His study also demonstrated that populations in remaining forest remnant patches that were within 65 meters of the edge of a clearcut experienced similar adverse effects, most likely due to a combination of reduced seed set and reduced survival of seeds and seedlings near edges. He speculated that, given the severe effects from fragmentation demonstrated for this common species, it is likely that the distribution and abundance of other understory plants were similarly altered. Jules concluded that the likelihood of maintaining biodiversity would be greater in areas that have never been harvested and where landscape fragmentation has not increased.

Isolation or severely restricted subpopulation size due to habitat fragmentation may also have adverse effects due to the lack of genetic interchange that can lower a species ability to adapt or respond to changing environmental conditions. This would constitute an increased long-term risk to species viability (Gilpin and Soule 1986).

Effects of Temporary Roads **–** 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 to support timber harvest or other activities often involves construction of multiple roads over time, providing a more continuous disturbance to an area than a single, well-designed, maintained, and use-regulated road. Rare plant populations can be lost during road construction, whether roads are temporary or permanent. While temporary roads may be used temporarily, for periods ranging up to 10 years, and are then decommissioned, their short and long-term effects can be extensive to rare plant populations.

Summary of Effects **–** Increased access into inventoried roadless areas would present an increased risk to rare plant populations and communities due to increased level of habitat disturbance, habitat fragmentation, introduction of nonnative invasive plant species, and collection or trampling of individual rare plants. Alternative 1, therefore, would pose the greatest threat to conservation of native plant species and communities.

Additional discussions on the effects of road construction and timber harvest relevant to plant species are in the Terrestrial, and Aquatic Animal Species sections, and in the biological evaluation.

Alternative 2

This alternative would offer a greater degree of assurance than Alternative 1 that current plant diversity would be maintained, due to lower levels of disturbance, less potential for additional forest fragmentation, and less development of road access.

Based on estimates provided by each national forest, there would be an approximate 75% reduction in the total miles of road that could be constructed or reconstructed in inventoried roadless areas through 2004 under this alternative. Under the exceptions common to all action alternatives (as described in Chapter 2 of the FEIS), approximately 300 miles of road would be constructed or reconstructed.

The amount of potential additional forest fragmentation associated with timber harvest would be reduced under this alternative. Timber harvest activities and road construction would continue in inventoried roadless areas, but at much-reduced levels. Table 1 displays planned offer volumes and miles of road construction or reconstruction, both with and without the Tongass exemption, for each alternative.

Without the ground disturbance, ecological edges, and uses created or enabled by additional road construction and reconstruction in inventoried roadless areas, these areas would be less vulnerable to establishment of nonnative invasive species than roaded areas of similar size. Relative to Alternative 1, this alternative would provide a lower risk of adverse effects to native plant species and communities from establishment of nonnative invasive species, providing greater protection of existing biodiversity and site productivity. All action alternatives are consistent with and help further the intent of Executive Order 13112 on invasive species.

Through 2004, two projects were identified for restoration of native plant communities that as currently designed would require 2.5 miles of road construction in inventoried roadless areas. These projects in Region 8 involve boreal habitat enhancement and variable sedge restoration. Alternative means of access could potentially be developed for both projects. Overall, the need for road construction and reconstruction for native plant projects appears to be minimal.

Summary of Effects **–** No adverse environmental effects to terrestrial and aquatic plant species would be expected from this alternative, as this alternative does not authorize any ground disturbing activities. Existing access to inventoried roadless areas would not be affected. The overall ability of this Agency or other Federal, State, or local government agencies with jurisdictional responsibilities to implement management actions for conservation of rare plant communities would be unaffected, including those actions needed for control or eradication of nonnative invasive plants. Overall effects to terrestrial and aquatic native plant communities would be beneficial.

Alternative 3

With a prohibition of non-stewardship timber harvest and of road construction and reconstruction in inventoried roadless areas, this alternative would provide a greater degree of assurance than Alternatives 1 and 2 that these areas would not experience increased levels of human-caused disturbance and degradation of native plant habitat quality, quantity and distribution. The overall beneficial effects of this alternative to native plant species and communities would be similar to those described under Alternative 2, but would be somewhat greater with the additional prohibition on non-stewardship timber harvest.

Information collected from each national forest indicates that much of the timber harvest currently planned in these areas would either require road construction and reconstruction or was not classified as "stewardship.", and hence, would not occur under this alternative. Table 1 displays planned offer volumes and miles of road construction or reconstruction, both with and without the Tongass exemption, for each alternative.

With a reduced level of planned timber harvest, there would be less potential for increased ground disturbance, ecological edges, fragmentation, and other associated timber effects. This alternative would provide additional assurance beyond Alternative 2 that inventoried roadless areas would retain current levels of resistance to the introduction and establishment of many nonnative invasive species. (See the discussion on nonnative invasive species under Alternative 2 above.) All action alternatives would be consistent with and would help further the intent of Executive Order 13112 on invasive species.

Summary of Effects – No adverse environmental effects to terrestrial and aquatic plant species would be expected from this alternative, as this alternative does not authorize any ground disturbing activities, and the overall ability of this Agency or other government agencies to implement management actions for conservation of rare plant communities would be unaffected. Overall effects to native plant communities would be beneficial.

Alternative 4

The beneficial effects of this alternative on native plant communities would be similar to those described in Alternatives 2 and 3, but potentially somewhat greater. This alternative would provide additional assurance that these areas would not experience increased levels of human-caused disturbance and degradation of native plant habitat quality, quantity, and distribution. Without any of the ground disturbance and ecological edges associated with timber harvest and combined with a 75% reduction in road construction and reconstruction, this alternative would provide the greatest assurance that these areas would retain current levels of resistance to the introduction and establishment of many nonnative invasive species. This alternative is consistent with and would help further the intent of Executive Order 13112 on invasive species.

This alternative would provide an exception to the prohibition on timber harvest, if needed, to protect or recover a T&E species or a species that has been proposed for listing under the ESA.

Summary of Effects – No adverse environmental effects to terrestrial and aquatic plant species would be expected from this alternative, as this alternative does not authorize any ground disturbing activities. Although there may be some local limitations, the overall ability to implement management actions for conservation of rare plant communities would not be affected. Overall effects to native plant communities would be beneficial.

Threatened, Endangered, Proposed, and Sensitive Species

The worldwide rate of extinction is estimated to be approximately 400 times that of recent geologic time, and is apparently increasing (Wilson 1985). Based on estimates made by the Nature Conservancy (Stein and Flack 1997), at least 110 species of plants and animals are known to be extinct in the United States, and an additional 416 species are possibly extinct, with no recent documented occurrences. They estimate that about one-third of the United States plant and animal species have an increased risk of extinction. It is conceivable that the number of species in the United States that merit listing early in the 21st Century may be 2 or 3 times that of the number currently listed (Wisdom and others 1999). These statistics indicate the importance of conserving the remaining relatively undisturbed, large blocks of habitat for species whose continued viability may be at risk.

A high percentage of federally listed T&E species, and species proposed for listing under the ESA as well as Forest Service designated sensitive species are affected by inventoried roadless areas. Statistics generated from Forest Service species lists indicate that:

- More than 55% of TEP species, with habitat on or affected by NFS lands, are directly or indirectly affected by inventoried roadless areas. This percentage represents approximately 25% of all animal species and 13% of all plant species listed under the ESA within the United States.

- More than 65% of all Forest Service sensitive species are directly or indirectly affected by inventoried roadless areas. This percentage is composed of birds (82%), amphibians (84%), mammals (81%), plants (72%), fish (56%), reptiles (49%), and invertebrates (36%).

These statistics suggest the important role that inventoried roadless areas fill, both individually and cumulatively, in maintaining species viability and biodiversity in all parts of the country. It is likely that some inventoried roadless areas are more important now than in the past in supporting species viability and biodiversity, due to cumulative degradation and loss of other potentially more biologically rich habitat in adjacent landscapes. With extinction risk for many species directly correlated to habitat loss and degradation (Stein and Flack 1997), the data in Table 5 indicate the numbers of species that may be at increased risk of endangerment or extinction if the relatively undisturbed habitat provided by these areas is not maintained. Even though the numbers vary between species group and parts of the country, nationally these inventoried roadless areas play an important role in providing habitat for TEP and sensitive species.

Table 5. Estimated number and percent of threatened, endangered, proposed, and sensitive species within each Forest Service region affected by inventoried roadless areas.

	Threatened, endangered, and proposed species		Sensitive species	
Region	Number of species	Percent by region	Number of species	Percent by region
Northern (1)	15	75	245	82
Rocky Mountain (2)	27	100	135	83
Southwestern (3)	45	57	245	57
Intermountain (4)	31	89	222	99
Pacific Southwest (5)	60	63	313	77
Pacific Northwest (6)	30	83	329	75
Southern (8)	65	38	346	54
Eastern (9)	29	85	276	42
Alaska (10)	1	25	26	93

(Roadless Database 2000)

Wilcove and others (2000) examined available information for 1880 imperiled and listed species and determined that habitat destruction and degradation contributed to the endangerment of 85% of those species. Other important contributing factors included competition with or predation by nonnative species (49%), pollution (24%), and overexploitation (17%).

Nationally, on NFS lands, there are approximately 400 proposed, threatened and endangered species, and 2,930 sensitive species. Inventoried roadless areas provide or affect habitat for approximately 220 TEP and 1,930 sensitive species. Forty-four species have designated critical habitat on NFS lands, along with proposed critical habitat for an additional eight species. Inventoried roadless areas provide or affect critical habitat for approximately 75% of these species. These species are identified in Appendix C of the FEIS.

The Forest Service Roadless Area Conservation Biological Evaluation for Threatened, Endangered, Proposed, and Sensitive Species (biological evaluation or BE) was completed for the alternatives in the FEIS and is part of the project record. As part of ESA consultation, the biological evaluation was provided to the National Marine Fisheries Service and the U. S. Fish and Wildlife Service, along with other supporting documentation. The level of analysis in the biological evaluation was commensurate with the national scale and non-ground disturbing nature of the action alternatives. It does not take the place of specific, project-level or forest-plan level planning and analysis for future decisions regarding other activities in these areas, but it does provide an important overall context for such analyses. The list of TEP species is included in Appendix C of the FEIS. This list, the sensitive species list and the BE are available on the project website at roadless.fs.fed.us.

The overall determinations of effect in the BE were the same for all action alternatives:

- May affect, but are not likely to adversely affect T&E species or adversely modify designated critical habitat; and are not likely to jeopardize proposed species or adversely modify proposed critical habitat. Furthermore, these alternatives may beneficially affect TEP species and critical habitat.

- May affect individuals, but are not likely to cause a trend towards Federal listing or a loss of viability for any sensitive species. Furthermore, these alternatives may beneficially affect sensitive species and their habitat.

The Terrestrial Animals and Habitat, Aquatic Animals and Habitat, and Terrestrial and Aquatic Plant Species sections provide additional description of the affected environment and environmental consequences of the alternatives including discussions on nonnative invasive species.

Alternative 1 - No Action

Refer to the Alternative 1 sections under Terrestrial Animals and Habitat, Aquatic Animals and Habitat, and Terrestrial and Aquatic Plant Species for a comprehensive discussion of the principal effects from road construction and timber harvest, and to the biological evaluation.

Relative to the No Action Alternative, all of the action alternatives would have the potential for important beneficial impacts to TEPS species, by reducing risks of future habitat degradation and disturbance, and conserving existing biological strongholds. The degree of beneficial effects would vary by alternative, in response to the level of prohibitions applied.

Past road construction and timber harvest practices have had substantial impacts on TEPS species and habitats in many areas. Recent changes in project designs and specifications, along with application of best management practices, have been effective at moderating or avoiding many adverse effects. Some effects, however, cannot be completely mitigated or avoided. The following summary lists the principal effects that have been associated with roads and timber harvest, but these are potential effects, and not every project would necessarily give rise to one or more of these effects. These effects are discussed in detail under the Terrestrial animal Habitat and Species, the Aquatic Animal Habitat and Species, and the Terrestrial and Aquatic Plant Species sections.

Potential Effects of Roads:

- Habitat loss
- Habitat fragmentation and loss of connectivity
- Adverse edge effects
- Displacement and avoidance behavior
- Access for poaching and illegal collection
- Increased potential for chronic negative interactions with humans
- Direct mortality from vehicles and recreational shooting
- Harassment and disturbance
- Dispersal and movement barriers for some species
- Lethal toxicity
- Introduction and spread of nonnative invasive species and diseases
- Increases sediment loads in streams
- Adverse changes in watershed hydrology and stream flows
- Alterations of stream channel morphology
- Degradation of water quality, including increasing chance of chemical pollution.
- Alteration of water temperature regimes

Potential Effects of Timber Harvest:

- Habitat loss, fragmentation, and negative edge effects.
- Habitat loss of snags and down logs
- Degradation of rare and unique communities such as those found in talus slopes, cliffs, caves, and wetlands
- Disruption of dispersal and species migration
- Lowered success in reproduction and rearing of young

- Increased levels of physiological stress for some species
- Introduction and spread of nonnative invasive species
- Changes in streamflow and the timing or magnitude of runoff events
- Loss of stream bank stability
- Increases in sediment supply and sediment storage in channels
- Degradation of water quality
- Altered energy relationships involving water temperature, snowmelt and freezing
- Loss of habitat complexity
- Alterations in riparian composition and function

Summary of Effects **–** The No Action Alternative would result in a greater likelihood of measurable losses of habitat quality and quantity in inventoried roadless areas, with the increased potential for adverse effects to some TEPS species[3]. Table 1 displays planned offer volumes and miles of road construction or reconstruction, both with and without the Tongass exemption, for each alternative. This alternative poses the greatest likelihood of increased risk cumulatively to species viability, although mitigation measures offsetting some adverse effects would undoubtedly be identified as part of site-specific national NEPA decisions, and where TEP species may be affected, ESA consultations and conferencing.

Alternative 2

With a prohibition on road construction and reconstruction in inventoried roadless areas, the potential for increased levels of human-caused disturbance and degradation of habitat quality, quantity, and distribution would be greatly reduced relative to Alternative 1, particularly in those areas currently open to road construction. Given the numbers, diversity, and distribution of TEPS species that have habitat in inventoried roadless areas, this alternative would provide important local, regional, and national conservation for these species and their habitats.

All of the action alternatives offer an exception to the prohibition on road construction and reconstruction for situations where an existing road needs to be realigned to prevent irreparable resource damage, which is being caused by the road itself. For example, this exception could be invoked to relocate a road to prevent substantial adverse effects to habitat for a threatened or sensitive fish species caused by excessive sedimentation from the existing road location, when such effects could not be avoided through maintenance.

With a 75% reduction in planned road construction and an associated reduction in many activities, including road-dependent timber harvest, habitat degradation and fragmentation, harassment, disruption, and illegal capture or harm would be less likely, relative to Alternative 1. Overall effects to conservation of species and maintenance of biodiversity would be beneficial, with no adverse effects anticipated.

[3] Assuming that roaded entry and timber harvest would continue in these areas at rates approximating that occurring in the past and given the disturbances from other road-dependent activities.

A comprehensive description of the principal effects from road construction and timber harvest is in the sections on Terrestrial Animal Habitat and Species, Aquatic Animal Habitat and Species, and Terrestrial and Aquatic Plant Species, and in the biological evaluation for this project. Table 1 provides the planned timber harvest and miles of road construction projected under this alternative.

Through 2004, no planned activities from conservation strategies for sensitive species were identified that would require road construction and reconstruction in inventoried roadless areas. Of the general (that is, not specifically targeted at TEPS) wildlife, fish, and rare plants projects planned, four fisheries projects and eight terrestrial species projects were identified that would require road construction or reconstruction as currently planned. It is likely that some of these projects would directly or indirectly benefit one or more TEPS species. If redesigned, some of these projects could likely be implemented without road construction and reconstruction.

One project was identified for recovery of T&E species that would require road construction in an inventoried roadless area. This involves stream barrier construction in the Forest Service Southwest Region to prevent movement of nonnative fish species into habitat occupied by threatened loach minnow and Apache trout, as well as other native fish species. As currently designed, it would require 1 mile of temporary road construction in an inventoried roadless area. A feasibility study for this project presented two alternatives that would not require road construction: using a site 8 miles upstream with current road access at a 20% cost savings, or using helicopter access to a site about 3 miles upstream at an 18% increased cost (USDI Bureau of Reclamation 1998).

In general, it appears that the need for road construction or reconstruction for recovery or protection of TEPS species would be minimal. There is no reason to expect that this would change in the upcoming decades. It is unlikely that alternate means of access could not be found to accomplish recovery or conservation objectives, although costs may increase in some situations. With the exception provided under all prohibition action alternatives that an existing road may be realigned to prevent irretrievable resource damage, adverse effects to TEPS and other species from existing roads may be mitigated.

Summary of Effects – No adverse environmental effects to these species would be expected from this alternative, since it does not authorize any ground disturbing activities. The current capability of the Forest Service and of other agencies with jurisdictional responsibilities to manage species or habitat within these areas would not be measurably affected by such a prohibition. None of the alternatives would reduce existing access. The Agency would retain the tools necessary to manage these resources. Overall effects relative to conservation of TEPS species and biodiversity would be beneficial.

Alternative 3

This alternative would provide important national conservation for TEPS species and their habitats given the diversity and distribution of these species affected by inventoried roadless areas. Without road construction and reconstruction, non-stewardship timber harvest, and many of the activities that roads enable, there would be a lower likelihood of harassment, disruption, illegal take, and habitat degradation, relative to Alternatives 1 and 2. Table 1 displays planned offer volumes and miles of road construction or reconstruction, both with and without the Tongass exemption, for each alternative. Overall effects to conservation of TEPS species would be beneficial, and would be somewhat greater than those of Alternative 2.

A comprehensive description of the potential effects from road construction and timber harvest that would be reduced or avoided under this alternative can be found in the sections on Terrestrial Animal Habitat and Species, Aquatic Animal Habitat and Species, and Terrestrial and Aquatic Plant Species, and in the biological evaluation for this project.

As described under Alternative 2, through 2004, no planned activities from conservation strategies for sensitive species were identified that would require road construction in inventoried roadless areas, and only one project requiring road construction was identified for recovery of T&E species, for which alternate designs not requiring road construction are available. There is apparently little need for road construction or reconstruction in inventoried roadless areas for recovery or protection of TEPS species.

Summary of Effects **–** The current ability of this Agency and of other government agencies with jurisdictional responsibilities relative to these species would be unimpaired. Under the exception that an existing road may be realigned to prevent irretrievable resource damage, adverse effects to TEPS and other species from existing roads may be mitigated. No adverse environmental effects to these species would be expected from this alternative, since it does not authorize any ground disturbing activities. The overall effects relative to conservation of TEPS species and biodiversity would be beneficial.

Alternative 4

Given the numbers, diversity, and distribution of TEP and sensitive species that have habitat in inventoried roadless areas, this alternative would provide important local, regional, and national protection for these species and their habitats. Without road construction, reconstruction, or timber harvest, and many of the activities that roads enable, there would be a lower likelihood of harassment, disruption, illegal take, and habitat degradation. The beneficial effects of this alternative would be similar to those described for Alternatives 2 and 3.

This alternative includes an additional exception for TEP species, as described in Chapter 2 of the FEIS. The responsible official may authorize an exception to the prohibition on timber harvest if it is determined that such harvest is:

- Necessary to prevent degradation or loss of habitat for a TEP species to the extent that such loss or degradation would increase the risk of extinction; or
- An important action needed to promote recovery of a T&E species.

In all cases, agreement that a project is warranted would need to be obtained from the NMFS or U.S. Fish and Wildlife Service, as applicable. It is not anticipated that this exception would be used frequently or for large-scale projects, but rather for conservation of specific habitat components necessary for continued species viability where a clear need is identified. This exception would not apply to sensitive species.

An example of why the exception may be applied is for recovery of the red-cockaded woodpecker (RCW). In their biological opinion on the revised land management plan for NFS lands in Texas, the U.S. Fish and Wildlife Service (USDI Fish and Wildlife Service 1996) identified concerns about the limited ability of the Forest Service to cut trees to maintain or improve habitat for RCW within Wilderness areas, which would permit midstory encroachment and uncontrolled southern pine beetle infestations. They concluded that several RCW clusters were likely to be lost and six more would be adversely affected by loss of foraging habitat. These same needs may exist for RCW habitat in inventoried roadless areas. Another possible scenario would be a thinning project to reduce fuel loading and risk of high-intensity stand replacing wildland fire to protect a single remaining endangered plant population. This exception would permit such activities, providing the appropriate regulatory agency concurs.

A comprehensive description of the potential effects from road construction and timber harvest avoided under this alternative can be found in the sections on Terrestrial Animal Habitat and Species, Aquatic Animal Habitat and Species, and Terrestrial and Aquatic Plant Species, and in the biological evaluation.

Potential for Adverse Effects from the Prohibition on Timber Harvest – An important objective of this analysis was to determine whether a prohibition on timber harvest in inventoried roadless areas would have any adverse effects on the ability of Agency to take actions needed to conserve or protect TEPS species and their habitats. For example, there may be situations where excessive build up of fuels could result in an increased incidence of uncharacteristically large, stand-replacing wildland fires. Pretreatment of areas through thinning may be desirable to safely use prescribed fire. There may also be a need to restore or enhance stand structure and composition to sustain suitable habitat for some TEPS species, such as previously described for the red-cockaded woodpecker.

The indirect effects of a prohibition on timber harvest, therefore, would have potential implications to management of TEPS species in inventoried roadless areas. Given that concern, the exception for timber harvest for conservation or recovery of TEP species was added to this alternative. As described above, Alternative 4 would not preclude use of timber harvest for stand enhancement, successional stage management, or fuels reduction when needed for recovery or protection of TEP species, provided the applicable Federal agency with ESA oversight responsibilities supports the need. As there is essentially, then, no prohibition of timber harvest that would preclude activities needed for recovery or conservation of TEP species, none of the action alternatives would pose an increased risk of adverse effects, relative to the No Action Alternative. This exception, however, would not apply to sensitive species.

In evaluating the potential need for fuels reduction efforts for conservation of sensitive species, it is important to recognize that, for many terrestrial and aquatic ecosystems, fire has played an important role in creating and maintaining suitable habitat at varying temporal and spatial scales. Many terrestrial and aquatic 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 and others 2000). Fire-killed trees provide an important and continuing supply of large woody debris to many aquatic systems, which is an essential habitat feature for many salmonid and other aquatic species. While such disturbance events may have negatively affected individuals of some TEPS populations, the overall effects on species population viability are less likely to have been adverse in nature.

The effects of wildland fires on terrestrial and aquatic species can vary depending on fire occurrence, intensity, severity, uniformity, size, and season. The effects of fire may be both direct and immediate, as well as indirect and sustained over an extended period (Minshall and others 1989; Niemi and others 1990; Smith 2000). Some impacts may result in short term habitat loss, but long-term habitat enhancement. For example, fires may destroy some northern goshawk nest sites. However, these same fires may also create the habitat mosaics that enhance goshawk habitat. Species with limited ranges or low population numbers may be more vulnerable. For example, adverse effects to fish populations have been limited to areas where native fish populations have declined and become increasingly isolated because of human activities (Gresswell 1999).

The analysis in the FEIS showed that some types of past timber harvest and the effectiveness of past wildland fire suppression have caused significant ecological shifts in vegetation, fuel loading, and fire regimes in some areas, increasing the risk of high-intensity, large-scale, stand-replacing fires in many areas. However, as previously discussed in the Fuel Management section, there appear to be minimal landscape level differences between alternatives, relative to the likelihood of timber harvest providing significant reduction in the risk of uncharacteristic wildland fire effects in inventoried roadless areas, at projected harvest levels. There is also a lack of current scientific literature addressing the feasibility, effectiveness, and ecological legacies of landscape-level fuels reduction efforts.

Regardless of the alternative selected, wildland fires of increased severity and size will continue to impact habitat for some species. While wildland fires may negatively affect individuals in some TEPS populations, the overall effects on population viability are less likely to be adverse in nature. None of the alternatives would preclude the use of other restorative tools like prescribed fire, which under some conditions can be used without prior thinning, to benefit early seral and open forest species.

Summary of Effects – Based on the information provided by each national forest, the need for road construction or reconstruction for recovery or protection of TES species appears to be minimal. Alternate means of access could likely be found to accomplish recovery or conservation objectives. With the exception provided in the proposed rule that an existing road may be realigned to prevent irretrievable resource damage, adverse effects to TEPS and other species from existing roads may be mitigated.

As previously discussed, the prohibition of timber harvest could be waived to permit needed for recovery or conservation of TEP species. This alternative would prohibit timber harvest that may be desirable to enhance or restore habitat for some sensitive species at the local level. However, it is unlikely that this inability would represent a substantial change in the overall level of risk to continued species viability from that expected under the No Action Alternative. Overall, this alternative would be beneficial to conservation of TEPS species and biodiversity.

Effects of Social and Economic Mitigations on Biodiversity Common to Alternatives 2, 3, and 4:

Several social and economic mitigation measures, in the form of exceptions to the prohibition on road construction and reconstruction in Alternatives 2, 3, and 4, were developed as a result of public comment on the DEIS. If selected as part of the final rule, these exceptions would allow the responsible official to authorize road reconstruction for public health and safety purposes, or road construction or reconstruction for Federal Aid Highway projects or permitted mineral leasing activities.

It is important to note that these exceptions in themselves would not authorize any activities, such as leasable mineral extraction, but rather would waive the prohibition on road construction or reconstruction for permitted activities in the specified categories. Rather than being automatically granted, proposals under these exceptions would have to meet certain conditions in order to be authorized, to assure that impacts to roadless characteristics are minimized, as described in Chapter 2 of the FEIS.

As is currently the case, all road construction or reconstruction projects, and the activities associated with them, would be subject to the requirements of applicable statutes and regulations, including the National Environmental Policy Act and the applicable land management plan standards and guidelines. Any projects that may affect threatened or endangered species would be subject to the consultation requirements of the Endangered Species Act.

These exceptions would decrease the number of miles of road construction and reconstruction that would be affected by the roads prohibition over the next five years by 76 miles (none of which would be on the Tongass). This would therefore increase the miles which would likely go forward to 369 (673 miles with the Tongass exemption) for Alternatives 2, 3, and 4. The effects of road construction associated with these exceptions would be similar to those previously described and is included under Alternative 1. The beneficial effects related to the prohibition on road construction under Alternatives 2, 3 and 4 would therefore be somewhat less than previously described, given the greater number of road miles that would likely be constructed, and the effects of the activities associated with those roads.

There is no way to predict the amount or location of road reconstruction that would be excepted for reasons of public health and safety. Realignment or upgrade of roads would likely result in additional ground disturbance but it is unlikely that the environmental effects of such reconstruction would substantially expand the area affected beyond that of the original construction, especially given the current emphasis on environmentally sensitive design and use of best management practices. Such reconstruction could, however, result in substantial changes in the kinds and amount of human uses in an area with associated potential adverse effects on biodiversity as previously described. Provided that conservation of other roadless characteristics is given strong emphasis in the project design and mitigation, this reconstruction would not be likely to result in additional substantial long-term ecological changes.

Estimates of the miles of road construction which may be excepted for Federal Aid Highway projects over the next five years indicate that few additional miles would likely be constructed in inventoried roadless areas. There is no reason to anticipate a substantial increase in the future. Only one 6-mile project is currently planned on the Chugach National Forest. While this project may have local effects on the characteristics and values associated with the affected inventoried roadless area, this limited level of activity would not result in a substantial change in the overall environmental effects of the alternatives.

As currently projected for the next five years, requests for new leasable mineral activities in inventoried roadless areas are expected on six national forests, requiring an estimated 59 miles of road construction. Undoubtedly there would be additional activities on these and other forests in the future, in response to changing economic conditions and shifts in supply and demand for these resources. The types of activities that would be eligible under this exception include exploration and development of geothermal, oil and gas, coal, and phosphate resources.

There appears to be limited potential in the near future for geothermal development activity associated with inventoried roadless areas, based on data submitted by the national forests and grasslands. Only one forest anticipated lease applications in the next five years, with three miles of associated temporary road construction. Although the magnitude of effects from geothermal exploration and development would be dependent on a variety of factors, impacts from such activities do not currently appear to pose substantial or widespread risks to biodiversity from the projected level of activity. Geothermal exploration activity in many areas has been restricted in extent, and has often resulted in little disturbance to areas around drilling sites. As the location of drilling sites for exploration is often somewhat flexible, environmentally sensitive areas usually can be avoided (USDA and USDI 1994b).

Oil and gas exploration and development activity within inventoried roadless areas is anticipated on four national forests in the next five years, with an 34 miles of road construction. It appears that nationally, the demand for these resources is increasing. Therefore, there may be increases in the level of this kind of activity within inventoried roadless areas on these four forests and other NFS lands where these resources occur. The associated road systems would likely account for a substantial portion of potential environmental effects, including increased risk of spread and establishment of non-native plant species. Other effects of these activities would be determined by the location and size of areas disturbed, the duration of the activity, mitigation measures used for environmental protection including containment of toxic materials used in the drilling process, the type and effectiveness of site reclamation, and the overall level of exploration and development activity within an area.

Ten projects on two national forests were identified which would involve exploration or development of coal or phosphate resources, with an estimated 22 miles of road construction. These kinds of activities can have adverse effects to both aquatic and terrestrial species, some of which can be substantial and long term.

Many of the principal effects to biodiversity from mining are to aquatic systems. The potential hydrologic effects of mining, such as changes in timing and volume of runoff and alterations of water quality, depend in part on the size of the area affected, and the effectiveness of runoff and pollution control measures. While historically, the environmental effects of these kinds of activities have often been substantial, best management practices are being incorporated in project designs to moderate effects to the extent feasible, and ongoing monitoring is conducted to insure early detection of potential mitigation failure.

Although any mining activity may have negative effects on aquatic ecosystems, the largest impacts have generally been associated with surface mining. Surface mining activities can have a number of adverse effects to aquatic systems including changes in the timing and magnitude of runoff and stream flows, accelerated erosion and substantial increases in sedimentation, contamination of water with metals, acids or other toxic substances, and increased bank and streambed instability. Surface mining can also affect aquatic habitats by removing riparian vegetation and physically altering or encroaching on the stream channel (Lee and others 1997).

In general, surface mining causes higher stream flows and greater storm flow volumes than underground mining due to a greater amount of surface area disturbance with associated removal of vegetation and topsoil, greater amounts of spoils, and general compaction of the area (Southern Appalachian Man and the Biosphere 1996c). While stream channels can adjust to increased flows and sediment loads, such alterations can have adverse effects on the quality of aquatic habitat.

Coarse sediments delivered to channels are likely to be deposited relatively quickly, affecting nearby aquatic habitat. Finer materials settle out more slowly and may create turbid water conditions for long distances downstream, affecting primary production and biomass by reducing the amount of light available to algae and rooted aquatic plants. (Lee and others 1997). Increases in turbidity can cause direct mortality to aquatic species, reduce growth and feeding activity (Nelson and others 1991), and can affect the abundance and diversity of benthic invertebrates (Lee and others 1997). Excessive fine sediment deposition in stream substrates can degrade spawning habitat for salmonids, and eliminate habitat for some bottom dwelling aquatic species by filling in spaces in gravels. (Nelson and others 1991).

Acidification of surface waters can affect aquatic species by lowering pH to sub-lethal or lethal levels, mobilizing toxic metals, and forming noxious ferric hydroxide precipitates commonly called "yellow boy" (Nelson and others 1991). The effects of low pH can include direct mortality, reduced growth rates, reproductive failure, skeletal deformities, and increased uptake of toxic metals. The early life stages of many aquatic species, including mollusks and fish, are often more sensitive to toxic metal contamination than are adult stages. Acidification can affect biodiversity by eliminating species sensitive to low pH and favoring the proliferation of those species that have a greater tolerance. It can also reduce overall population density and total biomass. (Nelson and others 1991).

Some mining activities can result in adverse effects to terrestrial species. Mining activities can fragment and degrade habitats, and disrupt, disturb and or displace some species. Mitigation measures are often developed to moderate these adverse effects. In some cases, these can be short-term adverse effects that end when the activities are discontinued. Conversely, these activities can result in long term adverse effects if activities persist for extended periods or occur during critical life-cycle periods. The Grizzly Bear Recovery Plan (USDI 1993) encourages consideration of grizzly bear habitat needs and phasing-in of road density guidelines to make mining exploration and development compatible with bear habitat requirements. The Lynx Conservation Assessment and Strategy (USDA and others 2000) identified several risk factors from mineral developments. The strategy states "most of these activities affect lynx habitat by changing or eliminating native vegetation, and may also contribute to fragmentation". The primary effects of leases and mines on lynx are probably related to the potential for plowed roads to provide access for lynx competitors, particularly coyotes.

Summary - Environmentally, application of the social and economic mitigation measures to the prohibition alternatives would diminish the potential beneficial effects of a prohibition on road construction and reconstruction, given the greater amount of area disturbed and the kinds of activities enabled. Depending on a variety of factors, leasable mining activities supported by road access could potentially have detrimental effects to aquatic and terrestrial habitats and species. At current levels of activity and given the application of best management practices, the potential extent of these activities and their impacts do not appear to be widespread and it is unlikely that most effects from individual projects would extend much beyond local levels. However, the effects associated with these roads and the activities enabled would measurably contribute to the overall level of cumulative adverse effects to biodiversity associated with loss of habitat quality and quantity, increased levels of habitat fragmentation, and overall levels of disturbance in these areas, contrary to meeting the stated purpose and need for this project.

If this exception is included as part of the final rule, decisions on whether to permit such activities, and if so, what environmental mitigation measures would be required, would be made using current planning and decision-making processes. Overall, even with application of these measures, Alternatives 2, 3, and 4 would still provide some important benefits relative to conservation of biological diversity.

Cumulative Effects on Biodiversity

Overview of Findings Relative to Cumulative Effects

The cumulative effects of the prohibitions, and past, present, and reasonably foreseeable actions on biodiversity were considered in this analysis for several time intervals and geographical scales. Short-term effects were considered to occur in the next 5 years. Long-term effects were considered generally to be two or more land management planning cycles (30 to 40+ years). Where applicable the cumulative effects were assessed at local, regional, and national scales, including local inventoried roadless areas, all NFS lands, regions of the United States, and the entire United States. Various land ownership patterns and land designations were also considered.

Several ecological and biological resource indicators described in Chapter 3 of the FEIS were used to assess the cumulative effects of the prohibitions, land uses and conversions, laws, regulations, policies, and nonnative species invasions on biodiversity. Resource indicators used were the habitat and population trends for terrestrial and aquatic plant and animal species, and communities (including TEPS) and landscape characteristics.

Based on current literature (Flather and others1999; Noss and Cooperrider 1994; Stein and others 2000) and data from Forest Service regions, it is possible to conclude that with or without conservation of inventoried roadless areas, biodiversity is at an increased risk of adverse cumulative effects from increased population growth and associated land uses, land conversions, and nonnative species invasions. Conservation of inventoried roadless areas which would be provided by the alternatives, however, may lessen this risk at least in the short term (20 years) by reducing the level of potential adverse impacts on inventoried roadless areas, which are some of the last relatively undisturbed large blocks of land outside of designated Wilderness.

The action alternatives would increase conservation of inventoried roadless areas and therefore could have beneficial effects on biodiversity conservation at the local, regional, National Forest System, and national levels. There would be similar incremental beneficial effects on biodiversity conservation when any one of the prohibition alternatives is combined with the past, present, and reasonably foreseeable land uses and conversions, laws, regulations, policies, and nonnative species invasions. The local, regional, and national cumulative beneficial effects could include:

- Conserving and protecting large contiguous blocks of habitat that provide habitat connectivity and biological strongholds for a variety of terrestrial and aquatic plant and animal species including TEPS species.
- Providing important local and regional components of conservation strategies for protection and recovery of listed TEPS species.
- Providing increased assurances that biological diversity would be conserved at a landscape level, including increased area of ecoregions protected, improved elevational distribution of protected areas, decreased risk associated with timber harvest and road caused fragmentation, and maintenance and restoration of some natural disturbance processes.

- Providing increased assurance that biodiversity would be supported within inventoried roadless areas including the maintenance of native plant and animal communities where nonnative species are currently rare, uncommon, or absent.

The value of inventoried roadless areas in conserving biodiversity is likely to increase as habitat loss and habitat degradation increase in scope and magnitude. With these increasing trends, the importance of roadless area conservation and other laws, regulations, and policies relevant to the management and conservation of biodiversity is also likely to increase.

The action alternatives when considered alone may not be as important on a national level as when considered in combination with other land conservation laws, policies, and strategies. For example, many inventoried roadless areas in combination with Wilderness Areas, Nature Conservancy Preserves, some National Forest System land allocations, national parks, or conservation easements provide large contiguous habitat blocks with national significance for biodiversity conservation.

The beneficial effects of the prohibitions may be most noticeable at an inventoried roadless area, regional, or NFS level, but there are also beneficial effects for the United States. For instance, in the Southeastern United States, because of the magnitude of land use and land conversion, and the relatively small size of existing protected areas, inventoried roadless areas are especially important for local species like the Louisiana black bear. Similarly, inventoried roadless areas in some areas of the Forest Service Intermountain and Northern Regions of the Western United States, contribute to habitat connectivity, which is an important feature of northern Rocky Mountain ecosystems for species like the grizzly bear, wolf, and lynx. In these examples, the local protection and conservation of T&E species habitat is also important in terms of conserving biodiversity at a national level.

Whether the cumulative beneficial effects of the prohibitions and other past, present and reasonably foreseeable actions would fully offset predicted future increases in land uses, land conversions, and nonnative species invasions is difficult to assess. Yet, it is possible to conclude that without the prohibitions, there would likely be an increased risk of adverse cumulative effects to biodiversity. When compared to the No Action Alternative, the prohibition action alternatives would help conserve management options over the next 20 or more years, so society would have time to make deliberate choices on biodiversity conservation.

At some point in the future, projected habitat loss and degradation from the direct and indirect effects of increasing population growth in other areas could potentially surpass the contribution of inventoried roadless areas to biodiversity conservation. In this scenario, habitat loss and loss of viable plant and animal populations may be of a magnitude such that the beneficial effects of the prohibitions and other laws, regulations, and policies relative to biodiversity conservation may be lost or overwhelmed. Even under this scenario, inventoried roadless areas would still likely convey some beneficial effects relative to conservation of individual species locally, regionally, and nationally.

Cumulative Effects Analysis

Cumulative effects are the "incremental effect of the action when added to other past, present, and reasonably foreseeable future actions" (40 CFR 1508.7).

Biological diversity or "biodiversity" refers to the variety and abundance of species, their genetic composition, and their communities (Wilson 1988).

1. Factors Affecting Biological Diversity

Protecting areas from the effects of human activities and disturbances is an essential part of biodiversity conservation (Wilson 1985, Noss and Cooperrider 1994). Wilcove and others (2000) identified habitat degradation and loss, non-native species, pollution, overexploitation, and disease as the primary threats to biodiversity. Noss and Cooperrider (1994), and Flather and others (1999) portray increasing human population growth and consumption of resources as ultimate threats, and habitat fragmentation, roads and global warming as intermediate threats to biodiversity.

Inventoried roadless areas generally have fewer human activities and human disturbances than roaded areas, and therefore are an important consideration in biodiversity conservation. The cumulative effects of the roadless area conservation action alternatives, and other past, present and reasonably foreseeable future actions on important resource indicators of biodiversity were considered in this cumulative effects analysis. The biodiversity resource indicators used are summarized below:

- ***Species habitats and populations:*** Habitat and population trends for terrestrial and aquatic plant and animal species, and communities including, threatened, endangered, proposed, and sensitive species (TEPS).

- ***Landscape characteristics:*** The distribution and representation of ecoregions and elevational classes; the size of relatively large and intact habitat areas, and adjacency to other protected habitats; the effects of large-scale landscape fragmentation in relation to lands with protected or conservation status; and the relationship of landscape patterns to past and present fire regimes.

2. Analysis Methods – Local, regional, National Forest System (NFS), and national trends of four interrelated factors were used to assess direct, indirect, and cumulative affects on biodiversity. These factors are land uses, land conversions, laws, regulations and policies, and establishment of non-native species. These factors drive changes in biodiversity at various time intervals and geographical scales. They are influenced by various actions, activities, and trends (measures) that act upon the environment to change baseline (current) biodiversity conditions towards some future condition. In this report, the measures used are listed following each factor, and are qualitative and/or quantitative in nature depending on the information or data currently available in the literature or existing databases. An attempt was made to describe each measure at inventoried roadless area, National Forest System (NFS), and national levels. However, in some cases, information was not available for each spatial level, nor was it deemed essential.

Land Use – Habitat and landscape changes from the direct, indirect, and cumulative effects of human activities such as road construction and use, timber harvest, mineral exploration/extraction, and recreation. Some changes may result in habitat loss and degradation, and/or species disruptions and disturbances. Other changes may improve and/or enhance habitats.

Measures considered:

- Road construction and reconstruction miles
- Timber harvest levels
- Wildfire acres resulting from past land use activities
- Species habitat and population trends
- Landscape fragmentation
- Recreation use and demand
- Social and economic values - conservation and consumerism
- Population growth and demographic shifts

Land Conversion – Habitat and landscape conversions (to parking lots, subdivisions, agricultural lands, and other types of human developments) are increasing in the U.S. Some habitat conversions may benefit some species, especially those species associated with rural environments, edges, and early seral habitats. Conversely, land conversions often result in irreversible habitat loss/degradation for many species and can cause habitat avoidance of adjacent available habitat or displacement of species from available habitat to other less disturbed habitats.

Measures considered:

- Population growth and demographic shifts
- Land development trends
- Species habitat and population trends
- Landscape fragmentation
- Land ownership patterns
- Social and economic values - conservation and consumerism
- Road construction and reconstruction miles

Laws, Regulations and Policies – The size, distribution, and quality of landscapes, species habitats, and plant and animal populations are significantly influenced by laws, regulations and polices affecting National Forest System (NFS) lands, and other federal and non-federal lands. Future laws, policies, and regulations (dictated by social and economic values) will likely change over the next 20 years, and will influence biodiversity.

Measures considered:

- Landscape patch (size) considerations
- Ecoregion distribution of protected and conserved areas
- Elevational distribution of protected and conserved areas
- Social and Economic Values - conservation and consumerism

- Recreation demand
- Road construction and decommissioning miles
- Timber harvest levels
- Species listings under ESA
- Population growth and demographic shifts

Non-Native Species – Habitat loss and degradation, and adverse effects to native species viability from the invasion and/or encroachment of non-native plant and animal species is increasing. These species are a primary threat to biodiversity.

Measures considered:

- Non-native species habitat and population trends
- Trends in species listings under (1) Endangered Species Act as threatened and endangered, and (2) Natural Heritage databases as imperiled[4] species (Natural Heritage Programs 2000)
- Road construction and reconstruction miles
- Timber harvest levels
- Wildfire acres resulting from past management activities
- Landscape fragmentation

The Biodiversity, Recreation, Timber Harvest, Minerals and Geology, and Fuels Management sections of the FEIS further describe the measures and factors including related actions and trends that can influence biodiversity.

3. Affected Environment

Spatial Scale

Inventoried roadless areas comprise about 58.5 million acres (about 49.2 million acres without the Tongass NF) or about 31% of National Forest System (NFS) lands, including portions of 120 National Forests and Grasslands (with the Tongass NF). Thirty-eight states, including Alaska have NFS inventoried roadless areas within their boundaries. The NFS inventoried roadless areas represent about 2% of the total land base of the United States, and provide relatively large blocks of intact landscapes, especially when considered in combination with designated wilderness areas and other protected areas.

Landownership has implications on biodiversity because of the various roles different landowners play in biodiversity conservation. According to Groves and others (2000), the U.S. government administers roughly 20 percent (400 million acres) of the land in the U.S. (excluding Alaska). A significant portion of this federal land is in the western U.S.

[4] **G1** Highly globally rare. Critically imperiled globally because of extreme rarity (typically 5 or fewer estimated occurrences or very few remaining individuals or acres) or because of some factor(s) making it especially vulnerable to extinction. **G2** Globally rare. Imperiled globally because of rarity (typically 6 to 20 estimated occurrences or few remaining individuals or acres) or because of some factor(s) making it very vulnerable to extinction throughout its range.

For example, the federal government administers more than 80 percent of the state of Nevada. The role of federal agencies in conservation of biological diversity is significant because of the amount of land it administers. The Forest Service has an important role because NFS lands cover almost 10 percent of the U.S. (excluding Alaska). State and local governments administer significant acreages variously designated as state parks, wildlife management areas, state forest, or state natural resource areas covering about 5 percent (108 million acres) of the U.S. landbase. Private lands account for approximately 60 percent of the land base.

Temporal Scale

The intent of inventoried roadless area conservation is to maintain associated characteristics and values of these areas for future generations. The prohibitions would help maintain conservation management options for the future, given the level of conservation provided by past, present and reasonably foreseeable policy, forest plans, and other protected land designations now and in the future. Biodiversity conservation at local, regional and national scales would be more likely with the prohibitions. The temporal extent of beneficial cumulative effects to biodiversity is speculative, but could continue well into the future.

Given that the United States population is estimated to increase from 278 million in 2000 to almost 380 million in 2040 (U.S. Department of Commerce, 2000), there will likely be associated substantial losses of habitat, and habitat degradation on non-NFS lands (and potentially more loss on NFS lands depending on social and economic values). In light of this increased population growth, the importance of NFS lands, including inventoried roadless areas (individually and in combination with other protected areas) in providing and maintaining biological diversity and species conservation is likely to increase as well.

It is important to recognize that, at some point in the future, projected habitat loss and degradation, increased urbanization, deleterious land uses and conversions, and other direct and indirect effects of population growth could potentially outweigh the contributions of inventoried roadless areas in supporting biodiversity conservation. In this scenario, habitat loss and loss of viable plant and animal populations may be of a magnitude such that the beneficial effects of the prohibitions relative to the conservation of native biodiversity may be lost or overwhelmed. However, even under this scenario, inventoried roadless areas would likely still convey some beneficial effects relative to conservation of individual species.

Ecoregions

Areas with similar ecological communities and dynamics are referred to as ecoregions. They are ecosystems of regional extent, which are distinct from their neighbors in terms of environmental conditions and groupings of species and ecological communities (Stein and others 2000).

National

- Forty-five of 83 ecoregions in the contiguous U.S. and Alaska have more that 100,000 acres of NFS lands that contain inventoried roadless areas.
- Sixteen ecoregions that contain more than 100,000 acres of NFS lands in the continental U.S. have been assigned a status of globally outstanding (Ricketts and others 1999).
- In the east, less than 8 percent of globally outstanding ecoregions are currently conserved; well below recommendations of Noss and Cooperrider (1994) and the World Commission on Environment and Development (1987).

<u>*Fragmentation*</u>

Habitat loss and fragmentation are among the most pervasive threats to the conservation of biological diversity (Wilcox and Murphy 1985). Human activities can fragment large, intact areas of forest into smaller separate (and some times isolated) patches that are poorly connected.

Inventoried Roadless Areas

- Habitat in inventoried roadless areas is generally less fragmented and better connected than in roaded areas of similar size.
- Road construction and timber harvest have affected an estimated 2.8 million acres of inventoried roadless areas in the past 20 years.

NFS Lands

- On NFS lands timber harvest activities and roads have contributed to increasingly fragmented landscapes.

National

- On a national level, fragmentation has increased dramatically over the past 20 years (Noss and Cooperrider 1994).

<u>*Size Considerations*</u>

There is a positive biodiversity relationship between size of a large, intact, relatively undisturbed areas and maintenance of biodiversity (MacArthur and Wilson 1967).

Inventoried Roadless Areas

- Inventoried roadless areas, including those over 5000 acres in size, can provide biological strongholds for many species including wide ranging carnivores and local endemics.

- There are over 2,800 inventoried roadless areas on NFS lands. Even though most of these are between 1,000 and 5,000 acres, most of the acreage occurs in the size class between 5,000 and 25,000 acres. In the east, there are about 90 percent fewer areas protected from road construction and reconstruction in the 5,000 to 25,000 acre size class than in the west.

NFS Lands

- On NFS lands, except for Wilderness areas, inventoried roadless areas are commonly the largest undisturbed (by human activities) blocks of habitats.
- A high percentage of inventoried roadless areas are adjacent to existing Wilderness. Almost 34% of the total inventoried roadless area acreage in the U.S. is adjacent to Wilderness areas resulting in a cumulative benefit to biological diversity.
- Close to 50 percent of these NFS lands (excluding Alaska) are designated as inventoried roadless areas, wilderness, national primitive areas or some other type of area with protective special designation.
- The NFS lands (191million acres) comprise almost 30 percent of federally owned lands (650 million acres) in the U.S. (excluding Alaska) (Bean 2000).

National

- Nationally, inventoried roadless areas in combination with wilderness areas conserve some of the largest blocks of large, intact, relatively undisturbed habitat.

Elevational Distribution

The conservation of habitat types across all elevational classes increases the probability that biological diversity will be conserved.

Inventoried Roadless Areas

- Inventoried roadless areas occur across all elevational classes. Inventoried roadless areas occur primarily below an elevation of 6,000 feet in Alaska; from 1,000 to 3,000 feet in elevation in the eastern U.S.; and above 6,000 feet in the western U.S.

NFS Lands

- NFS lands occur across all elevation classes, therefore encompassing a variety of habitat types and a diverse variety of plants and animals.

National

- Nationally, inventoried roadless area contributions are most significant to elevational class conservation at lower elevations, which encompass the largest area of land in Alaska, and the continental U.S., and have the least amount of area conserved (that is, under Wilderness, or other special designation).

Non-Native Species

Aggressive non-native species generally undermine biodiversity. Many areas that were historically rich in native plant and wildlife diversity now support hundreds of non-native species, many of which have had considerable detrimental ecological effects. Unfortunately, the ability to eliminate invasive species, once they are established, is often limited.

Inventoried Roadless Areas

- The extent of non-native populations in inventoried roadless areas is not known. However, lacking roads (a significant source of non-native species invasion) and many of the disturbances associated with them, inventoried roadless areas have more intact native plant and animal communities where non-native species are absent, rare or uncommon.
- As non-native species increase adjacent to the inventoried roadless areas, the likelihood of non-native species occurring in these areas increases, especially given natural disturbances and increased dispersed recreation (for example use of livestock hay).

NFS Lands

- Non-native species are increasing on NFS lands. It is estimated that 6 to 7 million acres of NFS lands are infested with non-native plant species (Lewis 1999). On BLM lands it is estimated that noxious weeds are spreading at over 2,300 acre per day, and on all western public lands at approximately 4,600 acres per day (USDI 1999). The extents of non-native animal species infestations are not known.

National

- The estimated number of established non-native species in the U.S. exceeds 6,200 (Williams and Meffe 1998), and is increasing. Non-indigenous weeds are spreading and invading approximately 700,000 ha/yr of the U.S. wildlife habitat (Babbit 1998)
- About 42% of the species on the Threatened and Endangered species list are at risk primarily because of non-native species (Pimental and others 1999). For instance, competition by non-native plant species is one of the leading causes for plant species being listed as endangered or threatened (Fay personal comm.).

Threatened, Endangered, Proposed, and Sensitive Species (TEPS)

Inventoried Roadless Areas

- Inventoried roadless areas provide or affect habitat for almost 60% of the proposed, threatened and endangered species found on or affected by NFS lands, representing approximately 25% of all animal species and over 10% of all plant species listed under the endangered Species Act within the United States. In addition, these areas affect almost 70% of Forest Service designated sensitive species.

NFS Lands

- It is estimated that over 400 proposed, threatened, and endangered and nearly 3,000 sensitive species[5] occur on NFS lands.

National

- The Nature Conservancy (Stein and Flack 1997) estimates that at least 110 species of plants and animals are known to be extinct in the U.S., and an additional 416 species are possibly extinct, with no recent documented occurrences.
- It is conceivable that the number of species in the United States that merit listing early in the 21st century may be 2 or 3 times that of the number currently listed (Wisdom and others 1999).
- On a national level, fish and aquatic species dominate the list of threatened and endangered animals species. Fish have been listed at a rate twice that of other vertebrates, while other aquatic species such as mussels are imperiled in a greater proportion relative to terrestrial species (Loftus and Flather 2000).

Species Habitat and Population Trends (Other than TEPS)

Inventoried Roadless Areas

- Many species occurring outside of inventoried roadless areas also occur within these areas. Because many inventoried roadless areas occur in the headwaters of larger watersheds, it is likely that they affect a substantial number of plant and animal habitats beyond their boundaries.
- Other than the 2.8 million acres of inventoried roadless areas that have been roaded in the past 20 years, the primary changes in habitat have been from natural disturbances such as wildfires. An average of 160,000 acres of inventoried roadless areas burn annually. This trend is expected to increase in the near future, but is uncertain to what degree. The impacts on plant and populations are not quantified. However, it is likely that species composition changes with changes in habitat.

NFS Lands

- Timber harvest activities have changed habitat compositions and structure over the past 20 years on NFS lands. The loss of late-successional or "old growth" forest habitats is an increasing concern (USDA and USDI 2000, Southern Appalachian Man and the Biosphere 1996c, USDA 2000i).
- Mid-seral, densely stocked forests are dominating many NFS landscapes (USDA and USDI 2000, Southern Appalachian Man and the Biosphere 1996c, USDA 2000).

[5] Individual salmonid Evolutionary Significant Units are each counted as one species for purposes of this analysis.

National

- Area shifts in land use from 1945 to 1992 have been less than 11 percent for the three major land uses that comprise 85 percent of the land area in the conterminous United States – namely forest land, rangeland and cropland (Flathers and others 1999).
- Rangeland and forest land in the U.S have declined from 1945 to 1992. Much of the decline in forest land reflects a change in management emphasis (parks, wilderness and others) instead of a change in forest cover (Flathers and others 1999).
- Cultivated croplands have declined by 7 percent; uncultivated croplands have increased by about 4 percent due to the enrollment of land in various Federal programs that retire acres from production (Flathers and others 1999).
- Urban land uses have more than doubled from 1945 to 1992 from almost 40 million to just over 80 million acres in 1992 (Flathers and others 1999).
- Federal and State parks, wilderness areas, wildlife areas, national defense areas and miscellaneous farmlands have almost doubled from 1945 to 1992 from slightly over 60 million to almost 112 million acres (Flathers and others 1999).
- Based on land use and land cover trends, it is likely that species that tolerate intensive land use activities, agricultural habitats would increase. Species associated with grassland and early seral forest habitats and wetlands would decrease (Flathers and others 1999).
- Nationally big game populations have increased substantially since 1975. Small game species associated with rangelands and agricultural habitats show evidence of decline, while species associated with forest habitats show mixed trends (Flathers and others 1999).
- Seventy percent of the U.S. river miles, lake acres, and estuarine area can support the “Aquatic life use” designated under the Clean Water Act. However, significant physical alternations in water bodies and watercourses have greatly altered habitat availability and water quality. Improved water quality trends have been identified from 1980 to 1989 for many sites in the U.S. (Loftus and Flather 2000).
- In the U.S., increased turbidity is one of the most significant threats to the quality of aquatic habitat. The EPA found that the sediment contamination exists in every region and every state of the country. More than two-thirds of the 1,363 watersheds survey by EPA has fish consumption advisories and seventy percent of the watersheds surveyed by EPA were classified as “Areas of probable concern” (Loftus and Flather 2000).
- Wetlands have decreased from 221 million to slightly more than 100 million since European colonization. The rate of wetland loss has declined overall with urbanization and associated activites the principal threat to wetlands (Loftus and Flather 2000).

Population growth and demographic shifts
Land Uses and land Conversions

National

- The number of people in the U.S. has grown about 1 percent per year since 1980, and it continues to increase at a steady rate. Since 1990, the U.S. population has increased 10.4 percent (USDC Bureau of the Census 2000).
- The most significant populations increases have occurred in the southeast, south central, and pacific southwest parts of the U.S. (USDC Bureau of the Census 2000).
- By the year 2040, the U.S. population is expected to increase by 37.4 percent to a total of 377.4 million people (USDC Bureau of the Census 2000).
- The average age of the population is increasing. By 2040, nearly one-quarter of the American population will be over 65, compared to 12 percent in 1990.
- An average of 3.2 million acres per year were developed between 1992 and 1997, in comparison to 1.4 million acres per year between 1982 and 1992. The rate of land development between 1992 and 1997 was more than twice the rate in the previous decade, while the population growth remained constant.
- On non-federal lands, forest, pasture, rangeland, and cropland continue to be converted to urban and built up areas and rural infrastructure.
- Land conversion from non-federal undeveloped to developed uses has not been evenly distributed across the U.S. Most of the development between 1982 and 1997 has been concentrated in the eastern U.S.

Recreation Demand

NFS Lands

- It is estimated that in the long-run approximately 100 million acres of the NFS would be unroaded, including designated Wilderness, inventoried roadless areas, roadless areas created through road decommissioning and obliteration, and forest plan decisions that restrict road construction in some areas.
- Prohibitions on road construction in a substantial portion of NFS lands would put increasing recreation pressure on currently roaded forest areas.

National

- The fastest growing outdoor recreation activities are non-consumptive wildlife, visiting historic places, sightseeing, downhill skiing, developed camping, and snowmobiling.
- The outdoor recreation user profile of the future will be older, increasingly diverse, and more international.
- The U.S. population is shifting in large numbers to California and the Southeast (USDC Bureau of the Census 2000).
- Demand will increase for amenity and ecological values of resources such as open space, clean air and water, abundant fish and wildlife populations, opportunities for personal renewal, and escape from urban environments.

Timber Harvest

Inventoried Roadless Areas

- Nationwide, approximately 1.1 BBF of timber could be offered within inventoried roadless areas from 2000 to 2004. It would be necessary to construct or reconstruct about 445 miles of classified road, and about 177 miles of temporary road to harvest about 800 million board feet (MMBF).
- The estimated volume of 1.1 BBF could be reduced by as much as 30 percent before harvest due to results of site-specific analyses, statistical variations in inventories and volume estimates, NEPA process delays, litigation, or difficulties in completing the sale preparation process.
- Using fiscal year 1998-99 national timber harvest volumes and total acres harvested adjusted by region, approximately 90,000 to 95,000 acres could be harvested within inventoried roadless areas from 2000 to 2004.

NFS Lands

- Of the 93 million acres of commercial forestlands in NFS lands, an estimated 47 million acres (51 percent) are considered suitable for timber production.
- The volume of timber sold from NFS lands declined from more than 11 BBF in 1987 to 2.2 BBF in 1999. The average annual volume sold from 1993 to 1999 was 3.2 BBF.
- The Tongass NF would offer nearly half of the national 2000-2004 timber sale program within inventoried roadless areas, 539 MMBF from approximately 14,000 acres.

National

- Of the 747 million acres of forestland in the U.S., about 490 million acres are considered commercial forest lands. About 72 percent of all commercial forestland is found in the eastern U.S.
- Private lands account for 71 percent of the total commercial forestland. National Forests account for another 19 percent of the total commercial forestland.
- The volume of timber on all forestlands has been increasing since 1952.

Road construction and reconstruction

Inventoried Roadless Areas

- An estimated 1160 miles of permanent and temporary roads would be constructed or reconstructed in inventoried roadless areas over the years 2000 to 2004. An estimated 366 miles would potentially be closed after planned use (includes 178 miles of temporary roads).

- Projecting future road entry using historic levels of road construction, an additional 5 to 10 percent of inventoried roadless areas would likely to be entered within the next 20 years without a prohibition on road construction and reconstruction.

NFS Lands

- The Forest Service maintains and administers approximately 386,000 miles of roads on NFS lands. In 1944, the FS estimated that there were 100,000 miles of roads on NFS lands.
- Over the past decade, road construction on all NFS lands has declined by 85 percent, from a high of 1,315 miles in 1991 to a low of 192 miles in 1999. The majority of these roads were built to support timber harvest activities. During the same time period, about 2,660 miles of roads were decommissioned each year.

Fire and Fuels

Inventoried Roadless Areas

- Currently an average of 160,000 acres of inventoried roadless are projected to burn annually. Of all acres burned, 93% is from large (1,000 acres or more) wildfires.
- Approximately 19, 14 and 8 million acres – in all fire regimes- of total inventoried roadless areas across the country have been identified as Condition Class 1 (low risk), 2 (moderate risk) and 3 (high risk), risk from uncharacteristic effects of wildland fire.
- In inventoried roadless areas, an estimated 90,000 to 95,000 acres of hazardous fuels (condition classes 2 and 3) could be treated in the next 5 years by traditional and timber stewardship harvest methods.

4. Cumulative Effects of the Prohibitions, and Past, Present and Reasonably Foreseeable Future Actions on Biological Diversity

The Forest Service recognizes that the inventoried roadless area prohibitions together with past, present and reasonably foreseeable land uses, land conversions, laws regulations and policies, and non-native species invasions could have cumulative effects on these two aspects of biodiversity:

- ***Species habitats and populations:*** The habitat and population trends for terrestrial and aquatic plant and animal species, and communities including, proposed, threatened, endangered, and sensitive species (TEPS).

- ***Landscape characteristics:*** The distribution and representation of ecoregions, and elevational classes; the size of relatively large and intact habitat areas, and adjacency to other protected habitats; the effects of large-scale fragmentation in relation to lands with protected or conservation status; and the relationship of landscape patterns to past and present fire regimes.

The incremental contribution from the action alternatives to cumulative effects on biodiversity was complicated to assess because of the national scope of the alternatives and effects. There are uncertainties on how biodiversity will be affected by future laws, regulations, policies, land uses and land conversion on private, state, and other federal and Tribal lands. However, based on the current literature, national assessments (Noss and Cooperrider 1994, Flathers 1999 and Stein and others 2000), and data from Forest Service Regions and National Forests, it was possible to conclude that with or without conservation of inventoried roadless areas, biodiversity is at an increased risk of adverse cumulative effects. Conservation of inventoried roadless areas, however, may lessen this risk for a period of time by reducing the level of potential adverse impacts to some of the last relatively undisturbed large blocks of land outside of designated wilderness.

The importance of inventoried roadless areas relative to these risks depends on the scale (inventoried roadless areas, regions, NFS lands or national) used to describe the cumulative effects. Individual inventoried roadless areas may provide important habitat for local endemic species or important linkages between habitats. Stepping up to a regional and NFS level where several thousands to millions of inventoried roadless acres occur, the importance of these areas is likely to increase, especially if there are few lands with protected or conservation status. For instance, in the southern U.S. (530 million acres) where conversion to urban land is most evident, the cumulative effect of inventoried roadless area protection (947,000 acres) is substantial as refugia for many plant and animal species. These local benefits have national level implications. For example, the substantial contribution of inventoried roadless area to grizzly bear recovery in the northern Rockies ecosystem has national implications in terms of threatened and endangered species conservation, biodiversity conservation, and societal values.

Action Alternatives 2, 3 and 4 – When compared to the No Action Alternative, these three alternatives would have similar effects. The magnitude of their value, importance, and cumulative benefits would vary locally, regionally nationally. Nevertheless, there would be similar cumulative effects on species habitats and populations, and landscape characteristics when Alternative 2, 3 or 4 is combined with other past, present and reasonably foreseeable future actions, including the effects of land uses, land conversions, laws regulations and policies, and nonnative species invasions.

The roads prohibitions would be the same in all alternatives. Some timber harvest would likely occur under Alternatives 2 and 3, and would essentially be of similar magnitude. Alternative 4 would prohibit timber harvest activities except for meeting threatened and endangered species objectives. The effects of this prohibition on timber harvest would be reductions of more than a billion board feet of timber volume from NFS lands, and approximately 90,000-95,000 acres harvest over five years. From a national perspective, this would be less than 10 percent of the five year projected timber harvest nationally on NFS lands. There might be some local adverse effects from wildfires, insect, and disease and other related indirect effects (for example, short term reductions water quality after large, catastrophic wildfires) without the timber harvest allowed in Alternatives 2 and 3. For example, disruptions in fire regimes affect 14 percent of federally listed species according to Wilcove and others (2000). The timber harvest exception in alternative 4 for threatened and endangered species would likely offset some of these potential adverse effects.

Land Uses and Land Conversions – Habitat degradation and habitat loss, including the effects of fragmentation, are primary threats to biodiversity (Wilcove and others 2000). These threats are likely to increase as human populations expand. According to the U.S. Department of Commerce, Bureau of the Census (2000), the number of people in the U.S. has grown about 1 percent per year since 1980, and it continues to increase at a steady rate. Since 1990, the U.S. population has increased 10.4 percent to more than 380 million people. Similarly, the rate of land development in the U.S. has increased. Between 1982 and 1992, land development was 1.4 million acres per year compared to an average of 3.2 million acres per year between 1992 and 1997. Much of this land development activity between 1982 and 1997 has been concentrated in the eastern U.S.

Landownership can indirectly affect land uses and land conversion trends and patterns. For example, according to Wilcove and others (2000), agriculture effects and land conversions for commercial development are the leading causes of habitat loss/alteration in the U.S. An overwhelming majority of these agricultural and commercial development effects occur on private lands. The important role of private lands in biodiversity management is reflected in the fact that private lands harbor about one-quarter of the documented populations of both imperiled and endangered species (Groves and others 2000).

The influences of agriculture, mining, oil, gas and geothermal exploration and development, logging, infrastructure development, and urban and commercial development are among the most significant types of land uses and land conversions affecting biodiversity (Groves and others 2000). These activities can result in significant changes in land cover types. For example, Flathers and others (1999) reported substantial increases (almost 24 percent from 29 million acres to 36 million acres from 1982 to 1992) in urban areas, especially in the southern U.S. In 1992, forest cover had decreased 30% compared to the time of European settlement. Almost 6 million acres of forest cover were converted to urban and transportation (for example roads) lands between 1982 and 1992. The impacts of this habitat loss are significant given that an estimated 90 percent of resident and common migrant vertebrate species in the U.S. use forest habitats to meet at least part of their life requisites (USDA 1979).

Land conversion and land use trends are affecting plant and animal populations, and threatening many threatened and endangered species. Based on land use and land cover trends, Flathers and others (1999) concluded that it is likely that species populations that tolerate intensive land use activities and agricultural habitats would increase. Species populations associated with grasslands, early seral forests and wetlands would decrease. Wilcove and others (2000) concluded that conversions to agricultural land uses affect the greatest number of species listed under the Endangered Species Act (38 percent), followed by commercial development (35 percent) and outdoor recreation (27 percent)). Flathers and others (1999), and Wilcove and others (2000) identified habitat loss as the most widespread threat to endangered species. They estimated that more than 85 percent of listed species were affected by habitat loss. It is conceivable that the number of species in the United States that merit listing early in the 21st century may be 2 or 3 times that of the number currently listed (Wisdom and others 1999).

In the future, the growing U.S. and global human population will demand more products from natural resources on NFS and non-NFS lands. This demand is exemplified by the U.S. accounting for about one-third of the total reported global materials consumption (by weight) in 1995, although the U.S. populations accounts for only 5 percent of total world population (Cinnamon and others 1999). Non-NFS lands will be a significant source of products and materials, but it is likely that there will be increased pressure to make use of timber, mineral, recreation, water, and other forest resources on NFS lands. This demand for NFS commodities (for example timber and mineral products, and recreation uses) will likely be concurrent with an increasing demand for conservation of biodiversity (and other ecological values, as well as demands for open space, opportunities for personal renewal, and escape from urban environments) on a finite NFS land base.

Cumulatively, the projected increasing trends in deleterious land uses and land conversion are likely to adversely affect many species habitats, populations, and communities. In addition, landscapes are likely to become more fragmented and disjunct resulting in increased risks to biodiversity. The action alternatives will likely decrease the short-term (5 to 20 years) risks by conserving inventoried roadless areas - the biological strongholds for many species, including many TEPS species; and some of the last remaining large, intact landscapes outside of designated wilderness areas. NFS lands, including inventoried roadless areas, are likely to become more important in future biodiversity conservation. The action alternatives would not result in an irreversible commitment of resources, but rather would help conserve management options over the next 20 years or longer, allowing society more time to make choices on biodiversity conservation.

Laws, Policies and Regulations – The laws, policies and regulations that govern use of public and private lands in the U.S play a significant role in the conservation of biodiversity. On federal lands (where large blocks of relatively undisturbed land still exist) and private lands (the largest U.S. landowner), laws policies and regulations can be especially significant in the management of biodiversity. For example, according to Groves and others (2000), one-third of populations for both federally listed and imperiled species are found on federal lands, which encompasses less than one-fifth of the land area. Private lands account for about one-quarter of the documented populations of both imperiled and endangered species and encompass 60 percent of the U.S. land area.

Local and state zoning decisions, forest practice acts, state wetlands regulation programs, private land tax incentives and habitat conservation plans all affect biodiversity (Groves and others 2000). The Wetlands Reserve Program, Forest Legacy Program, and 1996 Farm Bill combined have forestalled some development and suburban sprawl, thus maintaining future options for biodiversity conservation (Groves and others 2000). The Clean Water Act (CWA) and Endangered Species Act (ESA) are two principle laws that have resulted in increased regulation of land uses.

On NFS lands, the RARE II planning effort of the 1970’s, and more recent forest planning efforts of the late 1980’s and early 1990’s resulted in the designation of over 58 million acres of inventoried roadless area. The implication of this past conservation is evidenced at NFS, regional, and national landscape levels by the following examples:

- Comparing the distribution of inventoried roadless areas with centers of biodiversity identified in the Interior Columbia Basin Project (ICEBMP) (USDA and USDI 2000), an estimated 21 percent (1,650,000 acres) and 10% (2,800,000 acres) of these centers for animals and plants, respectively, overlap with inventoried roadless areas. In addition, almost 10 percent of the ICBEMP centers of endemism for animals and plants (2,780,000 and 1,370,000 acres, respectively) are contained within inventoried roadless areas.

- Inventoried roadless areas are contributing to the recovery of the grizzly bear. Almost 2.0 million acres of inventoried roadless areas occur within the estimated 23.0 million Grizzly Bear Recovery areas (USDI 1993). When combined with wilderness, an estimated 44 percent of the recovery areas are protected as large intact areas with habitat suitable for other large carnivores including lynx, wolves, and fisher. Some inventoried roadless areas are important linkages between grizzly bear recovery areas, and are important for the other large carnivores.

- Forty-five of 83 ecoregions in the contiguous U.S. and Alaska each have more than 100,000 acres of NFS lands that contain inventoried roadless areas. Fifteen ecoregions that contain more than 100,000 acres of NFS lands in the continental U.S. have been assigned a status of globally outstanding (Ricketts and others 1999).

- Nationally, inventoried roadless area contributions are most significant to elevational class conservation at lower elevations, which encompass the largest area of land in Alaska, and the continental U.S., and have the least amount of area currently conserved (that is Wilderness, or other special designation).

- On NFS lands, except for Wilderness Areas, inventoried roadless areas are commonly the largest undisturbed (by human activities) blocks of habitats. A high percentage of inventoried roadless areas are adjacent to existing Wilderness. Approximately 34% of the total inventoried roadless area acreage in the U.S. is adjacent to Wilderness areas, resulting in relatively large and intact blocks of land.

Management activities resulted in the roading of an estimated 2.8 million acres of inventoried roadless areas. The effects of this activity depended on the road locations and design, mitigation measures applied, and other activities that are associated with those roads. While roads may have some positive benefits, there are a number of risks to biological diversity from their construction, presence, and use. It is likely that the past 20 years of roading (and associated activities) in inventoried roadless areas has resulted in some level of habitat degradation (for example non-native species invasions) in some areas.

Past forest management (past 20 years) frequently emphasized commodity production at the expense of other resources, resulting in management of some biological resources (for example snags, riparian areas and spotted owl habitat areas) at "minimum" levels of habitat capability. Recent scientific study has indicated that some of this past management direction must be modified in order to conserve of some plant and animal resources. For example, recent research has indicated that past riparian buffer widths needed to be expanded to improve stream health (for example accommodate large wood recruitment and stream shading) for salmonid species, and past snag retention levels increased in some plant associations to meet the needs of some cavity dependant species like the white-headed woodpecker (Henjum and others 1994, USDA and USDI 1994a, USDA and USDI 2000).

More recent forest planning efforts have resulted in substantial changes in management direction and resource standards and guidelines, often emphasizing the conservation of biological resources and ecological sustainability instead of commodities production. For example, timber volume sold from NFS lands declined from more than 11 BBF in 1987 to 2.2 BBF, and road construction on NFS lands declined by 85 percent, from a high of 1,315 miles in 1991 to a low of 192 miles in 1999. The management and recovery of threatened and endangered species (for example, northern spotted owls and marbled murrelet in the Pacific Northwest) and changing social values that revere NFS lands for open space, clean air and water, abundant fish and wildlife populations, opportunities for personal renewal, and escape from urban environments, are primary reasons for the downward trends in timber harvest and road construction. The cumulative effect of this change in Forest Service management has been increased conservation of biodiversity on 10 percent of the U.S. land base that is NFS lands.

The Forest Service and other Federal agencies have a number of ongoing or recently finalized rulemaking and policy efforts, and regional planning efforts with implications to the prohibitions action alternatives.

The Forest Service NFMA Planning Regulations and the proposed Roads Policy would be complementary to the action alternatives. Overall, these three policy efforts combined are likely to have beneficial effects to biological diversity.

The Planning regulations combined with the action alternatives would likely result in additional conservation of inventoried roadless areas as land management planning processes address the public's interest in providing and conserving roadless characteristics and values. It is reasonably foreseeable that more inventoried roadless areas would be allocated to management uses that maintain their undeveloped roadless character under future land management plan revisions.

The proposed Roads Policy would provide an additional level of review and analysis to areas contiguous to inventoried roadless areas that is not provided by the prohibitions action alternatives. This policy would shift emphasis for transportation development to managing access within the capability of the land and within budgetary constraints. A possible result of the Roads Policy and the prohibitions would be larger contiguous blocks of unroaded (or lightly roaded) habitat; improved linkages between species habitats; secure areas where human disturbances are less than in adjacent roaded areas; and intact native plant and animal communities where non-native species are rare or uncommon.

The Cohesive Fire Strategy is a management framework for restoring and maintaining ecosystem health in fire adapted ecosystems primarily in the Western United States. At full program implementation, the strategy identifies a need for mechanical and/or prescribed fire treatment annually on 3 million acres in the West, and 1.2 million acres in the Eastern and Southern United States over the next 15 years. The Strategy does not advocate treating all acres at risk, or mandate where a specific fire hazard reduction project should take place.

The Cohesive Strategy would not identify or prioritize where treatments should occur, and inventoried roadless areas are not likely to be a high priority given wildland urban interface issues. Nevertheless, fuels management work could still occur in inventoried roadless areas, but the amount of work would probably be negligible in the action alternatives for at least the short term (20 years). Fuels treatment activities that did occur in inventoried roadless areas could beneficially affect biological diversity at least at a local level. However, the potential risks of fuels treatments (timber or non-timber related) would have to be weighed against the potential benefits.

Action Alternatives 2 and 3 allow for some timber harvest activities, and some could result in localized fuels reductions. For instance, the fiscal year 2000-2004 timber harvest program under Alternative 1 nationally, could treat approximately 90,000 acres of hazardous fuels in inventoried roadless area. Alternative 4 prohibits timber harvest activities except to meet specific TEP species objectives. Timber harvest to treat hazardous fuels in and around TEP species designated habitats (for, example core areas) is possible, however, the overall extent of fuels treatments would probably be substantially less that Alternatives 2 and 3. In any of the action alternatives, prescribed fire is an option for treating fuels. The inability to mechanically treat fuels prior to prescribed burning may limit the amount of acreage treated in some areas.

Overall, it is unlikely that very much fuels treatment (timber or non-timber related) would occur in inventoried roadless areas, at least for the next 20 years under any of the alternatives, including the No Action Alternative. Fuels treatment activities that did occur in inventoried roadless areas could beneficially affect biological diversity at a local level. However, the potential risks of fuels treatments (timber or non-timber related) would have to be weighed against the potential benefits.

The Forest Service Strategic Plan may be finalized prior to 2001. This plan states four broad strategic goals for the agency: (1) ecosystem health, (2) multiple benefits to people, (3) science and technical assistance, and (4) effective public service. The Chief's Agenda, which is tied directly to the Strategic Plan, identifies roads management as a key issue that needs to be addressed by the agency. The Roadless Area Conservation Rule and Roads Policy are intended to begin resolution of the important issue of roads management.

Regional and Forest Planning - The cumulative effects of various regional planning initiatives, forest plan revisions, and the action alternatives would vary depending on which regional, forest and prohibition alternatives are selected and/or implemented. For example, the decisions made in the Northwest Forest Plan (NWFP), and recommendations in the Lynx Conservation Assessment and Strategy (LCAS), in combination with the action alternatives would value large intact, unroaded areas, providing cumulative beneficial affects to biodiversity.

Land Management Plan Revisions - The Agency has 36 forests and grasslands that have published notices in the Federal Register of their intent (NOI) to revise or establish their land and resource management plans. At this time, four expect finalization during calendar year 2001. Only a few anticipate that they will publish a draft environmental impact statement in 2000. As other individual forests and grasslands initiate and complete their revisions, it is anticipated that their revised plans will change significantly in their goals, objectives, and amounts of projected outputs and uses. These changes will bring these plans more into alignment with the agency's current capacity and trends and with the public's demand for these changes.

Large-Scale Planning - The cumulative effects of the future decisions related to the Interior Columbia Basin Ecosystem management Plan (ICBEMP), Sierra Nevada Forest Plan Amendment (SNEPA), individual forest plan revision efforts and the action alternatives would vary depending on the alternatives selected for implementation. In some of the ICBEMP and SNEPA alternatives, wide-ranging restoration and/or commodity forest management activities are emphasized outside of inventoried roadless areas. With these alternatives, the conservation of inventoried roadless areas in the alternatives may become more important for the conservation of biodiversity. Other alternatives that emphasize precautionary adaptive management and/or protection and conservation would be more likely to conserve biodiversity outside of inventoried roadless areas, thereby complementing the potential beneficial effects of the action alternatives.

State, local and private land laws, regulation and polices will continue to play a significant role in the conservation of TEPS species and other aspects of biodiversity. It is likely that federal regulations (for example those for ESA and CWA) will become more pivotal in conserving biodiversity as population growth and associated land uses and land conversions place pressures on both NFS and non-NFS land management. In the short term (5-20 years), the cumulative effects of the action alternatives in combination with past, present and reasonably foreseeable laws, policies and regulations will likely result in increased conservation of biodiversity. However, continued conservation of biodiversity is not necessarily a long-term trend. In the future laws, policies, and regulations could de-emphasize conservation in the interest of meeting other social and economic objectives, thus placing biodiversity at risk. For example, if recreation demands in the future are oriented toward road use activities or developed facilities, there could be efforts to build roads into inventoried roadless areas and other NFS lands. In the short term (for example the next 20 years) however, the action alternatives in combination with other laws, regulations, and policies are likely to conserve options, thus allowing society to make deliberate choices on conservation of biodiversity for the future.

The Interagency Lynx Conservation Assessment and Strategy (LCAS) was prepared in January of 2000, and was appended to the Lynx Conservation Agreement signed in February of 2000. The strategy was developed to provide a consistent and effective approach to conserve Canada Lynx on federal lands in the conterminous United States. The strategy identifies a number of conservation measures that are identified to address lynx risk factors. The strategy does not identify specific habitat areas, but identifies them as a potential element in a long-term conservation strategy for lynx (and other large carnivores).

The LCAS identified fragmentation and degradation of lynx habitat (or refugia) as a large-scale risk factor. While the LCAS does not specifically identify important refugia, it is reasonable to conclude that many of these areas would overlap with inventoried roadless areas because of their relative large, contiguous, undisturbed nature, and habitat types. The cumulative effects of the LCAS and Alternatives 2 and 3 would be conservation of important habitat that may beneficially affect biological diversity.

The Draft Interior Columbia Basin Ecosystem Management Project (ICBEMP) EIS was released in March of 2000. A Record of Decision may be signed as early as December 2000. The ICBEMP takes a coordinated broad-scale approach to restoring and maintaining ecosystem health on approximately 63 million acres of Forest Service and Bureau of Land Management lands in Oregon, Washington, and parts of Idaho and western Montana. Almost 40 National Forest and BLM Districts are affected by the ICBEMP EIS. The ICBEMP will provide a context for Forest Service and BLM managers within the Columbia River Basin to make sound local decisions while considering effects, particularly cumulative effects, at a scale larger than individual administrative units.

The Draft Sierra Nevada Forest Plan Amendment (SNFPA) was released in April of 2000. A Record of Decision may be signed as early as December 2000. The Sierra Nevada Plan Amendment will amend 11 National Forest Plans on approximately 11.5 million acres in the Sierra Nevada Range. The key issues being addressed are old forest ecosystems, riparian ecosystems, fire and fuels, noxious weeds, and lower west-side hardwoods. These issues are considered to need urgent attention at a range-wide scale. Prescribed fire and adaptive management are cornerstones of the preferred alternative(s). The Sierra Nevada Ecosystem Project (SNEP) has significantly influenced the SNFPA.

The Northwest Forest Plan (NWFP) record of decision was signed in April of 1994. The NWFP was developed as coordinated management direction for 4.6 million acres of lands administered by the Forest Service and BLM within the range of the northern spotted owl. The NWFP affects almost 30 National Forest and BLM districts. The NWFP responds to the need for late-successional forest habitat and the need for forest products by taking an ecosystems management approach to forest management. The NWFP direction was incorporated into all land and resourced management plans within the range of the northern spotted owl.

<u>Non-native species</u> – The problem of invasive non-native species (or alien species) is worsening in the United States. Williams and Meffe (1998) cite the Office of Technology Assessment (1993) estimates that there are more than 6,200 species of established, self-sustaining populations of non-indigenous animals, plants and microbes in the United States. How many U.S. acres are affected by these species is not known. However, given that the number of non-native species is increasing steadily, it is probable that they will pose an ever-increasing threat to native flora and fauna. Wilcove and others (2000) estimate that competition with or predation by non-native species is the second-ranked

threat overall, to biodiversity, affecting nearly half (49 percent) of imperiled species. Imperiled native birds (69 percent), plants (57 percent), fish (53 percent), vertebrates (47 percent) are the species groups most affected by non-native species. Flathers and others (1999) concluded that non-native species are the second most widespread threat to endangered species (35 percent).

The NFS area affected by non-native animals is not known, but given national trends, it is reasonable to conclude that these species are increasing on NFS lands. For example, In the last century, the non-native Brown-headed cowbird have experienced massive range expansions and population explosions as forests have been opened to make way for agricultural and suburban landscapes. Cowbirds are directly implicated in or directly charged with the decline of several songbirds in the Sierra Nevada, especially the willow flycatcher, least Bell's vireo, yellow warbler, chipping sparrow, and song sparrow (USDA 2000i).

It is estimated that 6 to 7 million acres of NFS lands are infested with non-native plant species (Lewis 1999). How quickly these species are infesting NFS lands is not known, but it is probably similar to rates of spread on BLM lands (2,300 acre per day) (USDI 1999). Overall, on all western public lands, non-native plants have invaded over 17 million acres of rangelands more than quadrupling their range form 1985 to 1995. At this rate, native plant communities are being invaded at a rate of approximately 4,600 acres per day (USDI 1999).

The extent of non-native species infestations in inventoried roadless areas is not known, but it is likely that these areas, when compared to roaded areas, have fewer non-native species. Some past management activities and natural disturbances adjacent to and inside inventoried roadless areas (for example roads, timber harvest and grazing) have likely increased the risk of non-native species invading and expanding in these areas. However, lacking roads (a significant source of non-native species invasion) and many of the disturbances associated with them, most inventoried roadless areas are likely to have relatively intact native plant and animal communities where non-native species are absent, rare or uncommon.

As non-native species populations increase adjacent to inventoried roadless areas, the likelihood of non-native species occurring in these areas increases. For example, wildfires that overlap other NFS lands and inventoried roadless areas are likely to increase in the future, thus creating a potential avenue for non-native species invasions, especially if timber salvage activities are implemented. Similarly, if dispersed recreation increases in inventoried roadless areas, the potential for noxious weed infestations may increase with increased livestock use (because of illegal hay usage). Conversely, if timber harvest levels on NFS lands decrease or remain relatively low, then a potential avenue for non-native species invasions (for example cowbirds and scotch broom) also decreases. The overall affect of these activities and disturbances on non-native species invasions is not known, but their trends may predict potential threats of non-native species invasion into inventoried roadless areas.

Cumulatively, the projected increasing trends in non-native species will contribute to increased risks to biodiversity. The cumulative effect of the action alternatives in combination with other actions is likely to be reduced potential for introduction and establishment of nonnative invasive plants, in concert with other Federal, State, and local control efforts, such as those outlined in Executive Order 13112. However, non-native species introductions and establishment on a national or NFS level are not likely to be affected. Nevertheless, the action alternatives in combination with other actions will likely contribute to biodiversity by maintaining native plant and animal communities in inventoried roadless areas where non-native-species are rare, uncommon or absent.

Conclusions on Direct, Indirect and Cumulative Effects

Overall, the incremental effects of past, present and reasonably foreseeable actions when combined with the prohibitions action alternatives would be beneficial to biological diversity, including species habitats, populations and landscape diversity. Some of the potential beneficial effects include:

- Increased number and acreage of protected large contiguous blocks of habitat providing habitat connectivity for a variety of species that need large connected landscapes;

- Increased area of ecoregions protected and improved elevational distribution of protected areas; decreased risk associated with fragmentation from timber harvest and road construction;

- Conserving and protecting biological strongholds and other important habitats for terrestrial and aquatic plants and animals, including TEPS species; and

- Maintaining native plant and animal communities where non-native-species are currently rare, uncommon or absent.

- Providing increased assurances that biological diversity would be conserved, both within the area and the overall landscape in which it is found;

- Providing important components of conservation strategies for protection and recovery of federally listed proposed, threatened, endangered, and NFS Regional Forester sensitive species;

- Maintaining or restoring some level of natural disturbance processes at a local level and landscape levels, which are important controls for ecosystem composition, structure, and function.

There would be a lower risk of losses in biological diversity, including TEPS species, and native plant and animal communities, relative to the No Action Alternative. When compared to the No Action Alternative, the action alternatives would have similar cumulative effects on species habitats and populations, and landscape characteristics when considered with the effects of land uses, land conversions, laws, regulations and policies, and nonnative species invasions. Additional considerations relative to cumulative effects on biological diversity include the following:

- The projected increasing trends in population growth, deleterious land uses, land conversion and non-native species invasion are likely to contribute to increased risks to biodiversity.

- Inventoried roadless area conservation, when considered alone, is not as significant on a national level as when considered in combination with other land conservation policies, laws and strategies. The action alternatives in combination with past, present and reasonably foreseeable actions are likely to reduce some threats to biological diversity in the short term (5-20 years), while conserving options over the next 20 years thus giving society some time to make reasoned choices on actions needed to conserve biodiversity.

- As population growth and associated land uses and land conversions place pressures on both NFS and non-NFS lands, the value and importance of inventoried roadless areas in conserving biological diversity will increase.

- It is likely that Federal, State, local and private land laws, regulations and policies will become more pivotal in conserving biodiversity. However, future laws, policies, and regulations could de-emphasize land conservation in the interest of meeting future social and economic values, thus placing biodiversity at risk.

- The cumulative effect of the action alternatives in combination with other actions is not likely to affect non-native species introduction and establishment on a national or NFS level outside of inventoried roadless areas, but would help maintain native plant and animal communities in inventoried roadless areas where non-native-species are rare, uncommon or absent.

- In the future, habitat loss and loss of viable plant and animal populations may be of a magnitude such that the beneficial effects of the prohibitions, and other laws, regulations and policies relative to the conservation of native biodiversity may be lost or overwhelmed. Even under this scenario, inventoried roadless areas would likely still convey some beneficial effects relative to conservation of individual species, such as some TEPS species associated with large blocks of intact habitat in Forest Service Regions 1 and 4.

Attachment 1. Effects of Fire on Terrestrial and Aquatic Species

Effects of Fire Suppression

Wildfire suppression activities were generally successful in reducing the extent of wildfires beginning in the early 1900's[6]. Fuel loadings have steadily increased because of suppression efforts. The resulting landscapes in many areas have changed so that:

- Heavy fuel loads are more continuous;
- Fire frequency intervals have declined;
- Vegetation structure has become denser, and shade tolerant species are more prevalent;
- Wildfire sizes, intensities, and severities have been altered; and
- The likelihood of wildfires with uncharacteristic fire effects has increased.

Increased fuels and denser vegetative structure have altered habitats for some species. For example the white-headed woodpecker (USDA and USDI 2000, Milne and Hejl 1988), prefers, single-layered, open old growth, and the lynx (USDA and others 2000) utilizes early seral stages of forest development. Some of these habitats in the western United States are now multi-layered, closed canopied or densely stocked with small trees because of fire suppression. Conversely, some species like the northern spotted owl, which prefers multi-storied forested habitats, have had their habitat enhanced by fire suppression in some areas (USDA and USDI 1994b). There is concern that these habitat changes, and the associated increased risk of large wildfires with stand-replacement burn severity, may put some terrestrial and aquatic species habitats at risk, at least at a local level.

Fire Suppression in Inventoried Roadless Areas - The precise condition of fire regimes and corresponding risks of mixed or stand replacement severity wildfires has not been determined for inventoried roadless areas. Broadscale analysis indicates that in inventoried roadless areas, there are fewer acres at high risk (approximately 8 million acres) from uncharacteristic wildfire effects, than acres of moderate (approximately 14 million acres) and low risk (approximately 19 million acres) (USDA 2000b).

Fire suppression that has increased fuel loads, fire risk and burn severities across landscapes may not be as significant a factor in some inventoried roadless areas, compared to other NFS lands. 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. In addition, many inventoried roadless 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. The result may be forest stand conditions within or closer to the historic range of variability, and more normal levels of

[6] For more information on fire suppression, fuels management, and fire ecology see the *Fuels Management and Fire Suppression* specialist report (Roadless.fs.fed.us).

fuel loading, stand composition and structure. Many of these forests may be more resilient to fires; therefore more mixed severity and understory fires are possible.

Mixed Severity Wildfires

While the number of wildfires on NFS lands is increasing (U.S. General Accounting Office 1999), burn severity within individual fires continues to vary. Fire severity is the scale at which vegetation and a site are altered or disrupted by fire. It is the combination of the degree of fire effects on vegetation and soil properties. Some fires may result in large stand-replacement severity burns, but most fires burn as a mixture of understory, low, moderate, and high severity burn patterns. While some stand-replacement severity fires can result in local adverse effects to some species, the effects of mixed severity wildfires on plant and animal species can be beneficial because they create a mixture of age classes, structure and composition. Brown (unpublished) described how mixed fire severity in forests and woodlands could occur:

> *As fire moves across the landscape its behavior and effects can change dramatically due to variability in stand structure, fuels, topography, diurnal changes in burning conditions, and changing weather elements. This can result in highly variable tree mortality and survival patterns within a fire's boundary.*

Examples of wildfires with mixed severity behavior include:

- Within a large (200 sq. mi.) burn in Alaska, Gasaway and Dubois (1985) reported substantial variation in fire severity and many unburned patches, resulting in variation in plant mortality and perpetuation of the mosaic natures of the landscape.

- The 1988 fires in the Greater Yellowstone Area with their size and severe fire behavior, actually consisted of a complex patchwork containing areas burned by crown fire, areas burned by severe surface fire, underburned sites, and unburned areas (Rothermel and others 1994). The majority of severely burned area was within 650 feet of unburned or lightly burned areas (Smith 2000).

- The 42,875-acre Cerro Grande fire in Los Alamos, New Mexico resulted in 34% high, 9% moderate and 57 % low-unburned burn severities (USDA 2000a, *www.fs.fed.us/r3/sfe/fire/cerrogrande*.).

These types of mixed severity burn patterns or mosaics result in a fine-grained pattern or mosaic of stand ages, structures (Smith 2000), and plant species occurrence (Brown unpublished) across the landscape. Conversely, large stand-replacement severity wildfires that occur over successive years can create more of a coarse grain landscape with fewer and smaller disjunct patches separated by large areas of similar stand ages, structure, and plant occurrence. Regardless of which landscape pattern (or mosaic) is created, the effects of fires vary with fire regime, at landscape and local levels, at temporal and other spatial scales, and profoundly influence terrestrial (Smith 2000) and aquatic systems (Gresswell 1999).

Effects of Fires on Terrestrial and Aquatic Systems

The effects of wildfires on terrestrial and aquatic species vary depending on fire occurrence, intensity, severity, uniformity, size and season. The effects of fires may be direct, and both immediate and variable over time with the revegetation of burned areas (Niemi 1990, Smith 2000). Because fire has influenced vegetation composition, structure, and landscape patterns for millennia, it is reasonable to assume that many species have coexisted and adapted to periodic perturbations from fire (Smith 2000).

Species with limited ranges or low populations numbers may be especially vulnerable to some wildfires. Smith and Fischer (1997) suggested that fire might threaten a population that is already small if the species is limited in range and mobility or has specialized reproductive habits. Conversely, other species with larger home ranges and relatively stable population numbers may benefit from the creation of habitat mosaics. In either case, it is increasingly apparent that in both terrestrial and aquatic systems, fire plays an important role in creating and maintaining suitable habitat at varying temporal and spatial scales

Effects of Wildfires on Terrestrial Animals **-** The ability of individual members of a species to survive the direct effects of fire depends on their mobility and on the uniformity, severity, size and duration of fire. While fires have the potential to injure and kill animals caught in their path (Bendell 1974, Singer and Schullery 1989), they generally kill and injure a relatively small proportion of animal populations (Smith 2000). Many adult vertebrate species are mobile enough to flee burning areas or seek refuge. The young of the year are often most vulnerable to injury and mortality from fire (Smith 2000).

Though many species may leave a burning area, some return or live on the edges to take advantage of exposed prey and other food sources. Other species abandon burned areas because the habitat no longer provides the structure or foods that they require to survive or reproduce, and do not return until suitable habitat develops over time (Smith 2000).

At a landscape level, fires create and maintain habitat mosaics of different vegetation types (Mushinsky and Gibson 1991). These mosaics include various patch size, composition, and structure, as well as connectivity among patches. Smith (2000) identified the following landscape level fire effects on fauna: (1) changes availability of habitat patches and heterogeneity within them, (2) changes in the compositions and structures of larger areas, such as watersheds, which provide the spatial context for habitat patches, and (3) changes in connection among patches. During the course of post-fire succession, all three of these landscape features are in flux**.**

The following are some examples of animal behavior in response to direct fire effects and changes in habitat:

Birds

- In forested areas, fire effects on birds depend largely on fire severity. The young of birds nesting on the ground and in low vegetation are vulnerable even to understory fire during nesting season. Intense surface and crown fires could injure species nesting in the canopy, but this kind of fire behavior is more common in late summer and fall than during the nesting season (Smith 2000).
- Some raptor species took advantage of large mammal carcasses in the Yellowstone fires (French and French 1996);
- Dodd (1988) reported beneficial effects to northern goshawk and sharp-shinned hawks in ponderosa pine forests probably because of reduced hiding cover and exposed prey populations.
- Bevis and others (1997) found that spotted owls in south-central Washington, though continuing to use areas burned by understory fire, avoided stand-replacement burns, probably because their prey had been reduced.
- Although stand-replacing fire in Douglas-fir forests in western Montana favored birds that feed on insects, at least one insect feeder, Swainson's thrush, abandoned a burn immediately (Lyon and Marzluff 1985), probably due to its need for cover.
- Many species of woodpeckers show substantial population increases and disperse into areas burned by stand-replacing fire (Hejl and McFadzen 1998, Saab and Dudley 1998, Hutto 1995).
- Some species like the northern goshawk (Reynolds and others 1991) and flammulated owl (Hayward and Verner 1994) may benefit from fine-scaled landscape patterns of intermixed early, mid and late seral patches, and the connectivity between these patches. Fires that increase or maintain heterogeneity, and maintain connectivity may benefit these species. Conversely, fires that create large areas of homogeneous forest structure and reduce connectivity also reduce habitat quality and habitat availability for these species.

Mammals

- Direct fire-caused mortality has been reported for large as well as small mammals including coyote, deer, elk, bison, black bear and moose (French and French 1996, Gasaway and DuBois 1985, Hines 1973, Oliver and others 1998).
- Singer and Schullery (1989) reported that most large mammals in the Yellowstone fires simply moved away from danger during fires, while others died primarily from smoke inhalation.
- French and French (1996) concluded that because mortality rates of large mammals are low, direct fire-caused mortality has little influence on populations of these species as a whole.
- Small mammal mortality can be more severe because some species construct surface-level nests made of dry, flammable materials (Kaufman and others 1988, Quinn 1979, Simons 1991). However, many small mammals avoid fire by outrunning fires or using underground tunnels and nonflammable habitats of talus, soil and rock.
- The young of small mammals are especially vulnerable to fires, but most of these species also have high reproductive rates; if post-fire habitat provides food and shelter for them, their populations recover rapidly (Smith 2000).

- Like birds, mammals respond directly to fire-caused changes in cover and food. For example, many small mammals such as rabbits, snowshoe hare, red squirrel, northern flying squirrel, and voles generally avoid recent stand replacement burns (Ream 1981) probably because of lack of security and cover. Other mammals use burned areas exclusively, and some use them seasonally or as part of their home range (Smith 2000).
- Large carnivores and omnivores are opportunistic species with large home ranges. Their populations change little in response to fire, but they tend to thrive in areas where their preferred prey or forage is most plentiful, often in areas with recent burns (Smith 2000).
- Fire has been recommended for improving habitat for black bear (Landers 1987) and grizzly bear (Hamer 1985, Morgan and others 1994).
- While large-stand-replacement fires generally do not favor marten; mixed-severity fires in lodgepole pine, spruce and fire in northern Idaho left a mosaic of forest types that supported a diversity of cover and food types favorable for marten (Koehler and Hornocker 1977).

Amphibians and Reptiles

- Information on fire effects on amphibians and reptiles is limited. Mortality of reptiles and amphibians probably occurs, but according to a review by Russell and others (1999), there are few reports of fire-caused injury.
- Many reptiles and amphibians live in mesic habitats that are likely to burn less often and less severely than upland sites (Smith 2000). Nevertheless, fire-caused changes in plant species composition and habitat structure (for example woody debris and down logs) influence reptile and amphibian populations (Means and Campbell 1981; Russell and others 1999).
- Amphibians in forested areas are closely tied to debris quantities – the litter and woody material that accumulate slowly in the decades and centuries after stand replacing fire (Smith 2000) and reductions in debris can influence their populations.
- Bunnell (1995) found that the proportion of non-mammalian vertebrates (mainly amphibians) using woody debris was positively correlated with the length of fire rotation in forests of British Columbia.

Effects of Wildfires on Terrestrial Plants **-** Generally, the impact of fire on plants depends on the severity of the fire and on a species' inherent resistance and ability to recover (Brown and others unpublished). While fires may kill some plants, others simply lose the above ground portion of the plant and resprout. When plants are killed, the ability of seed in the seedbank or seed dispersed into the site to germinate depends on whether a favorable environment exists for seedling establishment. The following information relative to plant recovery and seedling establishment is from Brown and others (unpublished) in *Effects of Fire on Flora*:

- Whether herbaceous plants recover after fire depends largely on whether their regenerative structures (stolons and taproots) are exposed to lethal temperatures.

- Perennial grasses may be killed if fire burns meristems and buds.
- Post-fire species composition is usually an assemblage of many of the species that were growing on the site and represented in the seedbank at the time of the fire.
- There may be enormous reserves of seed in the seedbank. Seedling establishment is affected by the amount of seed present and conditions required to induce germination. Seed supply of various species and inherent seed longevity both affect the numbers of viable seeds in the seedbank.
- In ponderosa pine communities, viable seeds of most grass and annual forbs species were found mostly in the litter layer, indicating short term longevity and short seed dispersal, while seeds of perennial forbs species were found mostly in mineral soil, and were probably fairly long-lived (Pratt and others 1984).
- Seeds for some species persist in the soil for years after dispersal. For example, pincherry and snowbrush seeds can remain viable for 100 to 300 years, respectively (Whittle and others 1997, Noste and Bushey 1987).
- Some perennial forbs resprout after fire, flower, and produce abundant seeds that establish in the second and subsequent postfire years (Keeley 1998). Some species that establish from seed may be temporarily eliminated from a burn area because the postfire environment does not favor their establishment.
- For most species that develop from seeds dispersed after fire, the best seedbeds are microsites where most or the entire organic layer has been removed by fire because they provide the greatest chance for seedling. For seedlings that require shade, establishment does not occur until the canopy closes and deep litter layers form.

Non-native Invasive Plants - The same fire-induced site condition changes that affect native plant community compositions also determine the composition of non-native invasive plants. Fires can serve as a means of entry for many non-native invasive plant species because many of these plant species are associated with disturbances and can easily proliferate in burned areas (Sieg 1998, Baker 1998, Asher and Spurrier 1998).

The following information pertaining to the effects of non-native invasive plants is from the *Interior Columbia Basin Supplemental Draft Environmental Impact Statement* (USDA and USDI 2000):

- The establishment of these plants can lead to habitat loss and lowered reproductive success for some plant and wildlife species.
- Aggressive non-native invasive plant species tend to undermine native plant diversity through competition and habitat alteration.
- The invasion and spread of non-native plants can change the structure and composition of vegetative cover types and can change succession, preventing succession from leading to the vegetation that is the potential for a site.
- Exotic plants are often among the first species to arrive and colonize areas where the soil surface has been disturbed or where plant cover is lacking.
- Exotic plants that have an opportunistic colonizing life history (colonizers) are typically prolific producers of seed (or other reproductive parts such as rhizomes) and often are adapted to long-distance dispersal by vehicles, wind, wildlife, livestock, water or machinery. They usually germinate under a wide variety of

conditions, establish quickly, grow fast, and out-compete native species for water and nutrients

The Sierra Nevada, an area historically rich in plant diversity with over 3,500 native species, now supports hundreds of non-native species, many of which have had considerable detrimental ecological effects (Sierra Nevada Ecosystem Project 1996). Other parts of the country show similar situations. Areas infested with invasive species such as spotted knapweed and leafy spurge have been found to have much lower productivity of grasses (Hillis 1999). Once established, many of these species are extremely difficult to eradicate. The use of herbicides associated with control efforts can have unintended adverse effects to populations of other terrestrial and aquatic species (Norris and others 1991).

Most inventoried roadless areas have not been surveyed for non-native invasive plant species. However, it is reasonable to conclude that because roads (a primary source of entry) are lacking, fewer of these areas have established populations of non-native plant species. As a result, areas burned by wildfires within inventoried may be less likely to become invaded by non-native plant species.

Effects of Fires on Aquatic Systems **-** Mortality of fish and aquatic invertebrates from wildfires has been reported in a number of studies (Cushing and Olson 1963, Minshall and others 1997). According to Gresswell (1999), the cause of fire-related fish mortalities is generally associated with more intense and severe fires. Several studies have found that fire-induced changes in stream pH, ash extracts and smoke gases can be lethal to aquatic organisms (Cushing and Olson 1963, Spencer and Hauer 1991). In some cases, water temperature can apparently reach lethal levels. Minshall and others (1989) found that fish mortality from lethal water temperatures, and chemical toxicity levels from smoke and ash were generally not associated with second and third-order streams.

Minshall and Brock (1991) reported dead salmonids in three small streams in Yellowstone following the fires of 1988, but the simultaneous occurrence of live fish in these streams suggests that mortality was not uniform or that surviving individuals migrated into these streams soon after the fire. Research on the Boise National Forest following large intense fires in 1992 showed rapid recolonization of Boise river stream reaches by bull trout and redband trout (Rieman and others 1997). By 1995, fish densities were greater in the burned sections than in similar sections that did not burn. Research on recolonizaton of fish populations after large disturbance events or experimental removal indicates that full population recovery can occur quickly, frequently within a few years (Niemi and others 1990, Detenbeck and others 1992), or in appreciably shorter periods (Sheldon and Meffe 1995, Peterson and Bayley 1993).

Although Rieman and others (1997) documented that large fires can adversely affect aquatic systems, and can result in fish mortality and even extirpation, they concluded that the resilience and persistence of salmonid populations are heavily influenced by the complexity and spatial diversity of habitats. A complex, well-dispersed network of habitats is likely to be an important element in the persistence of fish populations during and after large fires. They conclude that some aquatic species, such as bull trout and redband trout, appear to be well-adapted to “pulsed” disturbances such as fire and its associated hydrologic effects, as opposed to more continual or "press" effects linked to roads and extended timber harvest. They recommend that where small or isolated sensitive fish populations occur in watersheds at high risk of uncharacteristic wildfire, management actions should be implemented only after careful site-specific evaluations of the risks.

Gresswell (1999) concluded that current evidence suggests that even in the case of extensive high-severity fires, local extirpation of fishes is patchy, and recolonization is rapid. Lasting detrimental effects on fish populations have been limited to areas where native fish populations have declined and become increasingly isolated because of human activities. Burns (2000) found that risks to fish populations from fire, either prescribed or wildfire, are low where fish populations can freely migrate and ecosystems are not severely fragmented. Furthermore, Gresswell (1999) cites Warren and Liss (1980), Sedell and others (1990), and Reiman and others (1997) in concluding that native fishes have developed a complex variety of life history strategies that increase the probability of persistence during periods of environmental fluctuation. Even in cases where fish are extirpated, reinvasion is rapid if habitat connectivity is maintained.

Upon reviewing the literature on physical responses to fire in forested watersheds, Gresswell (1999) concluded that most temporally intermediate effects of fire on aquatic organisms are related to hydrologic change from increased water yield and sediment routing. Hydrologic processes control channel morphology, sediment composition and concentration, and recruitment and distribution of large woody debris.

Post-fire erosion effects on aquatic systems are often a primary concern. Some conclusions about post-fire erosion are described below:

- Erosional effects are most extreme where the majority of vegetation and duff has been consumed by fire, soils are highly erosive, and large precipitation events occur after fire (Gresswell 1999).
- In highly erosive or unstable landscapes in the west, 30% to 70 % of the long-term sediment yields occurred during and immediately following fires (Gresswell 1999). Conversely, in less erosive regions such as the Appalachian Mountains, total sediment yield attributable to fire was approximately 5 % (Swanson 1981).
- Gresswell (1999) concluded that in watersheds that are prone to erosion, the primary effect of a single fire may be a short-term alteration of hydrological and erosional processes.
- Everest and others (1987) and Reeves and others (1995) concluded that postfire erosion events are important in maintaining long-term habitat complexity and suitable spawning and rearing habitats. Furthermore, because the proportion of a watershed that is burned influences the magnitude and extent of the postfire changes, smaller drainages in headwater areas often exhibit the greatest fire-related alterations.
- Swanston (1971) and Swanston and Swanson (1976) concluded that human activities could exacerbate the effects of natural events such as fire. In many cases, erosion at a watershed scale is more closely linked to timber harvest and road construction than fire.

The effects of fire-induced woody debris recruitment can last for decades. After fires, woody debris input into stream systems usually increases the rate of pool formation, and alters habitat structure, benefiting fish. Excessive woody debris can block fish passage, cover important spawning sites, and damage habitat during postfire flood events (Swanston 1991). Over longer periods, however, benefits of fire-related debris recruitment probably outweigh any negative effects (Swanson and others 1982, Reeves and others 1995).

Water temperatures can be elevated when fire reduces or removes streamside vegetation. Elevated temperatures may alter abundance, species diversity, egg incubation, and offspring survival (Betschta and others 1987, Reeves and others 1993). Conversely, in areas where low water temperatures limit primary production, elevated water temperatures (nonlethal) following canopy burning may actually increase productivity (Albin 1979, Minshall and others 1989).

Conclusions

Effects of Wildfire on Terrestrial and Aquatic Species

The potential effects of wildfire vary depending on species, fire occurrence, intensity, severity, uniformity, size and season. The likelihood of wildfire with deleterious impacts on individuals and/or local subpopulations of terrestrial and aquatic species has increased in many areas. Yet it is unlikely that wildfires will adversely affect population viability for any species. Even under the extreme wildfire conditions in the 1988 Yellowstone fires where some individuals were displaced, injured or killed, species persisted and many benefited from the changed landscape conditions.

Most species have coexisted and adapted to changes caused by wildfires. In addition, wildfires are responsible for creating and maintaining suitable habitat for many species. Most wildfires are of mixed severity and create fine grain landscape mosaics beneficial to many terrestrial and aquatic species. Even large stand-replacement severity fires can be beneficial. While wildfires may result in some short-term deleterious impacts, there is the potential for significant restorative impacts to habitats and populations, especially in the long term.

The Effects of the Prohibitions on Wildfires and Terrestrial and Aquatic Species

Even under the No Action Alternative, it is likely that fuel reduction activities in most inventoried roadless areas would not receive a strong emphasis. The priorities for fuels treatments would likely remain in areas where there is a risk to life and property (USDA 2000b). With the possible exception of some local site-specific examples, the prohibitions on road construction, road reconstruction and most timber harvest activities are not likely to affect the overall amount or severity of wildfires. As a result, the effects of wildfires on terrestrial and aquatic species are likely to be similar with or without the prohibitions. Whereas the benefits of less ground disturbance from road construction and timber harvest are well documented in the literature, it is less clear whether failure to reduce fuel loading would constitute a substantially increased level of risk, for either terrestrial or aquatic communities.

If all the timber management proposed in the Forest Service five-year timber program in inventoried roadless areas (2000-2004)[7] was prescribed to reduce fuel loads, then under the No Action Alternative, it is estimated that 90,000 to 95,000 acres of forest rated as Condition Class 2 and 3 would be treated. This represents just more than 1% of the 7.5 million acres in inventoried roadless areas potentially needing treatment. The resulting changes in site-specific Condition Classes depends on the effectiveness of silvicultural treatments and post-harvest activities. On a regional and national level, there would be an insignificant effect on reduction of fire risk, and a negligible effect on terrestrial and aquatic species populations. Any accelerated timber harvest programs in inventoried roadless areas to address high fire risk could also result in potential adverse tradeoffs to terrestrial and aquatic species, including adverse effects from fragmentation, disruptions, disturbances and roads.

Alternatives 2 and 3 do allow timber harvest, including prescriptions to reduce fuel loading. These activities may be desirable in some areas where there is an abnormally high risk of large, stand-replacement severity fires, but the overall effect on wildfires and terrestrial and aquatic species would be similar to the No Action alternative. There would be a negligible effect on the number and area of wildfires in inventoried roadless areas from year 2000 to 2004. Fuels reductions in alternatives 2 and 3 may provide some local, site-specific benefits if such activities are implemented with minimal habitat disruptions and disturbances. In some cases short-term habitat loss or deterioration may be proposed to provide long-term habitat resiliency.

Alternative 4 would have similar impacts on wildfires, and terrestrial and aquatic species as the No action alternative, and Alternatives 2 and 3. Alternative 4 would allow timber harvest needed to protect or recover TEP species. On a site-specific basis, timber harvest may be proposed to reduce the risk of large, stand-replacement severity wildfires that could deleteriously affect TEP species. Timber harvest planned to meet these TEP objectives may also have overlapping benefits to sensitive and other terrestrial and aquatic species as well. For example, stand opening treatments to maintain endangered Red-cockaded woodpecker (USDA 1995a) could benefit Bachman's sparrow, Florida mouse, Florida burrowing owl, American kestrel, gopher tortoise and Ozark chinquapin. Restorative timber harvest for the Mexican spotted owl could benefit northern goshawk and flammulated owls.

Alternatives 2, 3, and 4 do not preclude use of other restorative tools, such as prescribed fire, to benefit aquatic and terrestrial species.

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[7] For more information on the five-year timber program see the *Socioeconomic* and *Forest Management* specialist reports (*Roadless.fs.fed.us*).

Attachment 2. Effects on Game Species and Their Habitats

Some game species associated with early seral habitats are declining in some areas. An objective of this analysis was to determine whether prohibitions on road construction and reconstruction or timber harvest in inventoried roadless areas would reduce the ability of the Agency to create and maintain early seral habitats and natural openings, and if so, whether that could result in downward population trends and reduced hunting opportunities for some species.

This analysis concluded these prohibitions could potentially reduce the amount of early seral habitat resulting from timber harvest in some inventoried roadless areas at a local scale. This, however, would have little effect on the overall amount and distribution of early seral habitat at most spatial scales (county, national forest, state, regional or national level) given the potential to restore, maintain or enhance such habitat on other NFS lands and on lands under other federal or private ownership or administration, and the role that natural disturbance processes play in creating and maintaining such habitat. As a result, the prohibitions would not be likely to have negative effects on game species populations or current hunting opportunities when compared with the environmental baseline established by Alternative 1. In fact, there is substantial evidence that the prohibitions could benefit some game species in many ways, including providing security areas with less disturbances and disruptions when compared to roaded areas, and providing late-successional habitats with acorn capabilities.

The Relationship Between Game Species and Early Seral Habitats

Game species are wild animals that people hunt or fish for food or recreation according to prescribed seasons and limits (USDA 1999u, USDA and USDI 2000), and are generally described in terms of: (1) *big game* which includes white-tailed deer, mule deer, elk, bear, wild boar, and turkey; and (2) *small game* which includes ruffed grouse, blue grouse, hare, cottontail rabbits, gray squirrel and quail.

Game species are generally associated with mixed habitat patterns that include a variety of habitat types and age classes. Some games species are habitat generalists (for example deer, elk and ruffed grouse,) utilizing a variety of habitats, and therefore cannot be easily associated with specific habitat types (Southern Appalachian Man and the Biosphere 1996c). Nevertheless, in forested areas, early seral patches, natural openings, and open woodlands are important components of game species habitats.

For many years, game species have been the center of attention for public and federal agencies. Many game populations were reduced in numbers in the late 1800's and early 1900's because of over-hunting, poaching, habitat deterioration, and other factors. Relative to this earlier time, there have been substantial increases in population numbers for many of these species. These trends can be attributed to a number of factors, including state harvest strategies, habitat acquisition, increased knowledge from research, effective habitat management practices, and farm program provisions (Dickson 1995, Peek 1995, Storm and Palmer 1995, Flather and others 1999). In recent years game species population trends have varied with some species exhibiting declines, others have increased, and others are stable (Flathers and others 1999).

Flather and others (1999) suggest that in general, most detectable trends in game population levels are habitat related. As habitats change (habitat loss or habitat modification, enhancement or improvement), so can the distribution and population levels of game species. However, a number of other factors can influence game populations. For example, state harvest strategies and regulations are an important management tool for achieving desired population levels, especially in big game (Flather and others 1999). In addition, other factors like predation and disease can influence some game species populations. However, it is reasonable to assume that most game species population trends can be influenced by changes in their habitat.

The public interest in providing and maintaining game species habitat on National Forest System lands is evidenced by the various program initiatives that focus on these species. The Forest Service has collaborated with a number of organizations (for example Wild Turkey Federation, Rocky Mountain Elk Foundation, Quail Unlimited) to implement wildlife program initiatives such as: "Answer the Call", "Elk Country", "Dancers in the Forest", "A Million Bucks", and "Making Tracks". These initiatives have resulted in substantial amounts of game species habitat improvement, including the creation and maintenance of early seral habitats in some areas.

Five Landscape Assessments - Early Seral Habitat and Game Species Population Trends

A review of the following landscape level assessments provides a national and regional perspective on relationships between early seral habitats and game species populations over the past 20 to 40 years.

Wildlife Resource Trends in the United States(Flathers and others 1999) - This report suggests that a nation-wide decrease in species associated with early seral stages (and grasslands) could be expected in the next 20 years, with the northeastern United States (i.e., Missouri, West Virginia, Pennsylvania, Minnesota, Maine, etc.) displaying the most significant decreases. This conclusion is based on a nearly 80% decrease in early seral habitats (referred to as nonstocked stands with forest cover that is less that 10% stocked with growing trees) nation-wide from 1963 to 1992, and an expected continuation of that trend.

On a national and regional level, a decrease in early seral habitats does not necessarily indicate a decrease in all game species populations. For example, while early seral habitats decreased from 1963 to 1992, elk, wild turkey, deer, and black bear populations increased from 1975 to 1993 (Flathers and others 1999). In fact, Flathers and others (1999) predict that many game species populations are expected to remain relatively stable to the year 2045, the outer benchmark year for their fifty year projection. For example, black bears, wild turkey, pronghorn, and deer are expected to remain relatively stable across the United States. Elk are expected to decrease slightly after recent population increases and range expansion (Flathers and others 1999). Some small game species populations (for example, northern bobwhite quail, ruffed grouse and forest grouse) declined from 1975 to 1993, in part due to reductions in the amount of early seral shrub dominated sites. However, according to Flather and others (1999), expected future changes in small game abundance are likely to be less that 10% from 1993 estimates. Forest grouse species, western quail, and squirrel populations are expected to remain stable in the future. Hare and cottontail are expected to increase over the next 50 years.

Southern Appalachian Assessment (Southern Appalachian Man and the Biosphere 1996c) – In this 37.4 million acre assessment area, which includes parts of Virginia, Kentucky, Tennessee, Alabama, Georgia, South Carolina, and North Carolina, an estimated 8 percent of forested land is in early successional grass-shrub condition. Approximately 7% of all grass-shrub early seral habitats are on NFS lands.

An estimated 4.5 million acres of the assessment area are National Forest System (NFS) lands. In 1995, National Forest System (NFS) lands (approximately 12 % of SAA area) contributed 11% of the grass-seedling-shrub to the assessment area. Non-industrial private lands provided approximately 69% of these stages. For all ownerships within the assessment area from the 1970s to 1995, the acreage of grass-seedling-shrubs increased by 26 percent (1,578,958 to 1,983,995 acres). The other public lands (including state lands) increased by 185% (22,024 to 62,802 acres). During the same period, the National Forest grass-seedling-shrub decreased by 4 percent (237,299 to 227,744 acres).

From the 1970s to 1995 there have been mixed game population trends. White-tailed deer, wild turkeys, and black bears have increased and are expected to increase, level off, and become stable. Conversely, small game species like ruffed grouse and bobwhite quail are declining and are expected to continue declining over the next 15 years.

Ozark-Ouachita Highlands Assessment (USDA 1999a, USDA 1999u) - In this report, the assessment area of approximately 37.2 to 41.1 million acres (depending on the data source used) includes parts of Oklahoma, Arkansas, and Missouri.

An estimated 64 percent (23.9 million acres) of the Ozark-Ouachita Highlands (OOHA) is forested and 36 percent (13.3 million acres) is nonforested (agriculture, roads, towns or cities). An estimated 68% of timberland in the OOHA is non-industrial private forest (NIPF), and 85% of NIPF is potentially harvestable. Approximately 4 million acres or 10 percent of the OOHA area is NFS land. An estimated 16 percent of all timberlands are on NFS lands. On NFS lands, 59-79% of the land is classified as suitable for timber harvest. Over 80 percent of the NFS timberlands are in pole and saw timber size classes. The remaining NFS lands are primarily sapling age class. Early seral habitats were not estimated in the assessment. However, an estimated 14 percent (approximately 512,000 acres) of the area is in non-stocked or seedling/sapling age classes. These age classes generally represent some early seral habitats.

In the OOHA, white-tailed deer populations are increasing with moderate to high populations in one-half of the assessment area counties; wild turkey populations have increased since the 1970’s to low to moderate population levels with the highest levels on NFS lands; and black bear populations have expanded and increased since the 1970’s, but county population levels vary from absent, very low, or low. The bear population increases since the 1970s are a result of improved harvest strategies, habitat improvements, and protection measures. The ruffed grouse occurs in relatively low population densities because of limited habitat, and poor habitat quality in some areas. The bobwhite quail densities have remained stable since the 1970s.

Early Successional Habitat and Open Lands Assessment (USDA 1999e) – There are an estimated 25.2 million acres of NFS lands in NFS regions 8 and 9. For Regions 8 and 9 the amount of early seral (0-10 years) habitat on NFS lands ranged from 1% to 24%. A majority of the national forests had between 2% and 5% of lands in early seral condition. The size classes greater than 61 years old are the predominate age class in all national forests except the Jefferson NF, which has 65% of the forest age class in 51-60 year old stands. The assessment does not estimate or predict game species population trends. However, as described in the SAA and OOHA, game species populations in Regions 8 and 9 have been mixed.

Interior Columbia Basin Ecosystem Management Project Supplemental Draft Environmental Impact Statement (USDA and USDI 2000) – In the 63 million acre project area, early seral habitats are declining because of fire exclusion and accelerated regeneration of timber harvest areas; mid-seral forest age classes are increasing; and woody species encroachment and/or increasing density of woody species (sagebrush, juniper, ponderosa pine, lodgepole pine and Douglas-fir) have reduced herbaceous understories and openings. Relative to these conditions mule deer populations have stabilized since the 1960's; white-tailed deer populations are smaller, but are increasing; elk have expanded their ranges; and black bear populations are stable or increasing. Many of these current high population numbers are partially attributed to access management programs and selective animal harvest strategies. Many small game populations are felt to be declining because of decreases in shrub and early seral habitats.

Landscape Assessment Summary of Findings

Overall, the amount of early seral habitats appears to have decreased on NFS lands over the last 20 years. The affects of this habitat trend on game species have varied. Based on the projections of Flather and others (1999) that big and small game species are likely to remain relatively stable through the year 2045, it is reasonable to conclude that, on a national level, the prohibitions would not adversely affect game species populations. This conclusion remains valid when reviewing the regional (North, South, Rocky Mountain and Pacific Coast) populations trends described by Flathers and others (1999).

Most big game species populations have increased or are stable. Whitetail deer populations for example, have increased significantly in the last 20 years despite an apparent downward trend in early seral habitats and agriculture lands (Storm and Palmer 1995). Turkey populations have increased in many areas in the eastern United States where early seral habitats have decreased. In the Rocky Mountains, turkey population declines are attributed to dense forest and shrub communities.

Some small game species (for example, ruffed grouse in the east, and mountain quail and blue grouse in the west) may be declining locally because forest succession on NFS lands is reducing the amount of early seral, shrub-dominated sites (Southern Appalachian Man and the Biosphere 1996c, USDA and USDI 2000). However, there is no conclusive evidence to support this. Bobwhite quail in the east may be declining in some areas because of reduced early seral habitats. However, their decline is more likely attributable to changes in agricultural practices on non-NFS lands.

Obviously there are many other factors (e.g. hunting regulations, predation and disease) that cumulatively influence game species population trends. In addition, because many game species are habitat generalists (using a variety of habitats) and are therefore not restricted to early seral habitats, they may be unaffected by gradual or slight changes in habitat composition.

Inventoried roadless areas encompass a relatively small amount of individual states and regions. For example:

- Approximately 7% (954,000 acres) and 6% (664,000 acres) of NFS lands in Regions 8 and 9 respectively are designated as inventoried roadless area.
- In the Southern Appalachian Assessment Area, an estimated 2% of the assessment area is inventoried roadless area, with less than 0.1% (1,380 acres out of 1,570,000) of existing early seral habitats (grass/seedling/shrub) in inventoried roadless areas.
- An estimated 1% of the OOHA area is inventoried roadless area, and approximately 10% of the NFS lands in the OOHA area are inventoried roadless areas. Approximately 0.4% of the three states (approximately 1223.4 million acres) associated with the OOHA area are inventoried roadless area.

Because the amount of inventoried roadless area in early successional vegetation resulting from recent timber harvest is relatively limited at the local, regional and state levels, game species are not likely to be adversely affected by the prohibitions. In fact, there may be some benefits from the prohibitions. For example, black bear, turkey and deer, may benefit from the security and cover provided by inventoried roadless areas. In addition, these game species may benefit from increased acorn capability in mid- to late-succcessional oak forests associated with inventoried roadless areas.

A Regional Analysis of the Role Inventoried Roadless Areas have in Providing Game Species Habitats

The Forest Service regional boundaries, including other ownerships, were used to determine the influences inventoried roadless areas might have on a larger landscape area (Table 1). The following points can be drawn from this analysis:

- Inventoried roadless areas represent a relatively minor amount (<1% to 10%) of large regional landscapes (all ownerships).
- By stepping down to the NFS boundaries only, the inventoried roadless areas appear to have a greater landscape influence on game species habitats in some

regions. For example Regions 4 and 10 where inventoried roadless areas comprise 50% to almost 70% of NFS lands.

- Some populations could be impacted (either adversely or beneficially) at the local, site-specific level by inventoried roadless areas; however at a regional scale the impacts to game species may be most influenced by management activities outside of inventoried roadless areas.

Table 1. Approximate amount and percent of National Forest System (NFS) lands and inventoried roadless areas within the Forest Service regional boundaries

NF Region	[8]Approximate land area within regional boundaries (1,000 acres)	[9]Approximate amount of NFS land area within regional boundaries (1,000 acres)	[10]Approximate amount of NFS inventoried roadless area within regional boundaries (1,000 acres)	Percent regional boundary land area that is NFS	Percent regional boundary land area that is inventoried roadless area	Percent NFS lands that are inventoried roadless area
1	157,000	25,157	9,005	16	6	36
2	266,000	22,091	6,183	8	2	28
3	151,000	20,708	2,771	14	2	13
4	161,000	31,914	15,960	20	10	50
5	102,000	20,146	4,200	20	4	21
6	107,000	24,950	4,002	23	4	16
8	556,000	13,226	954	2	<1	7
9	430,000	12,026	664	3	<1	6
10	344,000	22,083	14,779	6	4	67

USDA 2000

[8] Cursory approximation that includes all other ownerships to nearest million acres.
[9] Approximation from Forest Service Roadless Area Conservation FEIS to the nearest thousand acres.
[10] Approximation from Forest Service Roadless Area Conservation FEIS to the nearest thousand acres.

Overall, the numbers in Table 1 imply a relatively limited inventoried roadless area influence on game species habitat and populations within the larger regional boundaries (all ownerships). Based on total land area alone, private lands, other NFS lands, and other ownerships may be more influential on game species habitats and populations than inventoried roadless areas. For example, deer and elk winter ranges on non-NFS lands are critical in maintaining stable populations. National Forest System lands, however, while not necessarily contributing a substantial amount of land to regional landscapes (2% to 23%), are important sources of high quality game species habitat. The conservation of inventoried roadless areas, would contribute to high quality game species habitat by providing areas where disruptions and disturbances are relatively low compared to roaded areas. For example, the black bear is increasing in the eastern United States in part because of security within NFS lands (Vaughan and Pelton 1995).

The importance of conserving inventoried roadless areas is especially significant given the impacts of recreation activities on NFS lands, private land conversion, agriculture, and land development. In some cases, NFS lands, and especially inventoried roadless areas are strongholds for some game species.

How do prohibitions on road construction, reconstruction, and timber harvest activities affect game species habitat?

Timber harvest activities and roads fundamentally change the composition and configuration of wildlife habitats. These changes can alter and modify animal behavior causing changes in population numbers and distribution (USDA 1999u). Timber harvest and roads can impact the amount, distribution and quality of game species habitat. Whether the impacts are adverse or beneficial depends on species requirements, and the extent, duration, timing and intensity of timber harvest activities and associated roads.

In forested habitats, game species are generally associated with a mixture of habitats and a variety of age classes. When timber harvest activities (in conjunction with effective road management programs) are designed to meet specific game species habitat requirements, there are often positive impacts (Brown and others 1985, Hoover and Willis 1984, Thomas 1979). Timber harvest activities that create, restore and maintain these habitat patterns are generally beneficial to most game species. For example vegetation management activities that create and maintain edge, early seral patches, natural openings, and open woodland habitats, are beneficial for most game species (Southern Appalachian Man and the Biosphere 1996c, USDA 1999u, Flather and others 1999, USDA and USDI 2000). Conversely, when timber activities are poorly placed on the landscape, and road densities are not managed, then game populations can decline due to poaching, concentrated legal hunting (USDA 1999p), reduced habitat quality or habitat loss (Brown 1985, Hoover and Willis 1984, Thomas 1979).

In some forested areas, deer and elk populations have benefited from improved forage conditions created by some timber harvest activities (USDA and USDI 2000). Turkey (Dickson 1992), forest grouse, and quail have benefited from openings and saplings created by some timber management activities. Effective road management programs in conjunction with timber harvest are often critical components in maintaining or improving habitat quality. For example, providing early seral foraging areas, cover areas and low road densities (0.8 miles or less) are critical to maintaining high quality black bear (Southern Appalachian Man and the Biosphere 1996c), deer and elk (Brown 1985, Thomas 1979) habitat.

In addition to providing access for timber harvest, roads often provide access to other game species habitat improvements. For example, water developments (for example guzzlers, ponds and spring boxes) are often located near roads to facilitate construction and maintenance of these structures. In addition, roads are often used to facilitate the maintenance of natural and created openings. Roads, however, frequently serve as a corridor for introduction of non-native invasive species which may out-compete native vegetation, causing a decline in forage productivity in an area.

The restrictions on timber harvest and road construction and road reconstruction proposed in the prohibitions alternatives will probably have a limited impact on the ability of the Agency to provide the mixed pattern habitats used by game species, given the planned level of timber harvest offer under the no action alternative (Table 1). In fact there is evidence that many inventoried roadless areas function as important security areas and provide key habitat linkages for some game species. While there may be some local, site-specific examples where a prohibition on all timber harvest in inventoried roadless areas could affect the ability of the Agency to implement specific projects to restore or enhance some game species habitat, it is unlikely that this would adversely affect game species population levels. Activities outside of inventoried roadless areas will continue to play an influential role in controlling habitat quality, and natural disturbance processes within inventoried roadless areas will continue to create a variety of openings and successional stages.

The prohibition of road construction or reconstruction may affect the ease of implementing some local habitat improvement projects, but the action alternatives do not preclude these projects, except for non-stewardship purpose timber harvest under Alternative 3, and all timber harvest under Alternative 4 with the exception of that needed for protection or recovery of TEP species. Prescribed fire would continue to be available as a habitat management tool under all action alternatives.

Game Species Habitat and Population Trend Summaries

Deer and Elk (Western US)

Mule deer numbers nationally have increased since the 1975 and are stabilizing. The exception is in the Rocky Mountains and Pacific Coast regions where mule deer populations have declined 11 and 12 percent, respectively (Flather and others 1999). These declines are most likely due to the encroachment of human developments on transitional and winter ranges (USDA and USDI 2000, Hoover and Wills 1984). Elk populations have increased by more than 70% in 11 states (Flather and others 1999). Mule deer and elk in the west have probably increased in part because of early seral vegetation and edge habitat created by timber harvest (USDA 1997b). Where timber harvest occurs, the highest population densities occur where effective road management programs are in place (Wisdom and others 2000, Fredrick 1991). As noted by Peek (1995), elk now occupy more suitable habitat and are more numerous than at any time since the turn of the century. Their populations are expected to increase through the year 2040 (Flather and Hoekstra 1989).

The prohibitions would not be likely to have detrimental impacts on mule deer and elk populations. Elk populations have been increasing across the west with limited timber harvest in western roadless areas. In fact populations are expected to continue to increase for the next 4 decades. Because of poaching (USDA 1999p), increased hunting pressure (Flather and others 1999), and continuing land use development in many areas, deer and elk populations may benefit from the security and isolation provided by inventoried roadless area conservation. In addition, natural disturbances such as wildfires continue to play a role in providing openings and quality forage areas for deer and elk.

White-tailed Deer (Eastern US)

Deer populations have increased significantly in the last 20 years. White-tailed deer in the east are found in higher densities where croplands dominate and developed and coniferous forests occur in lesser amounts (Southern Appalachian Man and the Biosphere 1996c). Warren (1997) concluded that an overabundance of white-tailed deer has become so prevalent that it will likely represent one of the more important wildlife management problems during the next decade. In the northeast, trends in deer abundance are largely functions of regulated harvest by hunters (Storm and Palmer 1995), and to a lesser extent changes in habitat. In the south, where deer numbers are approximately two-thirds of the northeast populations, habitat conditions probably play a greater role in deer population trends.

The prohibitions are not likely to detrimentally impact white-tailed populations. Deer populations have been increasing with limited timber harvest in roadless areas. In the east, deer density information for the Southern Appalachian Assessment (SAA) (Southern Appalachian Man and the Biosphere 1996c) indicates that the highest densities of deer in the SAA area are found in association with private croplands and agricultural lands. Additional support for negligible inventoried roadless area impacts is that less than 8 percent of National Forest System lands in Forest Service Regions 8 and 9 are within inventoried roadless areas. The prohibitions will likely maintain important deer security areas, and minimize potential increases in illegal hunting. The management of areas outside of inventoried roadless areas and state game regulations will be influential in deer population trends.

Black Bear

Black bears are habitat generalists. Ideal bear habitat includes early seral patches, edge, and open forested habitats (Hoover and Wills 1984, Wisdom and others 2000, USDA 1999u) in juxtaposition with mid to late seral-forested habitats. Black bears tend be absent from portions of the Southern Appalachians where large amounts of nonforested habitat and limited forested habitat occur. Dense forest cover, security areas, and remoteness provide protection from poaching and hunting and are key habitat parameters (Southern Appalachian Man and the Biosphere 1996c). Increases in mid-late seral oak forests, and the resulting acorn production, have contributed to increases in eastern black bear populations (Southern Appalachian Man and the Biosphere 1996c). Vaughan and Pelton (1995) found that of 40 states reporting black bear populations, 27 had an increasing trend, and only two had declining trends. Black bear populations are expected to remain stable on public lands, but decrease on private land due to continued loss of forest habitats and increased developments. The prohibitions are not likely to change these population trends, but may help stabilize populations on public lands in light of the private lands trends.

In both the eastern and western United States, the prohibitions will likely benefit bear populations. In the east where poaching, intense hunting pressure and land development are threatening bear populations, one of the primary limiting factors for bears is intact habitats. The remaining large tracts of roadless area in the east are important strongholds for bear populations, and may help stabilize bear populations over the long term. In the west, bear populations are expected to remain stable in the Rocky Mountains and increase in the Pacific coast. Eliminating new road construction in inventoried roadless areas will avoid habitat modifications and changes in animal behavior that can detrimentally impact large mammals like bears (USDA and USDI 2000, USDA 1999p, Fredrick 1991). While early seral habitats are important components of bear habitats in the east and west, the security and isolation provided by inventoried roadless areas is likely more significant at maintaining bear populations than are the potential forage opportunities created by timber harvest activities.

Wild Turkey

Turkeys prefer habitat where openings are interspersed with mature forests (Dickson 1992; USDA 1999u). In the eastern United States, turkeys reach their highest densities where oak forests and croplands and lesser amounts of coniferous forestland occur (Southern Appalachian Man and the Biosphere 1996c). The expansion of late-seral oak forests, and the associated acorn production, has resulted in turkey population expansion in the east. Flather and others (1999) reported that turkey harvests in 41 states have increased by more than 190% since 1975. Nationally, turkey populations are expected to increase in all regions (Flather and others 1999). This increase was primarily due to extensive restoration efforts, protection, and conservation harvest limits well as increased acorn capability from the increase in mid- to late-successional oak forests. In the Southern Appalachian Assessment Area, wild turkey population increases are expected to level out and become stable. In the western United States, turkey populations have declined in the Rocky Mountains, but increased in the Pacific coast (Flather and others 1999). Part of the decline in the Rocky Mountains can be attributed to poor habitat quality (dense forests and shrub communities) resulting from fire exclusion. The increases in the Pacific Coast area are probably a result of reintroduction efforts and increased amounts of early seral habitat.

Inventoried roadless areas probably contribute negligibly to changes in turkey populations in the southern and northeast regions. Less than 8% of NFS lands in Regions 8 and 9 are within inventoried roadless areas. The management of lands outside of inventoried roadless areas and the kinds of state game regulations would probably have a greater influence on turkey populations. In addition, the prohibitions will likely maintain important turkey security areas, and minimize potential increases in illegal hunting. In parts of the west (e.g. Region 4), the prohibitions could have a more noticeable local impact on turkey populations because more lands would be impacted by the prohibitions. Even in these areas, the management of areas outside of inventoried roadless areas and state game regulations would likely play an important part.

Small Game

Grouse populations have declined since the 1970's possibly due to decreased proportions of sapling/pole seral stages, which grouse favor (Flather and others 1999; Southern Appalachian Man and the Biosphere 1996c; Hoover and Wills 1982; Wisdom and others 2000). In the Southern Appalachian Assessment Area, small game species like ruffed grouse and bobwhite quail are declining and are expected to continue declining over the next 15 years. In the Ozark-Ouachita Highlands Assessment area, the ruffed grouse occurs in relatively low population densities because of limited habitat, and poor habitat quality in some areas. Bobwhite quail densities have remained stable since the 1970s. In the Interior Columbia Basin (USDA and USDI 2000), many small game populations are felt to be declining because of decreases in shrub and early seral habitats.

Squirrel numbers show steady but slight gains in the North, declines in the Rocky Mountains, and declines since 1985 in the South. Gray squirrel populations in the Southern Appalachian Assessment Area (Flather and others 1999) have remained stable and have benefited from increased acorn production from maturation of oak forests. In the west, gray squirrels have declined as interior ponderosa pine and Oregon white oak habitats are converted to human uses (Wisdom and others 2000).

The prohibitions would not be likely to have an adverse impact on small game populations. Grouse populations would benefit from protection of upper elevation winter range habitats. A decline in winter range higher elevation coniferous forests is a possible factor for blue grouse population declines in the western United States. Declines in early seral and sapling-pole stages may result in lower grouse densities in localized, site-specific areas. For ruffed grouse in the east, NFS lands provide a significant amount of habitat (Southern Appalachian Man and the Biosphere 1996c), but less than 8% of Region 8 and 9 NFS lands are in inventoried roadless areas. The management of areas outside of inventoried roadless areas, and state game regulations would probably have an influential impact on grouse populations. Other small game species (e.g. sharp-tailed grouse, bobwhite quail and cottontail rabbits) are found in heavily fragmented forested habitats, but are more closely associated with rangelands and highly interspersed forests, agricultural, and/or croplands (Wisdom and others 2000; Klimstra and Roseberry 1975; Flather and others 1999) and are therefore are not likely to be impacted by the prohibitions.

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