CHAPTER 3
ENVIRONMENT AND EFFECTS

Environment and Effects

Introduction

This chapter combines the affected environment and environmental consequences discussions required by the National Environmental Policy Act (NEPA) implementing regulations (40 Code of Federal Regulations [CFR] 1500-1508). The discussions are combined so that the environmental consequences (effects) of the alternatives on forest resources and the background information needed to understand these consequences are discussed together for each resource. Each resource is first described by its current condition, uses, supply, and demand, or expected use, along with an explanation of how each resource is measured and evaluated. The descriptions are limited to providing the background information necessary for understanding how the Environmental Impact Statement (EIS) alternatives may affect the resource. Methodology and scientific accuracy is discussed for most resources.

Many of the relationships established and discussed in the 1997 Tongass Land and Resource Management Plan (Forest Plan) Revision Final EIS (FEIS), the 2003 Supplemental EIS (SEIS), and the 2008 Forest Plan Amendment EIS are still valid and, therefore, are incorporated by reference in this EIS. However, this EIS updates some of this information to better reflect current conditions and focuses on the potential effects most relevant to the potential changes that could occur from this proposed amendment to the 2008 (current) Tongass Forest Plan.

Analyzing Effects

Following each resource description is a discussion of the potential effects (environmental consequences) to the resource associated with implementation of each EIS alternative. All significant or potentially significant effects, including direct, indirect, and cumulative effects, are disclosed. Effects are quantified, where possible, although qualitative discussions are also included. The means by which any identified potential adverse effects will be reduced or mitigated are also described.

Environmental consequences are the effects of implementing an alternative on the physical, biological, social, and economic environment. Direct environmental effects are defined as those occurring at the same time and place as the initial cause or action. Indirect effects are those that occur later in time, or are spatially removed from the activity but would be significant in the foreseeable future. Cumulative effects result from the incremental effects of actions, when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (federal or non-federal) or person undertakes such other actions.

Cumulative effects can result from individually minor, but collectively significant, actions taking place over a period of time.

Potential adverse environmental effects that cannot be avoided are discussed. Unavoidable adverse effects are those resulting from managing the land for one resource at the expense of the use or condition of other resources. Many adverse effects can be reduced or mitigated by limiting the extent or duration of effects. The 2008 Tongass Forest Plan is designed to mitigate potential adverse effects on forest resources and uses, especially through its mix of management prescriptions and Forest-wide standards and guidelines. Mitigation measures within standards and guidelines are specified for project activities to be implemented under the 2008 Tongass Forest Plan.

Short-term uses, and their effects, are those that occur annually or within the first 10 years of Forest Plan implementation. Long-term productivity refers to the capability of the land and resources to continue producing goods and services for 50 years and beyond. Long-term and cumulative effects may be projected out 100 years or more, as needed, to fully analyze the potential consequences for particular resources.

Irreversible and irretrievable resource commitments are typically not made at the programmatic level of a Forest Plan. Irreversible commitments are decisions affecting nonrenewable resources, such as soils, minerals, plant and animal species, and heritage resources. Such commitments of resources are considered irreversible because the resource has deteriorated to the point that renewal can occur only over a long period of time or at a great expense, or the resource has been destroyed or removed. While the application of Land Use Designations (LUDs) allowing land-altering activities can indicate the potential for such commitments, the actual commitment to develop, use, or affect nonrenewable resources is made at the project level. The gradual decline in old-growth habitat may be considered an irreversible commitment.

Irretrievable commitments represent opportunities foregone for the period during which resource use or production cannot be realized. These decisions are reversible, but the production opportunities foregone are irretrievable. An example of such commitments is the allocation of LUDs that do not allow timber harvest to areas containing suitable and accessible forest land. For the time over which such allocations are made, the opportunity to obtain timber from those areas is foregone, thus irretrievable. Irreversible and irretrievable commitments are not identified, as such, in the discussions.

For estimating the effects of alternatives at the programmatic Forest Plan level, the assumption is made that the kinds of resource management activities allowed under the Plan will in fact occur to the extent necessary to achieve the goals and objectives of each alternative. The actual location, design, and extent of such activities are, however, not known at this time because that is a project-by-project decision. In many cases, the discussions refer to the potential for effects to occur, realizing that in many cases these are only estimates.

The effects analysis is useful in comparing and evaluating alternatives, but should not be applied per se to any specific location within the Forest. Land management plans are tools for further agency planning and guide future management activities. The land management plan is a strategic plan that establishes a long-term management framework for the Tongass National Forest. Within that framework, specific projects and activities will be proposed, approved, and implemented depending on specific conditions, budgets, needs, proposals, and circumstances at that time. The plan can only speculate about the projects that may be proposed and budgeted and the events that may occur

that will force changes in the projects and the effects of these projects. Thus, the effects presented here are comparative in nature. Specific effects that can be meaningfully measured and evaluated generally occur at the project and activity stage.

An effort was made throughout the current Tongass Forest Plan amendment process to obtain and use the best available information to evaluate and compare the effects of alternatives. NEPA implementing regulations (40 CFR 1502.22) state that when "there is incomplete or unavailable information, the agency shall always make clear that such information is lacking." This was done where appropriate. The NEPA requirement goes on to say that if the incomplete information "is essential to a reasoned choice among alternatives" then considerations, such as the cost of obtaining it, apply. The 1997 Tongass Forest Plan Revision FEIS, the 2003 SEIS, the 2008 Forest Plan Amendment EIS, and this EIS, along with their planning records, will provide the Forest Supervisor with the "essential" information needed to make a reasoned choice among alternatives.

Cumulative Effects

Cumulative effects result from the incremental effects of actions, when added to other past, present, and reasonably foreseeable future actions, regardless of what agency (federal or non-federal) or person undertakes such other actions. For this analysis, the area considered for cumulative effects varies according to the resource being assessed. Cumulative effects are discussed in detail for each resource in this chapter. Appendix C discusses the projects considered and records which projects were considered for each resource.

For most aquatic or watershed-related resources, the area within the proclaimed Forest boundary (approximately 17.9 million acres, including 1.2 million acres of non-National Forest System [NFS] lands) was used and analyses were generally conducted at the watershed scale (sixth-level hydrologic unit).

For wildlife and other terrestrial resources, all of Southeast Alaska from Yakutat Bay southeast to the southeastern end of Alaska (approximately 21.6 million acres, including 4.8 million acres of non-NFS lands) will be used as the study area, although some analyses will be based on the area within the Forest boundary, depending on the availability and quality of available information. The Southeast Alaska area includes all of Glacier Bay National Park and the State, Bureau of Land Management, and other lands in the vicinity of Haines and Skagway. Often, Wildlife Analysis Areas (WAAs) will be used to summarize information within these study areas. In addition, biogeographic provinces will be used to summarize cumulative effects information for wildlife and other terrestrial resources.

For social and economic, recreation, and related human uses, all of Southeast Alaska and beyond will be given consideration for cumulative effects, especially regarding economic, market, and other factors.

Existing conditions reflect the extensive changes brought about by long-term human occupancy and use of the forest and represent the present-day condition resulting from past and present actions. Direct and indirect effects include the short- and long-term effects that would result from each of the alternatives considered in this EIS. Cumulative effects may result when the direct and indirect effects associated with the alternatives are added to the effects associated with other past, present, or reasonably foreseeable actions.

Cumulative effects analyses are presented in the effects sections for each resource.

Analysis of long-term cumulative effects extends at least 25 years into the future and to 100 years in many cases. This period is well beyond the proposed period for transitioning to a harvest that is dominated by young growth and covers the period within which the next Forest Plan revision will have taken place.

Generally, for the physical and biological resources, the actions considered in assessing cumulative effects will include the following:

- Past, present, and future timber harvest and road construction on NFS lands; including precommercial thinning;
- Past, present, and future timber harvest on private, state, and Native corporation lands within the National Forest boundary.
- Reasonably foreseeable land adjustments including the proposed Alaska Mental Health Trust land exchange, remaining land conveyances due to the Alaska Statehood Act, and acquisition of the Cube Cove tracts on Admiralty Island by the Forest Service;
- Existing mining at Greens Creek Mine on Admiralty Island, Kensington Gold Mine north of Juneau, and other existing sites, as well as possible future sites, including the Bokan Mountain and Niblack sites on the southern end of Prince of Wales Island;
- Existing and proposed mining projects in Canada within watersheds that drain to Southeast Alaska waters (e.g., Kerr-Sulphurets-Mitchell mine in the Unuk River watershed, Red Chris mine in the Stikine Watershed, and the Tulsequah Chief mine in the Taku Watershed);
- Electrical intertie and other utility line construction, including the Kake to Petersburg Transmission Intertie project;
- Regional transportation development as defined by the State Transportation Plan and Forest Service Alaska Region Long-Range Transportation Plan, road paving on Prince of Wales Island, the closing of roads, and construction of the Angoon Airport;
- Kake Access Project;
- Development of fishing and other lodges;
- Human settlements – expansion of cities like Juneau and Ketchikan – as well as recreational cabin development and land auctions by the State;
- Past, present, and future recreation sites and trails development on NFS lands or removal from NFS lands;
- Potential geothermal development at Bell Island;
- Existing and future hydroelectric developments (e.g., Angoon Hydroelectric, Sweetheart Lake, Soule River, Swan Lake expansion, Crooked Creek/Jim's Lake, and Tenakee Springs/Indian River);
- Climate change and yellow-cedar decline;
- The tourism (mostly cruise ship) industry will continue to grow at a rate of about (+/-) 5 percent per year; and

- Watershed restoration projects across the Tongass. Watersheds were selected based on watershed condition rating completed in 2011, following the national Watershed Condition Framework guidance.

A complete list of past, present, and reasonably foreseeable projects considered, and which resources have overlapping effects, is provided in Appendix C, Cumulative Effects.

Geographic Information System Database and Quantification for this EIS

The Forest Service has developed an extensive computerized geographic information system (GIS) database that is continually improved and is used for Forest Plan–level and project-level analyses. This system makes it possible to conduct spatial analysis of alternatives and effects, and to rapidly display resource information in map format. The GIS is a very large database, containing information on many of the resources of the Forest. Much of the data consist of map "layers," each representing a particular resource or attribute (such as forest type, soil type, or recreation places). Numerical data can also be stored, displayed, and analyzed. Computer technology and capability continues to improve and the Forest GIS program, especially at the project level, reflects such growth. Additional information, as well as improved information, is now available for many resource areas. This EIS takes advantage of the new technology capability and information.

The baseline numbers used to describe the existing condition do not always match the numbers in the 2008 Forest Plan Amendment EIS. This is primarily because of ongoing management of the Tongass National Forest. Examples include changes in land ownership, changes in resource conditions resulting from timber harvest and road construction, and forest plan amendments. In addition, the use of newer computer mapping and measurement techniques that are more accurate than earlier methods also affects the numbers. In general, the relative differences between previous documents and the baseline numbers used in this EIS are small, and do not affect the analysis relationships among these documents.

It should be noted that in some cases where the acreages are measured that depend on overlaying of multiple coverages, the acreage measurements for individual categories sometimes need to be adjusted to account for the fact that coverages do not always line up exactly in places where they should (e.g., along property boundaries, saltwater shorelines, lake edges). Very slight misalignment of the coverages can result in polygon slivers between the coverages, which can produce acreage differences initially. These differences can amount to tens or hundreds of acres or more, especially because we are dealing with such a large area (i.e., 17 million acres). However, on a percentage basis, these slivers and the adjustments that are necessary are insignificant.

It should also be noted that the figures presented are generally rounded to the nearest whole acre, whole mile, or whole percent. No attempt has been made to adjust the numbers to force the sums of rounded numbers to equal the expected totals. Therefore, the sum of rounded individual numbers will often be one digit higher or lower than the expected sum. The sums that are presented are the sums of the unrounded numbers.

Land Use Designation Groupings

For many resources, the effects and the differences in effects among the alternatives are best identified through the LUD allocations. While each LUD has a different management emphasis, many are similar in the kinds of effects they would potentially create. Based on this and in order to simplify the identification of effects, the LUDs have been grouped into four categories: Wilderness, Natural Setting, Moderate Development, and Intensive Development. For some analyses, the LUDs are grouped into two categories: Wilderness and Natural Setting LUDs make up the non-development LUDs and Moderate and Intensive Development LUDs make up the development LUD category. Note that the Minerals LUD is an overlay LUD and is managed according to the underlying LUD until such time that a Plan of Operations is approved. Therefore, acreages in this EIS generally reflect the underlying LUD acreages. Under each of the Action Alternatives, the Transportation and Utility System overlay LUD would be removed. Table 3-1 displays these LUD groupings.

Table 3-1
Land Use Designation Groupings Used to Discuss Effects

LUD Group	Land Use Designation
Non-development LUDs	
Wilderness LUD Group	Wilderness
	Wilderness National Monument
	Nonwilderness National Monument
Natural Setting LUDs	LUD II
	Remote Recreation
	Semi-Remote Recreation
	Old-Growth Habitat
	Municipal Watershed
	Research Natural Area[1]
	Special Interest Area[1]
	Wild River[1]
	Scenic River
	Recreational River
Development LUDs	
Moderate Development	Experimental Forest
	Scenic Viewshed
	Modified Landscape
Intensive Development	Timber Production
Overlay LUDs[2]	
	Minerals
	Transportation and Utility Systems[3] (Alternative 1 only)

[1] These three LUDs function as overlay LUDs (see footnote 2) when they occur within Wilderness, Wilderness National Monument, or LUD II areas.
[2] The Minerals and Transportation and Utility Systems (TUS) LUDs are overlay LUDs. Areas allocated to these LUDs are managed according to the underlying LUD until such time that mineral or transportation or utility development is approved, if at all. Generally, acreages in this EIS do not include the Minerals or TUS LUDs, but rather the underlying LUD.
[3] The TUS LUD would be eliminated under Alternatives 2, 3, 4, and 5.

Land Divisions

The land area of the Tongass National Forest has been divided in several different ways to describe the different resources and how they are affected by the alternatives. These divisions vary by resource because the relationship of each resource to geographic conditions and zones also varies. Several of these divisions are described briefly here.

Watershed

The 6th-level Hydrologic Unit Code polygons were used for watershed/fisheries effects. These come from the national Watershed Boundary Dataset – see the *Water* section.

Geographic Provinces

These are seven large land areas that are distinguished by differences in ecological processes. They are defined by a combination of climatic and geographic features. Geographic provinces are used in the evaluation of Research Natural Areas and Wild and Scenic Rivers. See the *Research Natural Areas* section of the 1997 Forest Plan Revision FEIS for a description of each province.

Biogeographic Provinces

Biogeographic provinces are areas within which certain kinds of plants and animals tend to occur together. They are defined by a combination of similarity in species, patterns of distribution of species, and natural characteristics or barriers. Twenty-one biogeographic provinces occur on the Tongass. They are used in the *Biodiversity* and *Wildlife* sections.

Ecological Sections and Subsections

Ecological sections and subsections are two classification levels within a hierarchical system for subdividing ecosystems according to the National Hierarchical Framework of Ecological Units (see the *Biodiversity* section of this chapter).

The framework consists of eight nested mapping levels that serve a variety of purposes. Within the hierarchy, ecological sections characterize medium to large ecosystems (on the order of 1,000 square miles) and ecological subsections characterize mid-sized ecosystems (10 to 1,000 square miles). Fourteen ecological sections and 73 ecological subsections occur on the Tongass.

Value Comparison Units

Value Comparison Units (VCU) are distinct geographic areas, roughly analogous to watersheds, each encompassing a drainage basin containing one or more large stream systems. The boundaries usually follow watershed divides. VCUs were used for the 1979 Tongass Forest Plan to compare the relative values of various resources by location and have been modified to account for changes in allocation for Wilderness and LUD II. The Forest currently has about 945 VCUs averaging 18,000 acres in size.

Wildlife Analysis Areas

WAAs are land divisions used by the Alaska Department of Fish and Game. Approximately 190 WAAs apply to the Tongass National Forest; they average slightly less than 90,000 acres in size. In general, WAA boundaries correspond with VCU boundaries and they typically include three to eight VCUs (averaging just under five). They are used in the *Subsistence* and *Wildlife* sections.

General Forest Description

A brief description of the physical, biological, and socioeconomic settings of the Tongass National Forest is presented in this section. Chapter 1 and the alternative maps include a vicinity map.

Physical Setting

The mainland and many of the islands of Southeast Alaska are mountainous, often rising abruptly from sea level to several thousand feet. Elevations of forested areas extend up to approximately 3,000 feet in the southern sections of the Tongass National Forest and up to 2,500 feet farther north. The mountain valleys provide reservoirs for huge ice fields and glaciers, located primarily on the mainland.

More than one million years ago, all but the highest mountain peaks and some outer coastal areas in Southeast Alaska were covered by ice. The great erosional powers of these vast expanses of ice molded and shaped the landscape as the glaciers moved downhill under their own weight, carving the bedrock below them. When the ice receded and uncovered the land, the more resistant mineral-rich rocks remained, revealing a network of islands dissected by numerous streams, U-shaped valleys, and fiords. By about 13,500 years ago most of southeast Alaska was ice free. This modification by glaciers gives Southeast Alaska's landscape its character.

The configuration of the coastline, the warm Japanese ocean current, and the high coastal mountains provide the factors necessary to produce abundant rainfall. The annual precipitation of Southeast Alaska averages more than 100 inches throughout. Precipitation is highest in the southern areas and decreases as one moves north. At higher elevations, more than 200 inches of snow may fall annually, perpetuating the existing ice fields and glaciers. Storms and moderate to heavy precipitation occur year-round, but most commonly from September through November. The abundant moisture feeds numerous streams, rivers, and lakes that dot the landscape.

Southeast Alaska has a maritime climate, resulting from the moderating influence of the Pacific Ocean. In the summer, this provides a cooling influence, while in winter, temperatures are warmer than would be expected for these latitudes. Normal temperatures range from mid-40 degrees Fahrenheit (°F) to mid-60°F in the summer, and from the high teens to the low-40s in the winter. During the warmer months, temperatures are highest inland and lowest along the coasts, while in the colder months, the reverse is true.

Biological Setting

The coastal forest of Southeast Alaska is part of the cool, temperate rain forest that extends along the Pacific coast from Northern California to Cook Inlet in Alaska. Most of the Forest is composed of old-growth conifers, primarily western hemlock and Sitka spruce, with a scattering of mountain hemlock, western redcedar (in the south), and Alaska yellow-cedar. Red alder is common along streams, beach fringes, and on soils recently disturbed by management activities and landslides. Black cottonwood grows on the floodplains of major rivers and recently deglaciated areas.

Blueberry, huckleberry, Sitka alder, Devil's club, and salal are common shrubs in the Forest. The Forest floor is composed of plants, such as deerheart, dogwood, single delight, and skunk cabbage. Because of the high rainfall and resulting high humidity, mosses grow in great profusion on the ground, on fallen logs, on the lower branches of trees, and in forest openings.

Grass-sedge meadows usually lie at low elevations, often along the coast. Stands of willows border many of the stream channels. Muskeg (bog plant) communities, dominated by sphagnum mosses and sedges, occur throughout the Forest.

The alpine zone usually lies above 2,500 to 3,000 feet. It occupies the area above the coastal forest and is separated from the Forest by a subalpine or transition zone. Resident plants have adapted to snowpack and wind abrasion by evolving low-growth forms. Low, mat-forming vegetation covers most of the area, with cushion-like plants occupying crevices on exposed rock outcrops and talus slopes.

The forests, shorelines, streams, and rivers of Southeast Alaska provide habitat for over 300 species of birds and mammals, including game and non-game animals, such as brown and black bear, Sitka black-tailed deer, moose, wolf, mountain goat, beaver, otter, and marten. The coastline provides ideal habitat for a large population of bald eagles, and wetlands provide nesting habitat for many waterfowl. Large tracts of intact ecosystems help preserve biodiversity.

The Forest is a productive landscape that sustains robust fish stocks for subsistence, personal use, commercial, and sport fisheries. Maintaining the habitat diversity and connections among watersheds is essential to the continued productivity of the Forest's salmon fisheries.

A highly productive marine environment includes an abundance of marine mammals, halibut, herring, and hundreds of shellfish. Both resident and anadromous fish are found within and adjacent to the Forest.

Socioeconomic Setting

There are dozens of communities, including many long-standing Native villages, that exist within the Forest boundary. These communities use and depend on forest resources. As a consequence, management decisions and actions of the Tongass National Forest have a great deal of influence on those communities. A multitude of resources and activities produced from the Forest fuel the economies, livelihoods, and way of life for the people who live there. The abundant resources of the forests and waters have provided food, shelter, and livelihood for its peoples for thousands of years. The first inhabitants of the area, the Tlingit, Haida, and Tsimshian, adapted well to the coastal environment and developed a rich culture. The numerous waterways allowed for mobility, which aided in expanding trade and gathering food. Their cultural identities and traditional way of life are rooted in and tied to the land and waters of Southeast Alaska. Alaska Natives have continuously inhabited the Forest for more than 10,000 years and today are dependent on subsistence hunting and fishing and utilization of all Tongass resources to sustain their bodies as well as their traditions, cultures, and livelihoods.

In the 1700s, Russian exploration began in Alaska. The fur trade, primarily sea otter pelts, was the main force driving colonization. When most of the sea otter populations were depleted, the fur industry declined and Russia lost interest in its North American colony. Alaska was sold to the United States in 1867.

Colonization continued under U.S. ownership, and new industries developed. In the late 1800s, commercial fish canning became an important part of the economy of Southeast Alaska. During that same period, the discovery of gold brought thousands of miners to the area, and many were followed by their families. The most important of the early gold discoveries occurred in Juneau. In the early 1900s, the Depression brought a decline in mining employment, and the impact of World War II resulted in the closures of the last remaining mines.

The timber resource was used by the earliest inhabitants in a variety of ways, including making buildings, canoes, totem poles, and carvings. The Russians harvested timber for building ships and structures. In the earlier part of the century, small timber mills operated in a few communities. During the 1950s, two pulp mills were developed in Ketchikan and Sitka, and the timber industry became a major economic component of Southeast Alaska's economy.

In the 1950s, Alaska focused its attention on statehood, and on January 3, 1959, became the 49th state of the United States. This resulted in an increase in

government employment and, coupled with the growth of the timber industry, a gradual shift towards a more diversified economy.

More than 74,000 people live in the towns, communities, and villages of Southeast Alaska. Most of the region's population is concentrated in a few communities, the largest being Juneau, Ketchikan, Sitka, and Petersburg. Services, state and local government, and retail trade were the largest economic sectors by employment in Southeast Alaska in 2013, accounting for 26, 23, and 11 percent of total employment, respectively. Employment in natural resource-based industries remains important in many of the region's communities. Tourism, which has increased in recent years, provides another important source of regional employment and income. Many rural communities continue to depend primarily on fishing, timber production, and subsistence uses.

Organization of Chapter 3

The remainder of Chapter 3 is divided into three broad parts:

- Physical and Biological Environment
- Human Uses and Land Management
- Economic and Social Environment

The resources that make up the physical and biological environment are described first and the effects of the alternatives are analyzed. This part sets the stage for the next part—the evaluation of human uses and land management. Finally, both of these parts set the stage for the final part—the economic and social environment. The focus is on significant effects, with the analysis centered on the key issues related to the Forest Plan amendment.

Physical and Biological Environment

Climate and Air

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Affected Environment

Climate

The Tongass National Forest occupies an archipelago and a narrow strip of the mainland between the Pacific Ocean and the crest of the coastal mountains. The configuration of the coastline, the warm Japanese ocean current, and the high coastal mountains combine to produce a cool, wet environment. According to climate summaries and narratives developed by the Western Regional Climate Center (WRCC 2008), precipitation at sea level in Southeast Alaska ranges from 30 inches per year at Skagway to 220 inches per year at Little Port Walter. Precipitation increases with elevation. It is estimated that the average annual precipitation may be as high as 400 inches on the mountains of southern Baranof Island and about 260 inches over the Juneau Icefield. Southeast Alaska has complete cloud cover approximately 85 percent of the year. Snowfall varies according to elevation and distance inland from the coast. October is generally the wettest month. May through July are, on average, the drier months. The Pacific maritime influence holds the daily and seasonal temperatures within a narrow range. Temperatures average 28 degrees Fahrenheit (°F) in the winter and 52°F in the summer (USDA Forest Service 2013b). During the warmer months, temperatures are highest inland and lowest along the coasts, while in the colder months, the reverse is true. Storms and moderate to heavy precipitation occur year-round, but occurs most commonly from September through November. The abundant moisture supports an extensive temperate rain forest and feeds numerous streams, rivers, and lakes, which in turn provide valuable fish habitat.

Climate Change

Southeast Alaska experiences considerable year-to-year and decade-to-decade variability in its weather, associated with large-scale shifts in ocean temperatures, salinity levels, and ice conditions. In fact, there is an inherent level of climate variability in the Pacific Northwest (which includes Southeast Alaska) associated with Pacific Decadal Oscillation (PDO), or the shift between two different circulation patterns that occurs every 20 to 30 years in the northern portion of the Pacific Ocean; as well as other multi-year sea-surface temperature anomalies. Shifts in the location of cold and warm water in the Pacific Ocean alter the path of the jet stream, and thus result in cyclical changes in weather patterns typified by “warm” and “cold” phases (Mantua et al. 1997).

Southeast Alaska’s climate has shown a strong warming trend since the middle of the 19th century (i.e., the end of the Little Ice Age), as has much of the Northern Hemisphere (Parson et al. 2001). A portion of this change in Southeast Alaska’s average temperature is likely the result of the natural changes in the

earth's climate, which are caused in part by "wobbles" in the earth's rotation around the sun resulting in changes to earth's position within its elliptical path (i.e., the precession of equinoxes) as well as the PDO discussed above. However, recently (in geological terms) humans have contributed to the acceleration of natural climate change on a global level through multiple activities such as the burning of fossil fuels, which have released greenhouse gases into the environment, as well as reducing natural carbon sinks (Intergovernmental Panel on Climate Change [IPCC] 2014; USDA Forest Service 2015a). The potential impacts of accelerated climate change on the ecosystems of Southeast Alaska may include acidification of ocean waters; increasing the temperatures of ocean and streams; altering water input sources; changing precipitation rates and patterns; increasing the rate of glacier retreat; increasing storm intensities; altering ecosystem composition and structure; altering species distributions; and altering fire regimes (Wolken et al. 2011; Shanley et al. 2015; EcoAdapt 2014).

The impacts of climate change have been, and will likely continue to be, more pronounced in the most northern and southern regions of the globe. Alaska, which is located farther north than any other U.S. territory or state, has experienced an increase in annual temperatures at twice the rate of rest of U.S. (Haufler et al. 2010; Chapin et al. 2014). Alaska's annual average temperatures have increased by 3.4°F over the last 50 years, with an increase of 6.3°F in average winter temperatures (Haufler et al. 2010; Chapin et al 2014; U.S. Environmental Protection Agency [EPA] 2014a). The average number of snow-free days has also increased in Alaska by about 10 days (Chapin et al. 2014).

The observed changes to the climate in Southeast Alaska have resulted in modifications to ecosystem processes and ecosystem services on the Tongass National Forest. For example, the warmer summers have led to longer growing seasons for trees and other vegetation, while warmer winters have resulted in more insect outbreaks, plant diseases, and population declines for some plant species.[1] The warming trend has also reduced snowpack in low-elevation areas, which may be contributing to ongoing yellow-cedar decline.[2] Drier summers may have also contributed to the number and duration of low stream-flow episodes, which can have adverse effects on salmon while warming of some watersheds may increase productivity for some fish populations (EcoAdapt 2014). The increase in the amount of precipitation falling as rain instead of snow since the 1970s has reduced the frequency of low- and moderate-elevation avalanches, which has allowed mountain hemlock to colonize some alpine areas (EcoAdapt 2014; Shanley and Albert 2014). Furthermore, although Alaska has not yet experienced the same extensive rate of establishment by invasive plant species that has historically occurred in rest of the U.S., the current and predicted milder winter temperatures and the longer growing season in Southeast Alaska have created opportunities for the spread and establishment of invasive plant species within this region (Bauder and Heys 2004; McKee 2006; Wolken et al. 2011).

The ongoing changes to Alaska's climate, as well as to the temperate forests in this region, can have global consequences. For example, recent data show that the melting of glaciers and ice sheets in Alaska has contributed more to the global increase in sea levels over the past 50 years than any other glaciated

[1] In 2014, Alaska Region Forest Health Protection surveyed 4.5 million acres of the Tongass National Forest and mapped 51,000 acres of insect and disease damage. The most widespread damage type was recorded for yellow-cedar (which had a decline of about 19,600 acres), followed by 12,000 acres of spruce defoliation. Seventeen other infestation/damages were mapped, most notably cottonwood defoliation, hemlock sawfly, and general conifer defoliation (Heutte, pers. comm. 2015).
[2] Almost 585,000 acres of yellow-cedar decline have been mapped in Alaska through aerial detection surveys since the surveys began in the late 1980s, with extensive mortality occurring in a wide band from the Ketchikan area to western Chichagof and Baranof Islands (USDA Forest Service 2015b).

region that has been measured, with the exception of the Greenland and Antarctic ice sheets (Wolken et al. 2011; Chapin et al. 2014). The coastal-temperate forests in Southeast Alaska comprise approximately 10 percent of Alaska's total forests and 19 percent of the world's coastal-temperate forests (Wolken et al. 2011). Although these coastal forest types are confined to a relatively small footprint globally (covering less than 0.5 percent of the earth's total forested area), they play a critical role in the delivery of dissolved organic carbon to coastal oceans (Wolken et al. 2011). In addition, these forests currently sequester and store large quantities of carbon (DellaSala 2014; DellaSala 2016; Law 2014). As a result, Southeast Alaska plays an important role in the global climate and carbon cycle.

Climate Models

There are several models that examine the potential future climate conditions and/or trends in Alaska's climate. The most reliable models suggest warmer, wetter conditions for Alaska. They generally state that rainfall may increase and snowfall may decrease at lower elevations in Southeast Alaska over the next 50 to 100 years (Bonsal and Prowse 2006; SNAP 2013). The Scenarios Network for Alaska & Arctic Planning (SNAP) recently developed a model for climate projections in Southeast Alaska (SNAP 2013 as cited in EcoAdapt 2014). SNAP's projections suggest that mean winter temperatures in Southeast Alaska may increase by an additional 1.8 to 6.3°F (or 1 to 3.5 degrees Celsius) by the year 2050 (SNAP 2013 as cited in EcoAdapt 2014). Their model also suggests that precipitation levels may increase in all seasons, with winter precipitation potentially increasing by 5 to 15 percent by 2050. The effects that this would have on local conditions would vary; with the increased precipitation potentially resulting in increased snow occurring at higher elevations where temperatures remain below freezing. Lower elevations could experience a shift from snow to rain and a decrease in snowpack as the lower elevations warm and the number of days with below freezing temperatures decrease (SNAP 2013 as cited in EcoAdapt 2014).

Carbon Sequestration

Carbon, primarily in the form of carbon dioxide, is one of the major greenhouse gases being released into the atmosphere through both natural and anthropogenic (i.e., human-driven) influences (McPherson and Simpson 1999; IPCC 2014). This atmospheric carbon, as well as other gases (e.g., methane, nitrous oxide, and water molecules), traps the sun's heat, thereby creating a natural "greenhouse effect" that makes life on earth possible (McPherson and Simpson 1999). The amount of carbon dioxide in the atmosphere is regulated by complex interactions between the atmosphere, terrestrial environment, marine environment, and geologic processes. Recent changes to the global carbon cycle, driven in large part by human activities, have been cited as one of the leading causes for global climate change and the general warming trend that has been detected (IPCC 2014).

The Tongass National Forest stores more forest carbon than any other national forest in the United States (Barrett 2014). As such, a critical ecosystem service sustained by this forest is carbon sequestration (i.e., the removal of carbon dioxide from the atmosphere and keeping that carbon inactive by storing it in live or dead biomass as well as organic soil matter). This makes the Tongass National Forest a critical component in the global carbon cycle (DellaSala 2014; DellaSala 2016; Law 2014).

Generally, the capacity of a forest system to sequester and store carbon depends on the location, age, and species composition of the forest (Birdsey et al. 1993; McKinley et al. 2011). In some forests found in warmer climates, the accumulation of carbon can decrease overtime as the carbon stored in soils and dead vegetative materials are released through the process of organic decay. However, the cool conditions on the Tongass National Forest slow down the rate of decomposition, which includes biomass breakdown/decay and carbon release. The dead or decaying plant matter is incorporated into the system's soil profile within the Tongass National Forest, where it accumulates and resides in various stages of decomposition for prolonged periods. As a result, mature forests within the Tongass National Forest generally store considerable amounts of carbon on the forest floor and in the soil profile. Smith et al. (2004) estimated that approximately 70 tons per acre of carbon are stored on the forest floor in the hemlock-Sitka spruce ecosystems found on the Tongass National Forest. Furthermore, some studies have indicated that trees can continue to accumulate carbon at increasing rates as they mature, thereby resulting in large amounts of carbon stored annually within mature trees (Stephenson et al. 2014). As a result, mature forests on the Tongass National Forest likely store considerably more carbon compared to younger forests in this area (within the individual trees themselves as well as within the organic soil layer found in mature forests).

Although the organic soils of the Tongass National Forest currently store considerable amounts of carbon, D'Amore and Lynn (2002) note that numerous studies have shown that carbon stored in soils may be released to the atmosphere in the form of carbon dioxide or methane, as the climate warms. Davidson and Janssens (2006) noted that many factors can affect the sensitivity of soil decomposition rates to increased temperatures (e.g., the relative mix of organic to mineral substrates, soil moisture levels, as well as other biotic and abiotic conditions) and that not all organic soil types would be equally sensitive to increased temperature; however, D'Amore has indicated that the organic layers in the soil profile of mineral soils as well as organic soils in general on the Tongass National Forest would likely experience increased decomposition rates if average temperatures were to increase (D'Amore et al. 2015; D'Amore 2016). As a result, the projected increases in average temperatures as a result of climate change could result in the release of portions of the carbon currently stored in the Tongass National Forest's soil layers. In addition, the clearing of forested areas during past and ongoing harvesting activities can increase this effect, by increasing the amount of solar energy that is allowed to reach the ground while the forest regenerates following a harvest. The projected increase in average temperatures and longer growing season could also increase the growth rates of fungi in temperate-forests (a taxa that aids in the decomposition of forest material) which would also increase the rate of carbon released to the atmosphere (e.g., currently stem-decay fungi consume approximately 31 percent of the volume of live trees; Wolken et al. 2011). Furthermore, dissolved carbon may be transported to streams and the ocean due to the increased precipitation predicted to occur over the next 50 to 100 years. Increased stream temperatures can also result in an increased rate of carbon released from aquatic systems.

Previous studies have been conducted to determine how much carbon is stored on the Tongass National Forest. Barrett (2014) examined the storage and flux of carbon in live trees, snags, and logs in the Tongass National Forest.[3] On the Tongass National Forest, growth and recruitment of live trees removed an estimated 760 pounds of carbon per acre per year from the atmosphere, but net change in live carbon mass was not significantly different from zero, with mortality and harvest estimated at 670 pounds of carbon per acre per year (Barrett 2014). Including its wilderness areas, aboveground live and snag carbon on the Tongass National Forest is estimated to be 601 (± 21) million tons on an estimated 9.7 million acres of forest.[4] Some 233 million tons of this carbon are on lands that are legally excluded from timber harvesting, such as formally designated wilderness areas (Barrett 2014). Total carbon densities on unmanaged forests were estimated as 72 tons per acre, which comprised 7 percent logs, 13 percent snags, and 80 percent live trees. Carbon densities on managed forests were estimated as 45 tons per acre, which comprised 38 percent logs, 8 percent snags, and 54 percent live trees (Barrett 2014). On a per-acre basis, the Western hemlock and Sitka spruce forest types were found to have the highest amount of carbon (Barrett 2014). Using the per-acre values by forest types, and extrapolating to include wilderness areas, provides a rough estimate of about 650 million tons in aboveground tree carbon on the Tongass National Forest, equivalent to 2.4 billion tons of carbon dioxide (CO_2; Barrett 2014). To put this in perspective, an estimated 83,500,000 billion metric tons of carbon are stored worldwide, primarily in the oceans and marine sediment, based on United Nations estimates. D'Amore and Edwards (no date) estimated that the carbon stored in the Tongass National Forest makes up about 8 percent of the carbon currently stored in the forests of the United States. Leighty et al. (2006) estimate that between 6.4 and 17.2 million metric tons (0.2 to 0.6 percent) of stored carbon has been lost on the Tongass National Forest since timber harvest began in the early part of the 20th century. For comparison, approximately 2,039 million metric tons of carbon was released to produce electric power in the United States in 2012 (U.S. Energy Information Administration [EIA] 2013). The total U.S. carbon emissions in 2012 (which includes the electric sector discussed above, as well as other sections such as industry, transportation, agriculture, and commercial/residential) were approximately 6,526 million metric tons (EPA 2014b).

Interest in enhancing ecosystem carbon sequestration and storage has intensified recently, as concerns about how to mitigate climate change have increased. The question of how active management of ecosystems may contribute to, or detract from, this mitigation effort is being explored, with varying results. A few studies have shown that the management of some forests with certain parameters being met (such as the addition of fertilizer) may result in heightened capacity for carbon sequestration and storage (Schroeder 1991; Binkley et al. 1997). A study in the eastern United States found that thinning a 50-year-old stand from below (i.e., removing the smallest trees) resulted in more stored carbon after 25 years than resulted from thinning stands from the middle or from above (Hoover and Stout 2007). A study conducted in the Pacific Northwest (Perez-Garcia et al. 2005) concluded that the use of wood in permanent structures resulted in "*significant atmospheric carbon reductions by displacing more fossil fuel-intensive products in housing construction*." However,

[3] A number of carbon pools and fluxes were not included in Barrett's report, including (1) carbon in non-forested lands, which includes alpine environments, wetlands, grasslands, and shrublands; (2) below-ground carbon, including roots, soils, and organic materials; (3) carbon in non-tree vegetation and litter within forest; (4) carbon in a few pools currently not measured by FIA, which includes stumps below 4.5 feet and dead saplings; and (5) carbon in forest lands in inaccessible wilderness.
[4] Note that this does not represent a complete accounting of stored carbon, as it does not take into consideration carbon stored in the soil, nor does it take into consideration the stored carbon present in the final products of the harvested timber.

Harmon et al. (1990) noted that even when timber is used for permanent construction purposes, 35 to 45 percent of the wood's biomass is lost to sawdust or scraps created during the processing; therefore, the final amount of carbon ultimately stored in permanent construction is much less than was originally harvested. Other studies, particularly two with application to Southeast Alaskan ecosystems (Harmon et al. 1990; Leighty et al. 2006), indicate that the Tongass National Forest would generate a net release of carbon to the atmosphere if active harvest of old growth is pursued (in other words, harvesting old growth instead of young growth could reduce the carbon sequestering ability of the forest).

As discussed above, timber harvesting and active forest management can affect a forest's ability to store and ultimately sequester carbon. DellaSala (2014, 2016) suggested that a logged forest would emit substantial amounts of carbon for at least the first 15 years following harvest, and that a young regenerating forest would remain a net carbon emitter for up to 50 years. Janisch and Harmon (2002) suggested that it can take more than 200 years following a timber harvest for forests to reach equilibrium (i.e., the point where carbon released from the initial harvest as well as ongoing decay of organic materials equals the amount of carbon that is absorbed into the system). The net effect of a timber harvest and active forest management action (i.e., amount of carbon released versus the amount stored) would depend on how the harvested timber was used (e.g., if it was used for durable timber products, paper, pulp, or biomass fuels[5]), what substitute materials are available for construction purposes (i.e., non-wood materials), the amount of carbon emitted during harvesting activities, the amount of carbon emitted via decomposition of on-site wood and organic soil matter losses, and the influence of the harvested wood on timber markets elsewhere (McKinley et al. 2011; Jonsson et al. 2012). If the emissions are less than the carbon stored in utilized wood, and if the system can rapidly replace losses from decomposition through tree growth, the activity may ultimately yield a net gain of stored carbon; otherwise, the activity would result in a net loss of stored carbon (which would have an adverse effect on carbon sequestering and potentially climate change rate). Although the amount of carbon that has been released on the Tongass National Forest since harvesting began has not been tracked or monitored, based on the understanding of carbon dynamics outlined in Barrett (2014), we can infer that the past harvests and management of the Forest has likely resulted in a net release of carbon to the atmosphere due in part to the practice of harvesting of old-growth timber on the Forest.

Air Quality

The air quality of Southeast Alaska and the Tongass National Forest is generally good. The prevalent airflow from the Pacific Ocean, the relatively small amount of industrial development in Southeast Alaska, the lack of large population centers, the absence of slash burning following harvest, and environmental regulations all contribute to maintaining clean air. Forest activities have historically had little direct effect on air quality on the Tongass (USDA Forest Service 1997a). However, cruise ship emissions in certain locations and trans-Pacific pollutants such as persistent semi-volatile organic pollutants and greenhouse gases are a growing concern.

The State of Alaska Department of Environmental Conservation (ADEC) under the Clean Air Act, via Title 1 and Title 5 of the EPA approved State Implementation Plan regulates air emission from stationary sources. ADEC

[5] If the harvested materials were all used for biomass fuels or other products that would be burned, this would result in a net release of substantial amounts of carbon to the environment (Holtsmark 2012; DellaSala and Koopman 2015). However, the Tongass Forest Plan does not specify how the harvested timber would be used, and the Forest is not managed for biomass fuels.

issues air permits to industrial sources that demonstrate compliance with the Alaska Ambient Air Quality Standards, which are identical to the National Ambient Air Quality Standards (NAAQS). The primary standards were developed to protect public human health and the secondary standards to protect public welfare. Six criteria pollutants are included in the NAAQS: sulfur dioxide (SO_2), carbon monoxide (CO), lead, ozone, nitrogen dioxide (NO_2), and particulate matter with a diameter of less than 10 microns in size (PM_{10}) and less than 2.5 microns in size ($PM_{2.5}$). The NAAQS are provided in Table 3.1-1.

Table 3.1-1
Criteria Pollutants, National Ambient Air Quality Standards

Air Pollutant	Averaging Period	Primary NAAQS	Secondary NAAQS
SO_2 (ppb)	1-Hour [1]	75	NA
	3-Hour	NA	500
CO (ppm)	1-Hour [2]	35	NA
	8-Hour [2]	9	NA
NO_2 (ppb)	1-Hour [3]	100	NA
	Annual	53	53
Ozone (ppm)	8-Hour [4]	0.075	0.075
PM_{10} (µg/m^3)	24-Hour [5]	150	150
$PM_{2.5}$ (µg/m^3)	24-Hour [6]	35	35
	Annual [7]	12.0	15.0
Lead (µg/m^3)	3-Month [8]	0.15	0.15

µg/m^3 = micrograms per cubic meter
ppb = parts per billion
ppm = parts per million
[1] NAAQS applies to the 3-year average of the annual (99th percentile) of the daily maximum 1-hour average concentration.
[2] NAAQS is not to be exceeded more than once per calendar year.
[3] NAAQS applies to the 3-year average of the annual (98th percentile) of the daily maximum 1-hour average concentration.
[4] NAAQS applies to the 3-year average of the annual 4th highest daily maximum 8-hour average concentration.
[5] Not to be exceeded more than once per year on average over 3 years.
[6] NAAQS applies to the 3-year average of the annual 98th percentile 24-hour concentration.
[7] NAAQS applies to the 3-year average of annual concentrations.
[8] NAAQS applies to the maximum arithmetic 3-month mean.

Air quality and sources of air pollution on the Tongass are described in Air Quality Monitoring on the Tongass National Forest: Methods and Baselines Using Lichens (Geiser et al. 1994) and Air Quality Biomonitoring with Lichens-Tongass National Forest (Dillman et al. 2007). An aerosol sampler near Petersburg was installed in 2004 as part of the Interagency Monitoring of Protected Visual Environment (IMPROVE) program. This was the only IMPROVE site in Southeast Alaska, with the next nearest station in Tuxedni Wilderness near Anchorage. Data from the IMPROVE site were collected over a 5-year period to observe trends and to determine regional, state, and national significance. A review of the latest data available (years from 2007 through 2009) at the IMPROVE site shows that $PM_{2.5}$ levels relative to NAAQS were well below the applicable thresholds near Petersburg (IMPROVE 2015).

Visual inspections of cruise ship emissions by wilderness rangers in Tracy Arm occur during the summer tourist season as part of an agreement with the State using EPA-approved methods. Also, the Tongass National Forest worked with the National Park Service in the Southeast Alaska Network and Forest Service Air Resource Program in Region 6 to coordinate a Southeast Alaska cruise ship emissions monitoring effort using passive air samplers in remote locations, including Tracy Arm (Schirokauer et al. 2014).

Juneau Air Quality

Juneau's Mendenhall Valley is the only area in Southeast Alaska that is known to have exceeded the NAAQS. The EPA listed Juneau City and Borough as a non-attainment area for particulate matter less than or equal to 10 micrometers in 1990. The area is classified as Moderate for this component of air quality, with an average daily rating of 110 out of a maximum of 500. Monitoring data indicate that air quality in Juneau has met state and federal ambient air quality standards in recent years. No state or federal ambient air quality standards have been exceeded since 1997. The last time particulate matter standards were exceeded in Juneau was in 1994 (ADEC 2014a). The State, via their approved Mendenhall Valley attainment plan (59 FR 13884), established control measures to maintain PM_{10} levels and to strive to achieve attainment status (EPA 1994). Because no exceedances have been monitored recently, on May 9, 2013, the EPA granted the request by the State to redesignate the area from nonattainment to attainment for PM_{10}. Areas like Juneau, Alaska, that have been redesignated as attainment areas are classified by EPA as maintenance areas (EPA 2014c).

Lichen tissues were collected on Mt. Roberts in the downtown Juneau area at five different elevations as part of the Tongass lichen biomonitoring program and in collaboration with the State. The lichen tissues analyzed were elevated above threshold levels in all five plots in three or more elements including sulfur, nitrogen, and heavy metals. Lichens from the plot at 175 feet above sea level had the greatest number of elements above threshold (i.e., 12 pollutants), indicating that the sources are probably local and anthropogenic (Dillman et al. 2007).

Sources of Air Pollution

There are 36 stationary sources of air pollution in Southeast Alaska that require air quality control permits as of 2015. These include diesel power plants, asphalt plants, incinerators, mining facilities, and other facilities. Some of these sources operate intermittently (e.g., back-up power plants may operate during power failures or during peak demand periods, and asphalt plants may operate seasonally), and others may be operating at full capacity (e.g., Greens Creek mine).

Other sources of air pollution in Southeast Alaska include mobile sources (such as cars, trucks, boats, cruise ships, airplanes, and helicopters) and area sources (such as home furnaces, wood stoves, and open burning). Under certain weather conditions, wildfires in Canada can affect air quality and visibility (i.e., regional haze) in parts of Southeast Alaska, although no advisories were issued by ADEC in 2013 or 2014 for the Tongass.

Cruise ship traffic has greatly increased in Southeast Alaska over the last several years. There were 489 planned cruise ship visits in Juneau during 2015, with an annual average number of visits of 492 ships for the 2014 to 2015 seasons (CLAA 2014a, 2014b). Cruise ship emission monitoring in Juneau by ADEC indicates that ship emissions are well within federal and state standards.

Cruise ship traffic in Tracy Arm creates a particular concern for air quality in Wilderness. Tracy Arm received 200 cruise ship visits in 2009 (USDA Forest Service 2009a). Tracy Arm is less than a mile wide (on average) and is surrounded by high mountains. Cruise ship emissions may linger above the fjord for hours. The emissions are most heavily concentrated in upper Tracy Arm, where vessels stop near the South Sawyer Glacier for 1 to 4 hours (depending on ice conditions). Ship emissions often increase because of rapid changes in engine loading necessary for the ship to maneuver through ice and turn around.

The Forest Service has received an increased number of public complaints concerning air quality within the Tracy Arm. In an effort to better address the visibility concerns in the Wilderness resulting from cruise ship emissions, the Forest Service and ADEC have developed a Memorandum of Understanding to train Forest Service wilderness rangers to visually monitor cruise ship emissions with EPA-approved standards. ADEC annually reviews the visible emission observations and takes action on any that exceed the State Marine Vessel Emission standard (18 AAC 50.070) (ADEC 2014b).

Three lichen biomonitoring plots were established within Tracy Arm. All were revisited in 2011 and 2012; results indicate that levels were at or above thresholds for sulfur, nitrogen, potassium, manganese, and silicon.

Environmental Consequences

Direct and Indirect Effects

Air Quality

The expected direct effects on air quality from forest management activities would be temporary and limited in nature, resulting from dust and vehicular emissions from logging operations, administrative and harvest-related use of Forest roads, and facilities and equipment required to support energy development. None of the alternatives considered would include broadcast burning of slash following harvest, which is seldom if ever used on the Tongass National Forest.

Alternatives 2, 3, 5, 4, and 1 would result in progressively more potential total harvest, road construction/reconstruction, harvest-related vehicle use and/or helicopter use, and wood processing comparatively, which could subsequently result in progressively more potential emissions by alternative (including emissions of green-house gases). However, due to the short-lived nature of these activities coupled with dynamic weather patterns throughout Southeast Alaska (consistent wind and rain throughout the year), no significant adverse effects on air quality are anticipated from these activities under any of the alternatives considered.

Indirect effects on air quality can result from the use of trees harvested from the Tongass National Forest, such as in the operation of industrial processing sites and firewood burning, as well as emissions from private vehicles using Forest unpaved roads. These indirect effects on air quality can be aesthetically displeasing or have potential health risks to both humans and the Forest. EPA and ADEC have limited regulatory responsibility, under the Clean Air Act, for air quality related to these kind of sources. The enforcement of the applicable regulations by these agencies is anticipated to keep any potential adverse effects within the standards for air quality; therefore, no significant indirect effects from the uses of the Tongass National Forest should occur.

Climate Change / Carbon Sequestration

The Tongass National Forest plays an important role in amount of carbon that is stored globally as well as the global climatic condition (see the discussion above in the Affected Environment section). As a result, land management and other actions taken on the Tongass National Forest can affect climate change at a local, regional, and global scale. Although there is a substantial amount of recent literature about the effects of forest management on climate change and carbon storage, different authors have reached widely different conclusions about net sequestration rates/effects due to different assumptions made regarding pre- and post-harvest decay rates, the amount of energy that would be expended during

the harvesting and transportation of timber, utilization rates and lifespan of wood products, future growth rates of young-growth stands, the substitution of wood for other products, and market leakage (e.g., Harmon et al. 1990; Birdsey et al. 1993; McKinley et al. 2011; Jonsson et al. 2012). Some of these factors may contribute to a net removal of carbon from the atmosphere, while other components can increase the carbon emission rate. Each of the harvesting alternatives would affect the amount of carbon that is stored in the forest; however, the amount/extent of this effect would depend on the time scale of consideration; how much of the wood is removed/harvested from the forest; how the wood is used; and how much carbon is released in cutting, yarding, transporting, and processing the wood as well as in soil carbon and woody debris decomposition (see discussion above, in the "Affected Environment" section). These factors and how they relate to the proposed alternatives are discussed in more detail below.

The harvesting of old-growth trees can reduce the carbon storage capacity of the forest and result in a net loss of carbon from the forest and into the atmosphere (Harmon et al. 1990; Leighty et al. 2006; also see the discussion in the Affected Environment section). The Tongass National Forest is unique within the National Forest System in regard to the substantial amount of old growth that is present outside of wilderness areas on the Forest. Also unique is the proportion of harvesting that has occurred in old-growth forest acres as opposed to young-growth acres during recent decades. Harvesting of old-growth creates an initial net release of CO_2 into the atmosphere relative to leaving stands unmanaged, and this release of carbon can continue for years as logs and snags left after harvest continue to decompose (Harmon et al. 1990). Some of the forest's carbon may be stored in the wood products that are produced following a harvest; however, the carbon in these products will transition back into the atmosphere over time as they degrade or are disposed of. For example, because harvest levels peaked in the 1970s, and much of the resulting wood products may now be in landfills, wood products from the Alaska Region are now believed to be a net emitter of carbon (Barrett 2014). In addition, approximately 35 to 45 percent of a tree's biomass is lost to sawdust or scraps during processing; therefore, the final amount of carbon ultimately stored in wood products would be less than was originally harvested (Harmon et al. 1990), likely resulting in a net release of stored carbon. In addition, some of the wood products could be burned as part of biomass energy production, which would rapidly release the stored carbon into the atmosphere (Holtsmark 2012; DellaSala and Koopman 2015).

Conclusions regarding carbon storage, carbon emissions, and ultimately sequestration can be strongly influenced by the temporal scale examined. For example, DellaSala (2014, 2016) suggested that a logged forest would emit substantial amounts of carbon for at least the first 15 years following harvest, and that a young regenerating forest would remain a net carbon emitter for up to 50 years. Janisch and Harmon (2002) suggested that it can take more than 200 years following a timber harvest for forests to reach equilibrium. Therefore, it appears that harvesting options proposed in the five alternatives considered would likely result in a net release of carbon in the short to medium timeframe (i.e., within the first 50 years following harvest), and could remain a net contributor to carbon emissions for more than 200 years.

The current land management plan for the Tongass National Forest focuses timber harvest primarily on old-growth forests (i.e., Alternative 1 would keep this practice as the primary management tool); and as discussed above, harvesting old-growth timber reduces the carbon storage and ultimately the carbon sequestration ability of forests in Southeast Alaska. Each of the Action Alternatives

considered for the plan amendment (i.e., Alternatives 2 through 5) would involve some harvesting of old-growth forests over a period of time (see Chapter 2); however, these would be at levels lower than what is currently allowed under the 2008 Forest Plan. As a result, although each of the alternatives would result in a net release of carbon to the atmosphere, all action alternatives would result in a lower carbon emissions and potentially higher sequestration compared to the current plan (i.e., Alternative 1) due to the extent of old-growth forests that could be harvested under the No Action Alternative. Based on the 25-year projection, Alternatives 2 and 3 would have the lowest potential old-growth harvest compared to the other alternatives considered, while Alternative 1 would have the highest potential old-growth harvest and the lowest potential total harvest (i.e., the total harvest level that includes both old-growth and young-growth harvests in the calculation) compared to the other alternatives. Alternative 2 would have the highest potential total harvest. (see Table 3.13-7 in the *Timber* section).

The assessment provided above in this section employs a qualitative evaluation of carbon sequestration. A qualitative evaluation of the differences among alternatives provides the most certain and reliable illustration of potential differences between alternatives. A preliminary quantitative (i.e., numeric) assessment is feasible, but the quantitative results would include a large amount of error or uncertainty, such that the calculated differences between the alternatives would be difficult to discern. As outlined in McKinley et al. (2011) quantitative assessment of forest carbon must carefully address uncertainty; and portions of a quantitative analysis for this project with particularly high uncertainty include the following:

1. While the amended plan specifies limits in timber harvest from old-growth and young-growth forest, it is unknown when forests will be harvested or the extent of harvest that would occur at any particular time (i.e., at or below the specified limit), for any alternative. This leads to high uncertainty in estimating differences in carbon pools over time.
2. The differences among alternatives in regard to the transportation of wood (location transported or shipped to) cannot be accurately estimated at this time.
3. Similarly, differences among alternatives in the types of forest products that will be produced from trees harvested on the Tongass is unknown (e.g., product type influences the timing and amount of carbon stored).
4. Finally, there are differences related to market leakage (McKinley et al. 2011; Jonsson et al. 2012) associated with timber harvest.

All these factors have a very high level of uncertainty at the Forest Plan level. Consequently, the programmatic assessment cannot compare quantitatively (within reasonable accuracy) the carbon emission or sequestration differences among alternatives,[6] Because of the large uncertainties in a quantitative life-cycle assessments for this amendment, we adopt a qualitative approach and focus on acres harvested, miles of road built, etc., which provides a more

[6] In addition to examining only standing carbon stocks, carbon mitigation can also be assessed through life cycle analysis. A recent synthesis of findings about the mitigation effectiveness of alternate forest management and wood use options concluded: *In the long term, sustainable forest management strategy aimed at maintaining or increasing forest carbon stocks, while producing an annual yield of timber, fiber, or energy from the forest, will generate the largest sustained mitigation benefit* (IPCC 2007). In a multi-use context, we are not suggesting that all lands be managed to generate the largest sustained carbon mitigation benefit, but rather simply citing IPCC scientists that research is being conducted on additional approaches that may lead to other conclusions. For example, Vose et al. (2012) report that life cycle evaluations of management and wood use options suggest more intensive approaches to wood production, harvest, and use to maximize carbon mitigation (Vose et al 2012).

transparent, tractable evaluation of the relative differences between alternatives. As discussed above as part of the qualitative assessment, it is anticipated that each of the alternatives would result in a net increase in carbon emissions, and Alternative 1 is estimated to have the highest contribution to short-, mid-, and long-term carbon emissions.

All alternatives include standards and guidelines that protect soils, such as standards/guidelines related to harvesting on steep slopes, roads built across steep slopes, and on soil disturbing activities. These measures would help retain carbon stored as organic material in the soil. Also, unlike many areas of the country, broadcast burning to reduce slash is not practiced on the Tongass; therefore, much more of carbon stored on the forest floor and in the upper layers of soil is retained compared to sites that are broadcast burned.

Cumulative Effects

Air Quality

Cumulative effects on air quality include harvest-related emissions from state and private land, vehicle and maritime emissions, permitted uses such as community incinerators, industrial operations, cruise ship emissions, and electricity generation. Appendix C provides a full list of all the projects considered in the cumulative effects analysis.

Most of the logs harvested on private land are expected to be exported; therefore, locally there would be little additional emissions due to processing and/or burning wood from state and private land locally. Because of the temporary and limited effects associated with timber harvest on National Forest System (NFS) lands, the alternatives are not expected to contribute significantly to cumulative effects on air quality. Air pollution from wood processing is likely to remain low, but could increase somewhat if more wood is burned to produce energy.

Emissions from vehicles, maritime activities, cruise ship operations, community incinerators and industrial operational emissions would continue to contribute to cumulative effects on air quality. There are no known substantial increases in these activities, and therefore, they are expected to continue to be a negligible source of air quality emissions.

Each of the action alternatives (i.e., Alternatives 2 through 5) would remove the windows[7] and avoidance language under the Transportation and Utility System (TUS) Land Use Designation (LUD) requirements and replace it with Renewable Energy Plan Components. Some areas would remain designated as TUS "avoidance"[8] areas under Alternative 1. See the Renewable Energy Section for more information on TUS windows and avoidance areas. There are preliminary

[7] A TUS "window" is an area potentially available for the location of transportation or utility corridors and sites. Windows represent areas of future opportunity where the applied management direction will not conflict with future designation of a TUS. A site-specific analysis is still required during project-level planning, to identify resource protection needs within these areas. Windows are designated through the allocation of lands to TUS windows in their standards and guidelines.

[8] A TUS "avoidance area" is an area where the establishment and use of transportation or utility corridors and sites is not desirable given the LUD emphasis. A search for "windows" should be exhausted before TUS facilities are considered in avoidance areas. When feasible, these areas should be avoided through site-specific analysis during project-level planning. Avoidance areas often include congressionally and administratively designated areas. Although special environmental or procedural considerations may be required for these areas, these special designations do not preclude consideration and use as a TUS. Avoidance areas are designated through the allocation of lands to LUDs specifically identified as TUS avoidance areas in their standards and guidelines. In cases where proposed or potential corridors are allocated to the TUS LUD that traverse other LUDs identified as TUS "avoidance areas," treat the corridors within such LUDs the same as TUS "windows" (subject to applicable laws).

plans for renewable energy projects in the Tongass National Forest that include hydropower, geothermal power, and tidal power production plants (Tetra Tech 2015). Although these renewable energy projects could still be built under Alternative 1, the Action Alternatives would likely streamline the development and permitting process for these projects making it more likely that they would be built. Although the Action Alternatives could make it more likely that renewable energy projects would be built, the plan does not specify or support any particular renewable energy type.

If built, these new power sources would require implementation of additional transmission lines and access roads to link the new power produced to the grid. Implementation of these renewable energy projects could result in long-term reductions in both air pollution and carbon emissions, as many communities may no longer have to rely on diesel generators if these new power sources are developed in the region. Nevertheless, initial development of renewable energy projects would result in temporary localized air quality impacts relating to construction of the projects and their support facilities (transmission lines and roads). Operationally, air quality emissions from these projects would likely be negligible, consisting of maintenance activities and worker trips. At this time it is not possible to quantitatively assess impacts from these types of developments because there is little to no detail available regarding these potential projects. Nevertheless, each of these renewable energy projects would proceed through their own National Environmental Policy Act effort where quantitative impact analysis would be competed and a determination of compliance with air quality standards would be made.

Periodic forest fires in western Canada would continue to pose a potential adverse air quality effect, although the infrequent and transitory nature of these events prevents the analysis of quantitative impacts to the Tongass.

Climate Change / Carbon Sequestration

This section will address two issues: 1) the cumulative effects of the proposed amendments and other past, present, and reasonable foreseeable actions on climate change and carbon sequestration; and 2) the cumulative effects of climate change on the Forest Service's future management of the Tongass National Forest.

The extent and scope of cumulative effects on climate change and carbon sequestration depends on the amount and condition of total forest land harvested (worldwide, as well as locally within Southeast Alaska); the use to which harvested wood is put; the use of the land post-harvest; how the non-NFS lands are managed (including private and state-managed lands within the U.S., as well as forests in other countries); on the amount of carbon released during harvest, processing, and transporting wood products; decomposition rates of organic materials; factors such as the amount of new hydroelectric or other renewable energy power projects that are built (e.g., those that might replace diesel generated power); future community expansion and development; as well as emissions from ongoing and future activities in the region. The anticipated scope and magnitude of many of these factors (e.g., the increased anticipated decomposition rates in organic materials in Southeast Alaska as average temperatures increase; the potential for new hydroelectric or other renewable energy power projects to be developed in the region; and emissions from ongoing and future activities) are discussed and analyzed above. It is anticipated that communities in the region and worldwide will continue to increase in some areas and decrease in others depending on local population sizes, as well as site-specific socioeconomic and other anthropogenic factors

(see the *Communities* section). It is uncertain how forested lands that are located outside of the U.S. would be managed by their respective governments or land-owners (and the Forest Service would have no jurisdiction over these foreign lands or entities), but it is likely that many of these areas will continue to be managed under their respective government's current forest management practices, as well as responding to global markets including the influences of the Tongass forest products on those markets leading to some level of market leakage (e.g., Jonsson et al. 2012). It is likely that most of the state and private commercial forest land in Southeast Alaska, except for state parks and some other state lands, would be managed for the production of forest products under any of the alternatives considered in this analysis. On Forest Service–managed lands, the maximum amount of suitable land on the Tongass that could be harvested would vary depending on the alternative selected (see the *Timber* section). Maximum levels of harvest would only occur if additional manufacturing facilities and markets are developed, as well as other factors such as funding and staff levels. If the products resulting from harvest are primarily lumber and other building materials, there is a potential that the carbon in these products would be stored for the life of the buildings, longer if the wood is recycled or placed in landfills. If the wood is used for paper products or fuel, carbon storage would be short term (Harmon et al. 1990). Any temporary storage of carbon in lumber products may be offset by carbon released during and after harvest, transportation, and processing.

Each of the alternatives would cumulatively add to the global effects of climate change by contributing to the net release of carbon to the atmosphere; however, the goal of the proposed amendment is to reduce the total old-growth harvest that could occur, and as a result, each of the Action Alternatives (i.e., Alternatives 2 through 5) would have lower cumulative effects to carbon emission levels compared to the 2008 Forest Plan (i.e., Alternative 1). Stated more directly, based on the extent of old-growth forest harvest, Alternative 1 would result in the lowest potential for carbon storage followed by Alternatives 4, 5, 2, and 3.

Climate change could impact the resources currently managed by the Forest Service as well as how the Forest Service manages the Tongass National Forest in the future. While there is general agreement among scientists that the climate of Southeast Alaska is warming, there is considerable uncertainty concerning the exact scope of the effects of climate change on the forests of Southeast Alaska and how best to deal with possible changes to the many resources managed on the Tongass.

Shanley et al. (2015) predicted that the increased temperatures and precipitation events estimated to occur in the region as a result of climate change would have the following effects to coastal temperate rainforests like those found in the Tongass National Forest: increased frequency of flooding and rain-on-snow events; an elevated snowline and reduced snowpack; changes in the timing and magnitude of stream flow, freshwater thermal regimes, and riverine nutrient exports; changing non-forested habitats; altitudinal and latitudinal expansion of lowland and subalpine forest types; shifts in suitable habitat boundaries for vegetation and wildlife communities; adverse effects on species with rare ecological niches or limited "dispersibility"; and shifts in anadromous salmon distribution and productivity (Shanley et al. 2015). Other effects on forests in the Tongass National Forest could include increased blowdown; increased tree mortality from insects and disease; increased fire frequency and severity; adverse effects on air quality; and changes to subsistence use and recreation.

If warmer winter weather results in higher insect populations and increased tree defoliation (as discussed above), there is a risk that increased dead material and

warmer weather may spawn more fires than are normal for the area. However, as Berman et al. (1998) state, it is difficult to predict the magnitude of the area likely to be burned in a region without an historic fire record, but they estimate that most fires would be small and of low intensity, suggesting a scenario in which 5,000 acres might burn over a period of decades (an average of approximately 100 acres per year). Juday et al. (1998) and Shanley et al. (2015) suggest that the effects of fires on resources are likely to be low in this region, but that the effects of insects and disease may increase. For example, Shanley et al. (2015) stated "[a]ssuming that seasonality of precipitation does not change significantly, fire will remain unimportant as a disturbance agent, but higher [mean annual temperature] is anticipated to increase the incidence and severity of insect and disease in lowland forests."

Plant and animal species will respond to changing climates individually; and some species or individuals will be more sensitive and vulnerable than others (Millar et al. 2006). For example, forest losses (either from climate induced increases in insects, diseases, or fire) could harm wildlife habitat, which in turn could adversely affect subsistence resources; while conversely, Juday et al. (1998) suggested that warmer winters could result in sustained higher populations of Sitka black-tailed deer, one of the most important subsistence resources for residents of Southeast Alaska and a major prey species for wolves. Juday et al. (1998) also postulate that warmer, drier conditions could increase stream temperatures and cause seasonal low flows, both of which could adversely affect salmon (EcoAdapt 2014). Berman et al. (1998) estimated that a 25 percent decline in salmon stocks would result in a loss of $25 million a year (approximately $31 million in current dollars). However, Oswood et al. (1992) state that melting glaciers would result in more runoff entering streams. This could offset any decrease in summer flows due to reduced summer precipitation, at least in the short run. In time, glacial mass would be reduced and their contribution to stream flow would decrease (EcoAdapt 2014). Oswood et al. also believe that climate change would result in changes to the nutritional levels of leaf material entering streams, but could not predict whether this would have a positive or negative effect of fish. Some recent studies have postulated that watersheds currently fed by snow may transition to rain-fed systems, thereby altering water storage and flow dynamics that can affect salmon health (Wolken et al. 2011; Shanley and Albert 2014). The rate of decline and mortality of yellow-cedar in Southeast Alaska may be increased as a result of climate change (Hennon and Shaw 1997; Wolken et al. 2011; Hennon et al. 2016), as the snowpack in low-elevation areas may continue to be reduced as a result of the warming trend, resulting in greater exposure of yellow-cedar's fine roots to freezing, especially in the southern portion of the region (see the *Forest Health* section).

Warmer temperatures are expected to result in a loss of carbon stored in leaf litter and soil organic matter, due to increased soil respiration (Bachelet et al. 2005). The clearing of forested areas during harvesting or other development actions could increase this effect, by increasing the amount of solar energy that is allowed to reach the ground.

Shanley et al. (2015) hypothesized that climate change could also affect the quality of timber products that could be harvested from this region. For example, they state that "[a]ccelerated forest growth rates, if driven by [mean annual temperature] warming, may in turn increase the quantity but decrease the tight grain quality of forest products from second-growth forests, relative to those harvested from primarily forests during the 20th century." Furthermore, some studies have found reduced productivity of forests throughout Alaska as a result of recent changes to climatic conditions (Wolken et al. 2011).

All of these factors and anticipated effects related to climate change can have both local and global implications to communities as well as associated social costs (Larsen et al. 2007; IPCC 2014; EcoAdapt 2014). These include changes to subsistence and recreational resources, impacts to infrastructure and land-use, changes to transportation routes and options, and potential impacts to public health as a result of climate change.

The Forest Service will continue to work with local stakeholders and Pacific Northwest scientists to develop measures to alert the Forest Service to trends that may affect the health of the Forest and the species that depend on it, as well as measures that could be implemented to minimize or adapt to the effects of climate change on managed resources. One monitoring effort that the Forest Service currently uses to track changes in vegetation is the Forest Inventory and Analysis-Forest Health Monitoring (FIA FHM) program. Researchers have analyzed the existing FIA data from plots containing epiphytic lichen, and vascular plant data to develop air pollution and climate models (Root et al. 2014). Annual insect and disease surveys also provide information on how climate change may be affecting forests. Stream gauges, some of which provide long-term data on stream flow, are another tool used by the Forest Service to monitor the effects of climate change on the Tongass National Forest. The ongoing work of the Forest Service, local stakeholders, and Pacific Northwest scientists will aid in developing management tools to address ongoing changes to the environment and climate.

Geology, Karst, and Caves

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Affected Environment

Geology

The Tongass National Forest is underlain by complex geology. Southeast Alaska is located near the boundaries between the Pacific and North American tectonic plates. During the past 170 million years, tectonic movements have brought massive crustal blocks from across the Pacific Ocean and lodged and welded them onto the edge of the North American plate. The resulting southeast-northwest trending rock belts, or accreted terranes, include a wide variety of geologic materials (Nowacki et al. 2001). As the Pacific and North American plates collided, the coastal mountains of Southeast Alaska were uplifted. More recently, fault movements have offset the accreted terranes, adding further geologic complexity to the region. This tectonic plate boundary forms part of the "Ring of Fire," the area around the Pacific Ocean that is high in volcanic, mountain-building, and seismic activities. Evidence of relatively recent volcanic activity exists within the Tongass National Forest. The Mount Edgecumbe volcanic field volcanic activity began about 600,000 years ago. Mount Edgecumbe itself formed as a result of several explosive eruptions 12,000 to 14,000 years ago. The volcanic field last erupted between 5,000 and 6,000 years ago. On the southern Tongass are two other volcanic fields that have developed during the late Pleistocene. The Craig volcanic field consists of 18 known vents that range in age from 847,000 to 6,700 years before present. The Ketchikan volcanic field consists of 30 vents ranging in age from 400,000 to 8,100 years before present (BP). These features consist of cinder cones, lava flows, rhyolite domes, and obsidian flows, many of which erupted subglacially or marginal to ice.

Together, these tectonic, seismic, and volcanic forces have resulted in many different geologic formations in Southeast Alaska. Within the Tongass National Forest, generalized lithologies have been delineated and include granitics, noncarbonated sedimentary, carbonate sedimentary, metasedimentary, complex sedimentary and volcanics, volcanics, and mafics/ultramafics (Nowacki et al. 2001). During the past 12.5 million years, many of these lithologies have been affected by glaciers.

Within the Tongass National Forest, recurrent ice sheets formed and spilled from the St. Elias and Coast Mountains onto adjacent surfaces (Nowacki et al. 2001). Pushing seaward, these continental ice sheets combined with smaller alpine glaciers descended from isolated island peaks. Together, the ice sheets and glaciers reworked the topography of the land by rounding mountains, scouring bedrock, depositing glacial sediments, and carving U-shaped valleys and submarine trenches. In some areas, unconsolidated sediments were left, including glacial till (ice-contact deposits), glacial outwash, and glacial marine sediments. During the last glacial maximum, ice flowed all the way to the continental shelf. As glaciers retreated worldwide, the ice sheet receded first at

coastal margins, then north and eastward along major channels and valleys into the mountains. Deglaciation was rapid and largely complete by 13,500 years ago.

The group of islands and fjords that currently make up the Tongass National Forest developed after the last major glacial retreat as seawater flooded the deeply incised valleys and trenches. Since deglaciation, coastlines have shifted dramatically due to tectonic events, worldwide sea level changes, and land rebound in the absence of the glaciers' massive weight. Elevated fossil-bearing marine beaches and deltas along the coastline indicate an uplift of the land relative to the sea since the last glacial maximum.

There are multiple sites with important vertebrate and invertebrate paleontological resources throughout the Tongass, including 220 million year-old sites on Gravina Island and the islands in Keku Strait (Baichtal 2006). Many important paleontological resources have been identified in caves on the Tongass National Forest. Paleontological resources are managed and protected on federal lands per Subtitle D of the Omnibus Public Land Management Act of 2009 (Public Law 111-11). The Forest Service recently issued new rules for paleontological resource preservation that became effective on May 18, 2015 (80 [74] Federal Register 21587-21638). The new rule addresses the management, collection, and curation of paleontological resources from National Forest System (NFS) lands including management using scientific principles and expertise, collecting of resources with and without a permit, curation, confidentiality of specific locality data, and penalties for illegal activities.

As a result of the geological processes in Southeast Alaska, the region's physiography is topographically complex. Broad physiographic areas in the Tongass National Forest include icefields, recently deglaciated areas, large mainland river systems, angular mountains, rounded mountains, hills, lowlands, and recent volcanic fields. These distinct areas reflect the geomorphic and glacial history of the land. Continental ice sheets flowed, scoured, and deposited materials, tectonics added blocks of distinct geology, and volcanism superimposed younger rocks.

Karst and Caves

The geology and climate of Southeast Alaska are particularly favorable for karst development. Karst is a comprehensive term that applies to the unique topography, surface and subsurface drainage systems, and landforms that develop by the action of water on soluble rock (primarily limestone and marble [carbonates] in Southeast Alaska). The dissolution of the rock results in the development of internal drainage, producing sinking streams (streams that sink into the stream bed or karst features), closed depressions, sinkholes, collapsed channels, and caves.

Because of fractures in the carbonates, high annual precipitation, and peatlands adjacent to the carbonate bedrock, karst has developed, to varying extents, within all carbonate blocks. The Tongass National Forest contains the largest known concentration of dissolution caves in Alaska. Approximately 431,030 acres of karst are on NFS lands.

In Southeast Alaska, the karst landscape can be characterized as an ecological unit found atop carbonate bedrock in which karst features and drainage systems have developed as a result of differential solution by surface and ground waters. These acidic waters are a direct product of abundant precipitation and passage of these waters through the organic-rich forest soil and adjacent peatlands. Recharge areas may be on carbonate or adjacent noncarbonate substrates. A few characteristics of this ecological unit include mature, well-developed spruce and hemlock forests along valley floors and lower slopes, increased productivity

for plant and animal communities, extremely productive aquatic communities, well-developed subsurface drainage, and the underlying unique cave resources (Baichtal and Swanston 1996). The visible karst landscape also contains "epikarst," or surface features, particularly in the alpine and sub-alpine zones. These include deep shafts and fissures, eroded rills, and spires or spikes of limestone.

Karst lands add a vertical, underground dimension to land use planning. Karst subsurface drainage networks generally operate independently of, and with more complexity than, the surface drainage systems above, and the watershed characteristics of the surface may have little or no relationship to the subsurface system. On karst lands, the many solution-widened fissures at the surface become entry points into the subsurface drainage system, where water and sediment from surface sources move vertically downward into the underground lateral systems. Sediment and water from disturbed lands or roads may enter this system at a single point and emerge unexpectedly at one or more distant springs, sometimes crossing surface watershed boundaries. Karst groundwater systems routinely transport water for several thousands of feet to receiving caves, springs, and surface streams.

Most Tongass National Forest caves pre-date the most recent glaciation, as evidenced by the presence of glacial clays, glacial sediments, wood, Pleistocene vertebrate remains, and possibly ancient ice. Speleothems (i.e., secondary mineral deposits such as stalactites, stalagmites, flowstone, and crystal growths) from El Capitan Cave, on Prince of Wales Island, have been radiometrically dated to between 107,000 and 115,000 years old, or during the last interglacial period. Speleothem dates from other caves in the Tongass National Forest range from 53,000 to 185,800 years old. The most recent glaciation modified a pre-existing karst landscape, collapsing some passages and systems, gouging into others, and filling some with sediments. The epikarst (surface karst), which is well developed in higher elevations, has been removed in places at lower elevations by glaciation. Where low-elevation epikarst is present, primarily on the outer coast of islands seaward of Prince of Wales Island, vegetation has been re-established and a forested epikarst created. With the development of forested epikarst and peatlands, and the entrance of associated acidic waters into underground tributaries, a system of enlarged caves and vertical shafts has developed.

There is a definite tie between the karst landscape and the productivity of the spruce and hemlock forests found there. Dense stands of very large diameter spruce and hemlock at lower elevations are characteristic of many karst landscapes. The major contributors are believed to be the nutrient rich soils, well-developed subsurface drainage, and dissected bedrock surface, which allows the tree roots to hold fast and become more windfirm. The old-growth forest on this low-elevation karst provides a well-structured, multi-layered canopy resulting in high-quality winter habitat for many wildlife species. The structure of the forest provides many forbs and shrubs, which provide forage. It is possible that this forage contains, at a minimum, higher calcium levels allowing for better bone, muscle, and antler development. The combination of quality forest structure and abundant nutritional browse make the karst landscape, in general, exceedingly important habitat.

Many wildlife species, including mammals, birds, and invertebrates, find the surface karst features and the stable environment and shelter provided within the caves to be valuable habitat (Baichtal and Swanston 1996). Cave systems provide critical summer and winter roosting and hibernating habitat for bats (Baichtal and Swanston 1996). Preliminary studies suggest that aquatic habitats

associated with karst landscapes may be 8 to 10 times more productive than adjacent non-karst aquatic habitats (Baichtal and Swanston 1996). Karst aquatic habitats support a greater abundance, distribution, density, and variety of invertebrate species than non-carbonate habitats, have higher growth rates for smolts and resident fish, have less variable water temperatures and flow regimes, and contain unique habitat affecting species distribution, abundance, and adaptation.

The potential cultural and paleontological significance of the caves and karst landscape is high (Baichtal and Swanston 1996). The Pleistocene paleontology of the area is primarily known from cave and rock shelter deposits, which are often intimately related to archaeological sites. The cool, stable, non-acid environments in the caves result in exceptionally good preservation of bone and organic materials. To date, significant archaeological and paleontological materials have been discovered in over 30 caves and rock shelters within the Tongass National Forest. Evidence of human habitation, the oldest dating to about 9,700 years BP, has been discovered in several caves on Prince of Wales and nearby seaward islands. Eighteen black bears (*Ursus americanus*), one dating to approximately 39,000 years BP, and 13 brown bears (*Ursus arctos*), ranging in age from about 35,400 to 7,200 years BP and now extinct on Prince of Wales Island, have been found.

Cave invertebrate collections have yielded at least five troglobitic and 40 troglophilic invertebrate species. Many of these species, such as *Onychiurus* n.sp., *Tomocerus* n.sp., and *Stygobromus* n.sp., have only just been discovered. These species and their distribution may shed light on the extent of past glaciations and the timing of sea level fluctuation in the region.

Of the 431,030 acres of NFS karst lands, approximately 278,000 acres were originally productive old growth (POG). Based on geographic information system (GIS) queries, 82,240 of these POG acres (29 percent) have been harvested, leaving 152,800 acres of existing POG on NFS karst lands.

Aerial and on-the-ground observations are revealing the effects of past resource management on karst systems. Hydrologic evidence suggests that timber harvest alter the timing and intensity of surface flow, resulting in accelerated sediment and debris transport. Passages have flooded that had not flooded for centuries, and many cave entrances were infilled and/or blocked by logging slash, sediment, and debris, resulting in surface flows being rerouted into different passages. In the past, runoff generated from road surfaces commonly was diverted into karst features. It is not yet fully known what cumulative effects past timber harvest have had on the epikarst landscape. In some portions of the Tongass National Forest, 70 to 80 percent of the commercial forest land within specific karst blocks have been harvested. Overall, about 41 percent of original POG on karst lands below 800 feet in elevation have been harvested on the Tongass. In the North Central Prince of Wales Biogeographic Province (which includes most of Thorne Bay Ranger District and part of the Craig Ranger District), about 57 percent of the original POG on karst lands below 800 feet have been harvested.

The Land and Resource Management Plan (Forest Plan) includes standards and guidelines that provide for other land uses while taking into account the function and biological significance of the karst and cave resources within the landscape. The Forest manages karst lands using karst vulnerability mapping. This strategy assesses the susceptibility of the karst resources to any land use. Vulnerability mapping utilizes the fact that some parts of a karst landscape are more sensitive than others to planned land uses. The key elements of the strategy focus on the

openness of the karst system and its ability to transport water, nutrients, soil and debris, and pollutants into the underlying hydrologic systems. The strategy strives to maintain the capability of the karst landscape to regenerate a forest after harvest, to maintain the quality of the waters issuing from the karst hydrologic systems, and to protect the many resource values within the underlying cave systems as per the requirements of the Federal Cave Resources Protection Act (FCRPA).

Multiple reviews of the karst management strategies have been conducted by two panels, independent reviewers, and internally as well. These reviews include the Karst and Cave Resource Significance Assessment, Ketchikan Area, Tongass National Forest, Alaska (Aley et al. 1993); the Application of a Karst Management Strategy: Two Case Studies from the Tongass National Forest, Southeastern Alaska; The Challenges of Implementation (Baichtal 1997); the Heceta Sawfly Salvage Sale, Soils, Karst, and Cave Resource Evaluation, Heceta Island, Southeastern Alaska (Baichtal and Landwehr 1997); the Karst Vulnerability Assessment Review, Heceta Island (Aley 1997); and the Karst Management Standards and Implementation Review, Final Report of the Karst Review Panel (Griffiths et al. 2002). These reviews, combined with implementation and effectiveness monitoring and resource specialist input, formed the basis for the changes to karst and cave management standards and guidelines adopted in 2008.

In 2008, the Tongass National Forest amended the 1997 Forest Plan and made substantial changes to the karst and cave management standards and guidelines. The 2008 Forest Plan also included additions to the geologic special interest areas to protect nearly 47,000 additional acres (57,164 acres total) of karst lands that are most vulnerable to disturbance from development. In 2014, the National Defense Authorization Act for Fiscal Year 2015 changed some of those Geologic Special Areas to Land Use Designation (LUD) II Geologic Conservation Areas. The land ownership of some of the Geologic Special Areas was transferred to the Sealaska Corporation. Currently, 69,825 acres (16 percent of the Tongass karst lands) are Geologic Special Interest Areas or LUD II Geologic Conservation Areas.

On the low to moderate vulnerability karst lands (defined in the Karst and Cave Resources Standards and Guidelines of Chapter 4 in the Forest Plan), where mineral or glacially derived soils fully or partially cover the epikarst, forest regeneration is exceptional. In these areas, even the complete loss of soil and litter from the surface of the limestone will not prohibit the re-establishment of a forest because the displaced surface materials are retained within the epikarst channels (Harding and Ford 1993). On highly vulnerable karst lands, the epikarst channels are too deep to allow conifer seedlings to establish themselves even if the displaced soil is retained. The bottom of the channels may also be open, directly transporting sediment and debris into the karst groundwater system. Highly vulnerable karst areas are generally found at higher elevations, have thin organic soils that are easily displaced, are on steeper slopes, or are in areas of intense karst development. Previous harvest in such areas has increased the percentage of bare rock, resulting in less-than-desirable forest regeneration. Recent implementation and effectiveness monitoring (USDA Forest Service 2013c) found that the Karst and Cave Standards and Guidelines outlined in the Forest Plan were being implemented to the fullest extent practicable. Through effectiveness monitoring, the karst and cave standards and guidelines outlined in the Forest Plan were shown to ensure a high level of protection for significant caves and karst resources overall. The karst resources standards and guidelines have been fully implemented in proposed and ongoing projects, such as the Big Thorne Timber Sale, Dargon Point Environmental Assessment,

Logjam Timber Sale, Twelvemile Restoration Environmental Assessment, review of the Juneau Access Road Proposal, Phases 1 and 2 of the Forest Highway 43 construction from the Coffman Cove Junction to the Whale Pass Junction, and the Sunnahae Trail construction (USDA Forest Service 2012a, 2013c). Programs such as the small-sale program on Thorne Bay Ranger District allow the karst management specialist to work closely with the presale forester, purchaser, and sale administrator to ensure consideration of karst resource values.

Recent post-harvest monitoring has been limited because only a minor amount of harvest occurred on karst lands where mitigation had been prescribed. In the limited subsurface karst evaluations to document changes, no substantial changes as a result of management activities were documented (USDA Forest Service 2012a, 2013c).

Although most caves found to date on the Tongass are not suitable for recreation purposes because of frequent flooding, instability, or presence of fragile structures, the Forest Service is seeking opportunities for surface and subsurface public access and interpretation. Currently, free guided tours are provided by the Forest Service at El Capitan Cave during the summer where interpretive information is provided regarding karst geology and archeological discoveries.

Karst areas in Southeast Alaska are most comparable to those of karst lands found on Vancouver Island and the Queen Charlotte Islands of British Columbia (Canada), portions of Patagonia (Chile), Tasmania, and the west coast of the South Island of New Zealand. All of these areas have very steep surface slopes and subsurface hydraulic gradients, and very high levels of rainfall. These characteristics put them among the most dynamic karst terrains on earth, evolving and changing more rapidly and abruptly than karst in more moderate settings. The Karst Panel Report (Aley et al. 1993, as cited in USDA Forest Service 1997a) found the karst lands of the Tongass National Forest to be of national and international significance for a variety of reasons. The Karst Review Panel in the summer of 2002 confirmed these findings (Griffiths et al. 2002). Both of these panels consisted of world renowned karst experts with a breadth of karst resource backgrounds and a wide variety of international exposure to karst areas and management considerations. Not only is the level of karst development and the karst hydrology and mineralogy globally significant, the paleontological and archaeological discoveries have provided information on the prehistory of Southeastern Alaska and contributed to and challenged theories of the peopling of North America.

The natives and local inhabitants of Southeast Alaska have long known of the presence of caves. The existence of well-developed cave systems was first reported in 1975 and mapping of the caves began in 1987. The existence of vast areas in which karst had developed was fully recognized in 1990. Though noted by early foresters and geologists, the relationship between high site productivity and the presence of karst landscape became apparent at about this same time. With the passing of the FCRPA in 1988, the Forest struggled with methods to protect the many caves throughout the landscape. At first, protection focused on the large, significant karst features and cave entrances. Subsequent measures tended to look at entire karst hydrologic systems.

Currently, the Tongass inventory includes 611 caves (plus one state cave). Of these, 290 were identified in 1996 during the initial process of identifying significant cave resources. An additional 87 caves were added in 2003. The Tongass National Forest has received another 57 nominations that are pending.

The remaining 177 caves do not have nominations. Intense karst development has been identified on northern, central, and south-central Prince of Wales Island, Kosciusko Island, Dall Island, Heceta Island, Revillagigedo Island, Chichagof Island, and on the mainland southeast of Wrangell (Baichtal 2006).

Approaches to characterizing karst areas on the Tongass National Forest in recent years have included tracer dye studies to define karst watersheds and water quality parameters, physical monitoring of karst springs, and measurement of rainfall (USDA Forest Service 2013c). These efforts provided preliminary data on how karst groundwater systems and water chemistry relates to precipitation and runoff. These data will be used to establish baseline conditions, and will be compared with karst conditions monitored after implementation of management activities. In addition, Light Detection and Ranging (LiDAR) technology has been used in ongoing inventories of karst and cave resources.

Environmental Consequences

Direct and Indirect Effects

Geology

None of the alternatives modify standards and guidelines for geology. As per current direction, geologic inventories would be conducted to cover bedrock geology, surficial geology, stratigraphy, hydrogeology, geomorphic features, geological hazards, karst features, caves, and paleontology, including potential for geologic formations to yield fossil resources of scientific and other values. The continued focus on geologic resources results in protection of unique features and utilization of geological resources. Refer to the *Minerals* section for more information on potential effects related to mining and mineral resources.

Karst and Caves

Potential effects to karst systems and caves and associated drainages from timber harvest and road building include changes in hydrology, infiltration rates, sediment production, debris transport, pollutants, and introduction of organics that can lead to oxygen depletion. Issues and concerns related to karst lands primarily revolve around potential changes to groundwater flow in the underground system. Any management activity that causes sediment or organic debris to build up in the subsurface conduits decreases the capacity of these conduits and makes the formation of surface streams more likely. Similarly, any management activity that increases groundwater recharge may also affect the capacity of the conduits in the underground system and make formation of surface streams more likely. Changes in the presence of surface water can produce broad ecosystem changes both above and below ground. Groundwater recharge in karst lands occurs by either discrete or diffuse recharge. Discrete recharge refers to losing or sinking streams that enter the subsurface at specific insurgence points. Diffuse recharge refers to subsurface entry of water through the forest floor and the epikarst. Losing or sinking streams can rapidly deliver sediment into subsurface passageways.

Sediment transport into karst systems also produces concern. This concern is primarily attributed to the size of past harvest blocks and the rate at which the landscape was harvested prior to the early 1990s, when the extensiveness and significance of karst terrain on the Tongass National Forest became more fully recognized. The current standards and guidelines address these concerns to a high degree.

Potential effects on karst lands from planned timber harvesting, associated road construction, and quarry development may occur; however, with implementation of the current or proposed standards and guidelines (as modified through ongoing monitoring and adaptive management), and site-specific mitigation measures (designed and implemented at the project level), the Forest expects to mitigate the effects of any proposed activity. Site-specific mitigation measures include protection of the high vulnerability karst areas and features, partial cutting, reduced harvest unit size, use of logging systems that achieve at least partial suspension, reductions in rate of harvest, and other changes in logging practices.

The Karst Review Panel in the summer of 2002 found that implementation of the Karst and Cave Standards and Guidelines from the current Forest Plan had ensured a high level of protection for karst resources overall (Griffiths et al. 2002). The Panel noted high standards in both the philosophy of management and the way that specific management practices were formulated and applied. Implementation of specific policies and procedures was found to be very good and in general compliance with the stated goals and objectives of the karst program. The Panel also noted the extent to which high vulnerability karst had been protected since 1997. In addition, the Panel outlined the action required to more actively manage karst landscapes covered with second-growth stands and recommended a new procedure for assessing the autogenic (precipitation on carbonate rocks) recharge component of karst units.

Several elements of the Karst and Cave Standards and Guidelines were updated in 2008 to better assess karst landforms and vulnerability, as well as allow flexibility depending on the professional judgment of karst-trained specialists. The 2008 Record of Decision also designated several geologic Special Interest Areas. These Special Interest Areas included all identified high vulnerability karst lands that were not already protected within current non-development LUDs.

Much of the karst land within development LUDs has been designated as high vulnerability karst land and is protected or mitigated by standards and guidelines or included within geologic Special Interest Areas. It is estimated that 30 percent of the other karst lands will be determined to be high vulnerability karst with ground verification in the future.

Approximately 431,030 acres of karst underlies NFS lands inside the Tongass National Forest. Alternative 1 would result in the lowest estimated maximum future harvest on NFS karst lands at 49,807 acres, including POG and young growth on suitable karst lands (Table 3.2-1). Alternative 2 would result in the highest estimated maximum future harvest on karst lands at 67,933 acres. Karst inventories and vulnerability assessments would continue to be required before timber harvest could occur on suitable lands under all of the alternatives. Alternatives 2 and 3 have the greatest acres of harvest on karst lands because they allow young-growth harvest in the most LUDs that are not currently considered suitable for timber harvest and they allow commercial thinning on high vulnerability karst. Alternative 4 would also allow commercial thinning on high vulnerability karst, but is limited to the existing development LUDs.

Table 3.2-1
Estimated Maximum Future Tongass Harvest (acres) on Karst Lands under the Alternatives after 100 Years

	Old Growth	Young Growth by Vulnerability Class			
Alternative	All Karst Lands	High	Moderate	Low or Unmapped	Total Area
Alternative 1	5,631	0	2,136	41,320	49,087
Alternative 2	2,688	4,017	2,563	58,665	67,933
Alternative 3	2,118	3,880	2,502	57,302	65,802
Alternative 4	4,090	783	2,231	48,166	55,271
Alternative 5	4,639	0	2,389	52,422	59,451

The vast majority of harvest would occur on low vulnerability or unmapped karst lands. Low vulnerability karst lands are not sensitive to management activities due to the depth of overlying material (e.g., glacial till) and low hydrologic conductivity. There would be no change to management practices on these lands between any alternatives. Should these lands later be determined to be high vulnerability karst lands, the more restrictive management rules would apply.

Even-aged management on low vulnerability karst and limited clear-cutting in medium vulnerability karst has always been allowed, although more restrictive guidelines than normally employed on non-karst lands may be needed on medium vulnerability karst. Alternatives 1 through 4 would be managed in similar fashion so long as karst management objectives could be met. Under Alternative 5, created openings are limited to 10 acres with a maximum removal of 35 percent of the original stand. Project-specific karst evaluations would still be required and effects would be avoided or minimized through project and site specific management prescriptions, such as requiring partial suspension yarding or limiting the size of openings moderate changes to precipitation throughfall.

No additional harvest is anticipated in any areas mapped as high vulnerability karst under Alternatives 1 and 5. These areas are included in the existing Special Interest Areas, and are not suitable for harvest under these alternatives. Alternatives 2, 3, and 4 each allow for commercial thinning on high vulnerability karsts on a case-by-case basis when the karst management objectives can be met. While it is believed that these activities can be carefully planned and implemented to accomplish this, a shortage of monitoring on the effects to karst from second-growth management on the Tongass is recognized and there is some uncertainty. However, where commercial thinning is determined to be an appropriate treatment on high vulnerability karst lands, effects to karst will be addressed through project-specific prescriptions and analysis to ensure karst management objectives can be met.

The amount of new road construction on karst lands would also vary by alternative in relation to the acres of old growth harvested on karst lands. The estimated maximum amount of future old-growth harvest that could occur on NFS karst lands would vary by alternative, ranging from 2,118 acres under Alternative 3 to 5,631 acres under Alternative 1 (Table 3.2-1).

Cumulative Effects

There are approximately 549,522 acres (859 square miles) of karst lands within the boundaries of the Tongass National Forest. Some 431,030 acres (674 square miles) are on NFS lands. Past timber harvest has affected the epikarst landscape on the Tongass National Forest. In some portions of the Tongass, 70 to 80 percent of the commercial forest land within specific karst blocks has been harvested. It is estimated that about 29 percent (82,239 acres) of the karst lands on NFS lands have been harvested (based on the GIS database). In addition,

several hundred miles of authorized and unauthorized roads have been constructed on karst lands. All alternatives would involve additional future harvests (Table 3.2-1) and associated road building and reconstruction on karst lands to varying degrees. Appendix C of this EIS provides a full list of all the projects considered in the cumulative effects analysis.

Baichtal and Swanston (1996) observed sediment deposits and waterline marks in underground systems that suggested that past timber harvesting had increased sediment and debris transport and flooding of underground passages, many of which had not previously flooded for centuries. These timber harvests were conducted prior to the Karst and Cave Resources Standards and Guidelines implemented in the 1997 Forest Plan. As a result, they had more significant effects on karst lands than current and future harvest activities. At that time, many cave entrances were filled or blocked by logging slash, sediment, and debris. Additional runoff generated from road surfaces commonly had been diverted into karst features. They also noted strong evidence of greatly increased surface runoff on karst landscapes and adjacent surfaces after timber harvest, which increased sediment, nutrient, and debris transport capability of associated drainage networks.

Based on information from Prince Wales Island, Baichtal and Swanston (1996) noted few tree regeneration problems in low-elevation stands on karst landscapes. As a consequence, most easily accessible, low-elevation karst areas on the island had been harvested. After the initial timber harvests, harvest activities concentrated on steeper, higher elevation karst landscapes characterized by shallower, excessively well-drained soils. Baichtal and Swanston (1996) suggested that trees were smaller and regeneration problems were greater at these steep, upper elevation sites. This condition possibly resulted from shallow soils with low nutrient availability, excessive drainage of surface and soil waters into subsurface karst systems, removal of much of the shallow soil because of inadequate log suspension, and continued desiccation of the soil once the protective forest canopy was removed. After timber removal, high rainfall rapidly transported fragile soils into the well-developed epikarst.

More recent monitoring of karst lands near harvested areas (USDA Forest Service 2012a, 2013c) have confirmed that current timber harvest practices have adjusted substantially to accommodate Karst and Cave Standards and Guidelines. For example, karst resource input was provided for timber sales projects throughout the Tongass.

Extensive landscape changes and ground disturbance have occurred and are likely to continue to occur on non-federal lands in Southeast Alaska. These include timber harvest and road construction, mining, recreation and tourism, growth of human settlements, transportation projects, and energy and transmission projects. Forest Service regulations requiring protection of karst resources do not apply to non-federal lands. Approximately 109,800 of the nearly 540,600 acres of karst lands within the Tongass National Forest boundary are on state or private lands.

Transfers of karst lands from NFS lands to other land managers or private owners could also occur under any of the alternatives through land exchanges or other types of land adjustments (such as the Alaska Mental Health Trust Land Exchange). This type of future action could increase the amount of karst lands in Southeast Alaska that are not in a protected LUD. Any exchange or other type of adjustment (outside of legally required conveyances) would require National Environmental Policy Act analysis, most likely an EIS, which would include public involvement and would disclose any adverse effects to karst and cave resources, as well as to other resources.

Soils

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Affected Environment

Soils in Southeast Alaska develop in parent materials originating from a variety of geological or vegetative sources. Parent material is the inorganic or organic matter in which soils develop, and in the Tongass National Forest includes volcanic ash; glacial deposits; hillslope, stream, and uplifted marine sediments; rock; and deposits of decomposed plant materials. Soils are commonly divided on the basis of their parent material. Both mineral and organic soils occur extensively within the Tongass National Forest, where more than 100 different soils have been identified. Soils cover 84 percent of the inventoried land surface area of the Tongass; the remainder consists of ice, exposed bedrock, and bodies of water.

From a resource management perspective, soil productivity (i.e., a soil's ability to support vegetative growth) and the potential loss of soils or off-site effects from erosion and landslides are the principle concerns. The productivity of soils directly or indirectly affects the productivity of other forest resources. Tree growth, wildlife and fish habitat quality, and recreation uses and potentials depend in part on the quality of soils. In Southeast Alaska, soil productivity, in terms of tree growth, is high on well-drained soils (e.g., on steep slopes, in karst areas, and on floodplains) and decreases as latitude and elevation increase and as drainage becomes poorer.

Soil, or site, productivity is generally measured by the rate of biomass accumulation, and site index is commonly used to give a relative indication of this productivity. Site index is determined by the height of dominant trees at a specified age. The site index tables or curves available for use in Southeast Alaska were developed from trees in even-aged stands, not the uneven-aged or old-growth stands that predominate here; consequently, the resulting site index categories are more useful for comparison than as absolute numbers. Soil productivity also can be estimated from the characteristics of individual soil types. The principal characteristics are soil depth, drainage, acidity, and coarse fragment content. Over one-quarter of the total productive forest land mapped in the Tongass National Forest Soil Resource Inventory has been identified as the highest site index category (Category 4), which means that on average these sites will grow trees greater than 80 feet tall in 50 years (Table 3.3-1). Approximately 11 percent of the Tongass productive forest land falls into the lowest site index category (Category 1), which corresponds with trees less than 40 feet high in 50 years. Approximately one-quarter of the productive old growth (POG) and two-thirds of the harvested young growth have been mapped as Category 4 (Table 3.3-1).

Table 3.3-1
Estimated Percent of the Productive Forestland on the Tongass by Site Index Category

	Site Index Category					
	1	2	3	4		
Productive Forest Land Category	**Avg. Site Index = 0-40**	**Avg. Site Index = 41-60**	**Avg. Site Index = 61-80**	**Avg. Site Index > 80**	**Unmapped[1]**	**Total**
Productive Old Growth	12%	12%	23%	25%	28%	100%
Young Growth – Harvested	5%	6%	20%	64%	4%	100%
Young Growth – Natural	12%	14%	25%	34%	16%	100%
Total Productive Forest land	11%	12%	23%	28%	26%	100%

[1] Unmapped areas are mostly in Wilderness or National Monument.

Soil erosion in the form of gully, sheet, and rill erosion is a minor occurrence under natural, undisturbed conditions in Southeast Alaska, because the thick surface duff layers that cover the mineral soils protect them from surface erosion. Mineral soils can be disturbed and exposed either by natural causes, such as landslides and blowdown, or management activities, such as timber harvest and road and landing construction. Surface erosion can become active once the duff layer is removed and can remain active until revegetation occurs.

The Soil and Water Standards and Guidelines in the 2008 Forest Plan are important for minimizing potential detrimental soil disturbance. According to results of recent soil and water implementation and effectiveness monitoring (USDA Forest Service 2013b), the Tongass National Forest is implementing the standards and guidelines for soil disturbance successfully during timber sale activities and road and landing construction. The Tongass National Forest has collected over 50 miles of soil disturbance transect data following timber harvest. Data collected indicate that all timber harvest units, including cable, helicopter, and shovel yarding systems (restricted to slopes less than 30 percent gradient), are within the established Region 10 soil quality guideline of less than 15 percent soil disturbance that is considered potentially detrimental (Landwehr et al. 2012), as set forth in Forest Service Manual (FSM) 2554 (FSM R-10 2500-2006-1).

Soil quality monitoring with soil disturbance transects continues on the forest. Monitoring and evaluation reports are written annually in addition to periodic reports summarizing soil disturbance transect data and/or soil bulk density sampling data. The most pertinent of these reports are Landwehr and Nowacki (1999), Landwehr (2008a and 2014), and Landwehr et al. (2012). These reports are discussed further in the Environmental Consequences section.

The longevity of soil disturbance has been evaluated in young-growth stands in the Tongass National Forest by re-monitoring 15 year-old young-growth harvest units where relatively high levels of soil disturbance were documented following harvest (Landwehr 2008a). Results indicate that many small soil disturbances, less than about 25 square feet in area, are not identifiable after 15 years of recovery and likely not detrimental to woody plant growth even on relatively poor soils. Areas of detrimental soil disturbance are typically in coarse textured nutrient poor soils and lie in a landscape position where soil erosion or other factors have prevented natural recovery of the site (Landwehr 2008a).

Recent monitoring of soil conditions has also been completed in older young-growth stands (more than 50 years old) to evaluate soil disturbance over the long term (Landwehr et al. 2012). Results indicate that highly productive, relatively nutrient rich soils may tolerate more severe and extensive soil disturbance before exhibiting a reduction in desired vegetation or vegetation growth at the desired growth rates. Soil displacements smaller than 100 square feet in area were rarely identified in highly productive stands after 50 or more years of recovery. Detrimental soil conditions in 50+ year-old young-growth stands were primarily soil displacements and soil erosion. Soil displacements occurred primarily on tractor skid trails and spar tree yarding corridors. Soil erosion was identified on steeper slopes in the displaced areas as evidenced by the presence of small gullies and ephemeral streams; however, soil erosion was almost entirely arrested after 50 years of recovery. Areas of displaced soils greater than 100 square feet in area generally resulted in different vegetation communities and reduced growth rates compared with adjacent undisturbed sites (Landwehr et al. 2012).

Landslides, both naturally occurring and human-caused, dominate soil movement processes on steep forest lands in Southeast Alaska (Swanston 1969, 1974). Written over the course of more than 40 years, Swanston's many papers present excellent characterizations of landslides in Southeast Alaska. Landslides deliver eroded material to streams more quickly, and in greater quantity, than surface erosion. Landslides can seriously retard soil productivity for forest regeneration on slopes by removing the soil mantle down to bedrock or glacial till. It can take 50 to 100 years or more for soil layers to be rebuilt on exposed bedrock in these landslide areas. Debris deposited on lower slopes and valley bottoms may improve site productivity locally because of incorporation of organic nutrients and improved drainage. Regeneration at such sites is rapid.

A recent study (Johnson et al. 2007) compared the effects from 100 percent tree removal to partial cuts (25, 50, and 75 percent removals) on landslide potential. They focused on effects to soil saturation (groundwater levels) and found increasing soil saturation with increasing percent tree removal. Increased soil saturation likely correlates with increased potential for soil erosion through landsliding, although they did not model this possibility directly because of uncertainties in estimating loss of cohesion as a result of changes in root strength in partial cut.

The amount of soil saturation may be impacted by future climate change. Soil saturation impacts are predicted to be highly variable based on site-specific physical characteristics such as soil type, bedrock orientation, and gradient. At the broad scale, predicted changes in temperature and precipitation are not expected to measurably change existing soil saturation conditions (EcoAdapt 2014). The *Climate and Air* section includes discussion of soil carbon loss in a warming environment.

In the Tongass National Forest, several factors including soil depth, soil type, drainage characteristics, and landform type control soil stability on steep terrain. On steep forested slopes, the dominant failure type is debris avalanche, which is the failure of a finite mass of water-charged overburden material along a relatively planar surface. These landslides occur primarily at shallow depths (1 to 3 feet) in the soil overburden and may break apart and transform into debris flows, which are a mixture of water, soil, rock and organic debris that rapidly moves downslope. The texture of the soil overburden is characteristically gravelly silt or gravelly silty sand; less commonly the texture might be sandy gravel with little or no cohesion (Swanston 1997). Organic content may exceed 30 percent locally because of the downward migration of organic particles into the mineral soil zone, which substantially increases cohesion at some sites.

The Mass Failure Rating Classification developed by Alexander (1987) and refined by Swanston (1997), provides an indication of the relative frequency of mass failures when vegetation is cleared or the land is disturbed. In this system, soil map units in the Tongass National Forest are classified in the Mass Movement Index (MMI) from low to high or extreme risk (MMI 1 to MMI 4) of management induced landslides. The Mass Movement Index is based on slope gradient, parent material and soil properties, level of dissection, and evidence of prior landslides or snow avalanches (Swanston 1997). Slope is a primary factor in the MMI.

Almost half of the Tongass is made up of lands with slopes less than 35 percent (Table 3.3-2). Nearly one-third of the Tongass ranges in slope from 35 to 67 percent, and the remaining 19 percent exceeds 67 percent slope. Only 14 percent of productive old-growth lands and 5 percent of harvested young growth lands exceed 67 percent slope. In general, these steep slopes pose greater risks for soil erosion through landslides.

Table 3.3-2
Estimated Percent of the Tongass National Forest, POG, and Young Growth by Slope Category

		Percent Slope Category			
Forest Land	**Acres**	**0-35%**	**35-67%**	**>67%**	**Total**
Productive Old Growth	4,999,684	49%	37%	14%	**100%**
Young Growth – Harvested	421,616	69%	26%	5%	**100%**
Young Growth – Natural	83,126	83%	13%	4%	**100%**
Other Areas	11,242,029	49%	30%	22%	**100%**
Tongass National Forest	16,746,454	49%	32%	19%	**100%**

Swanston and Marion (1991) mapped landslides in the Tongass National Forest during the 21-year period, 1963 through 1983. They noted an occurrence rate of 118 landslides per 980 square kilometers (242,163 acres) in harvested or roaded areas over 21 years. Based on this count, an average of one landslide occurred per 2,052 acres of harvest over 21 years, or one landslide per 43,092 acres (on average) per year. They found that landslides were 3.5 times more likely on harvested areas. These landslide rates are generally supported by other landslide inventories and analyses that have been completed on the Tongass National Forest (Bishop and Stevens 1964; Landwehr 1994 and 1998).

Swanston and Marion (1991) showed that roughly 10 percent (118) of the landslides occurred in clearcut harvest areas or were directly associated with timber harvesting, whereas roughly 90 percent (1,277) occurred in unlogged areas. Landslides in unlogged areas appear to be larger and longer than those in logged areas.

A Forest-wide inventory to identify, delineate, and digitize all landslides as an independent layer in GIS was initiated in 2001. The first phase of the landslide inventory to map all landslides in development land use designations and other areas where soil mapping exists was completed in Fiscal Year 2012. Keeping this landslide inventory current is a challenge. To date, landslide frequency analyses and evaluation of landslide densities in managed stands versus unmanaged areas have not been completed on this dataset. Future planning efforts include a landslide frequency analysis based on slope class using an updated 5- to 10-meter digital elevation model with a projected delivery date of 2016 (USDA Forest Service 2013b).

Environmental Consequences

Direct and Indirect Effects

Forest management activities can cause soil erosion and subsequent loss of site productivity through the exposure of mineral soil, alteration of subsurface drainage, and the concentration of soil and rock material at unstable sites. Best Management Practices (BMPs) are used to minimize soil erosion from all management activities. BMP implementation and effectiveness is monitored on a subset of activities on the forest each year. Monitoring for the past 10 years indicates a high rate of BMP implementation and effectiveness (USDA Forest Service 2013b).

Soil Quality Monitoring over the past 25 years indicates that old-growth timber harvest activities (as currently practiced) are achieving the FSM-2554-R10-2006, (Region 10 soil quality standards). The transition to young-growth harvest may result in soil erosion and subsequent loss of site productivity to varying degrees. Due to the substantial amount of vegetative groundcover remaining on harvest units during and following timber harvest, surface erosion from these areas is usually relatively small (Martin and Kirtland 1995; Swanston 1969); however, detrimental soil conditions persist in the landscape in the form of temporary roads, landings, rock pits and some yarding disturbances may result in a loss of productivity, in terms of desired vegetation growth. Relatively nutrient rich soils, such as deep soils with limestone influence, appear to be more tolerant of moderate levels of soil disturbance without an obvious change in productivity. In contrast, heavy soil disturbance from harvest on coarse textured, nutrient poor soils developed in gravelly outwash, has been shown to result in reduced tree growth on those sites (Billings 1970; Harris et al. 1976; Landwehr 2008a; Landwehr et al. 2012).

Young-growth stands may have detrimental soil conditions remaining from the first timber harvest. Recent soil quality monitoring of young-growth stands (greater than 50 years old) was completed by Landwehr et al. (2012). Detrimental soil conditions in these stands were primarily soil displacements and soil erosion from tractor skid trails and spar tree yarding corridors. The monitoring also found that the duff layer thickness was reduced in harvested stands on limestone soils when compared with adjacent unharvested stands. On soils of mixed minerology the duff layers were not significantly different in harvested stands compared to unharvested stands. Regarding duff thickness, more work needs to be done, but Landwehr et al. (2012) suggests several possible reasons for reduced duff thickness, none of which equate to reduced productivity of the limestone sites. The existence of soil erosion was identified by the presence of small gullies and ephemeral streams; however, after 50-years of recovery erosion is almost entirely arrested (Landwehr et al. 2012).

Due to the possibility of detrimental soil conditions in existing young-growth stands, the Forest Plan requires an evaluation of detrimental soil condition prior to harvest. This management approach will help insure that soil conditions remain within Region 10 soil quality standards.

Due primarily to economics of harvest many young-growth timber harvests will be conducted using ground-based equipment. Shovel yarding has been used on the forest for more than 25 years. Landwehr (2014) summarized the history of ground-based equipment timber harvest on the forest and provided the most recent soil quality monitoring data for timber harvest with ground-based equipment, especially on slopes over 30 percent gradient. The report documents the increase in detrimental soil conditions with operations on steeper slopes. On slopes over 30 or 35 percent gradient the amount of detrimental soil conditions caused by ground-based equipment triples, but was still within Region 10 Soil

quality standards. Landwehr (2014) recommends restricting equipment to slopes less than 30 to 35 percent gradient.

Alluvial soils are generally included in riparian management areas. Alternatives 2 through 5 allow limited commercial timber harvest in riparian management areas outside Tongass Timber Reform Act buffers as long as riparian management objectives (Appendix D of the Forest Plan) can be met. The need to minimize soil disturbance on alluvial soils, especially in areas of braided channels, has long been recognized (1977 Southeast Alaska Area Guide, Martin et al. 1995). Appendix D of the Forest Plan requires minimizing soil disturbance on fluvial channel process groups (alluvial fans floodplains and moderate gradient mixed control channels) to prevent the formation of new channels and to limit alder regeneration. Soil disturbance can be reduced considerably by the method of harvest and guidelines for equipment operations. For example, tractor logging, commonly used in the 1950s and 1960s, typically resulted in more than triple the amount of soil disturbance as cable yarding during the same time period. (Landwehr et al. 2012). Monitoring of more recent shovel yarding operations indicates that shovel yarding on slopes up to 30 percent gradient results in soil disturbance amounts similar to cable logging. On slopes over 30 to 35 percent gradient, soil disturbance from shovel yarding increases (Landwehr 2014).

The effects of timber harvest on site productivity are described in several papers in Slaughter and Gasborro (1988). Regeneration after clearcutting is excellent on all but a few sites in coastal Alaska, except in isolated areas with severe soil disturbance. Once established, growth rates of hemlock and spruce are relatively high (Farr and Ford, as cited in Slaughter and Gasborro 1988). New stands contain several thousand stems per acre, and crown closure begins to take place by age 15 to 20 years. Crown closure approaches 100 percent by 25 to 30 years of age and remains so for 100 years or more. Silen (in Slaughter and Gasborro 1988) also states that more than 90 percent of clearcut areas densely restock naturally in Southeast Alaska. Precommercial thinnings aid in achieving desired stocking levels and increased growth (Pawuk, in Slaughter and Gasborro 1988).

Klock (in Slaughter and Gasborro 1988) notes that soil compaction, most frequently by ground skidding operations, leads to reduced timber volume growth. In a world-wide review of literature related to areas of forest soil productivity decline, Powers et al. (1990) identified soil compaction and loss of soil organic matter as a two factors common to areas where forest soil productivity declined. Powers et al. (1990) observations led to the creation of the Long-Term Soil Productivity (LTSP) experiment, which is testing the effects of two levels of organic matter removal and soil compaction on soil productivity. The LTSP is a long-term, controlled, field scale experiment with installations throughout North America and several other countries.

Several soil compaction studies have been completed on the Tongass National Forest. The most recent studies have measured soil bulk density on skid trails created as part of the commercial thinning project (Landwehr and Silkworth 2011) and shovel trails used for stream restoration (Landwehr and Foss 2014). The shovel trails used for stream restoration experienced tens and in some cases hundreds of equipment passes to move wood from the roadside to the stream. The commercial thinning tractor skid trails moved cut logs to the roadside and most trails received tens and in some cases hundreds of passes of equipment. Both of these studies and studies before them (Landwehr and Foss 2006; Landwehr et al. 2012; Alexander 1990) found that soils at a few individual sample sites on equipment trails were compacted but overall the equipment trails were not compacted.

There are several reasons for the lack of detrimental soil compaction in Tongass soils. First, Tongass soils are generally coarse textured with clay contents typically less than 20 percent. Secondly, Tongass soils have high organic matter content and often have high coarse fragment content that resists compaction. Thirdly, Tongass forested soils are subject to rapid root growth by conifers in young-growth stands. The root growth tends to loosen soils. Trees in many old and young-growth stands are subject to strong winds which causes tree rocking or windthrow that loosens upper layers of soil. Finally, on the Tongass cull logs and slash are used to spread the weight of equipment out over a larger surface area, thus avoiding potential compaction (Landwehr and Foss 2014).

Blowdown, or windthrow, can increase along the edges of regeneration harvest units, and this may expose mineral soil. Blowdown increases the potential for soil erosion and may increase the potential for landslides.

According to a study by Kramer et al. (2001), watersheds in the Tongass National Forest that experience more intense soil mixing from windthrow have lower levels of strongly humified soil carbon pools (e.g., lower levels of reprecipitated acid) than areas that have not experienced windthrow. The disturbed watersheds include more organic matter in a partially decomposed particulate form, which translates to less acidic carbon forms, higher ion exchange capacity, higher soil pH, and lower bulk density in the soil (Kramer et al. 2004). The disturbed soils are more aerated, better drained, and have higher nutrient status. Conversely, Stephens et al. (1969) found a reduced site index in stands regenerated following windthrow. Stephens et al. (1969) identified shading of the soil surface caused by windthrown trees as the reason for lower site index in windthrown stands. Predicted climate trends have the potential to increase the frequency of windthrow events due to higher winds and saturated soils in extreme events (EcoAdapt 2014).

Soil productivity decreases from the construction of roads and landings because land is taken “out of production” (i.e., removed, covered over, or compacted). Erosion increases from the construction of roads and landings because of the destabilizing effect of cuts, fills, and drainage alterations, and the lack of protective vegetation cover on road and landing surfaces and other disturbed areas. Standards and guidelines, BMPs, including those identified in the Soil and Water Conservation Handbook (USDA Forest Service 2006a), and National (USDA Forest Service 2012b) and other relevant mitigation measures, are applied at the project level to minimize potential adverse effects. At the Forest Plan level, the overall difference in acres disturbed by roads is a good indication of how site-specific effects are likely to vary between alternatives. Refer to the *Water* and *Fish* sections for more detailed analyses of potential effects on water quality or fish habitat due to roads.

Table 3.3-3 displays the maximum cumulative acres, by alternative, to be covered by road surfaces after the first 25 and after 100 years of implementation of the Forest Plan (assuming none of the roads is completely obliterated). The cumulative acres of road surfaces after 25 years of implementation would be similar under Alternatives 2 through 5. The amount of road acreage under these alternatives would be less than expected under the 2008 Forest Plan (Alternative 1) due to the ability to utilize or reconstruct existing roads (i.e., open, closed, or decommissioned) for harvest of young growth, thereby reducing the amount of new road construction necessary. The cumulative acres of road surfaces after 25 years of implementation would be least under Alternative 3 and least under Alternative 4 after 100 years of Forest Plan implementation.

Table 3.3-3
Estimated Maximum Cumulative Acreage Covered by Road Surfaces on NFS Lands after the first 25 Years and after 100 Years by Alternative[1]

Alternative	Existing Condition	After 25 Years of Implementation	After 100 years of Implementation
1	15,278	16,121	18,109
2	15,278	16,057	18,445
3	15,278	16,013	18,338
4	15,278	16,049	17,892
5	15,278	16,079	18,259

[1] Acres covered by road surfaces are calculated based on an average of 3 acres per 1 mile of road.

Landings are considered part of the road network based on transportation handbook direction and are co-located, to the extent possible, with turnouts, borrow areas, and turnaround areas required for road construction and subsequent safe travel. Both Region 10 and National BMPs specifically consider landing location and design and re-use of existing landings while maintaining water quality protection. For young-growth management, many existing roads and landings would be reused if the roads and landings are compatible with management objectives and water quality protection (National Core BMP VEG-6).

Table 3.3-4 contains the estimated maximum road miles, by alternative, to be constructed, constructed over a decommissioned roadbed, and reconstructed over 25 years by alternative of implementation. The miles of road construction over 25 years of implementation is least under Alternative 3. Less road construction translates to less direct impacts on soil productivity and less indirect impacts from road associated soil erosion. The miles of road construction after 25 years of implementation is highest under the 2008 Forest Plan (Alternative 1).

Table 3.3-4
Estimated Maximum Road Miles to be Constructed or Reconstructed over 25 Years by Alternative

Alternative	Road Construction (Miles)	Road Construction over Decommissioned Roadbed (Miles)	Road Reconstruction (Miles)
1	281	64	160
2	260	125	256
3	245	110	229
4	257	97	209
5	267	102	219

Landslides may adversely affect soil quality. They also have the potential to affect aquatic habitats, both positively and negatively. Landslides have a positive effect by providing new sources of woody debris and gravel favorably altering elements of fish habitat. They negatively affect aquatic habitats by destroying viable fish eggs by smothering and bed load overturn, and by destroying habitat elements for fish (pools, riffles, log discharge, etc.).

As part of the effects analysis, the average landslide frequency from the Swanston and Marion (1991) study was applied to the estimated harvest levels likely under each alternative over the first 25 years of the Forest Plan implementation. However, the Forest Plan includes standards and guidelines and mitigation measures that were not in effect during the period of the landslide study (e.g., Riparian Standards and Guidelines, and BMPs). For the purposes of this comparison, a projected maximum harvest over 25 years is used because

the landslide occurrences reported by Swanston and Marion (1991) reflect long-term averages. As previously stated, landslides typically are associated with storm events and large amounts of precipitation, which are highly variable from one year to another. For example, widespread landsliding in headwater tributaries following basin wide clear-cut logging on Prince of Wales Island was triggered by intense rainstorms in 1961 and 1993 (Gomi et al. 2004).

The data in Table 3.3-5 are used to compare the long-term landslide estimates that may result from the individual harvest levels under each alternative as a means to compare the relative level of effects under each alternative. All alternatives have a higher landslide potential (i.e., maximum increase in number of landslides over first 25 years) than under the 2008 Forest Plan (Alternative 1) because there are more total acres being harvested in order to transition to young-growth harvest. Alternatives 3, 4, and 5 would have slightly lower potential increase in the number of landslides than Alternatives 2. Alternative 2 has an estimated increase of 10 landslides over 25 years when compared to the 2008 Forest Plan (Alternative 1).

Table 3.3-5
Estimated Maximum Increase in Landslide Frequency over the First 25 Years of Forest Plan Implementation[1]

Alternative	Projected Maximum Acres of Harvest in First 25 Years[2]		Estimated Maximum Increase in Number of Landslides over First 25 Years
	Old Growth	Young Growth	
1	38,527	9,669	17
2	15,027	63,787	27
3	16,599	53,734	24
4	23,255	40,760	22
5	23,813	43,316	23

[1] This table uses the landslide frequency of one landslide per 2,052 acres in harvested and roaded areas cited in Swanston and Marion (1991) and one landslide per 7,100 acres for unharvested acres (based on their estimate of landslides being 3.5 times more prevalent in harvested vs. unharvested areas), in order to estimate the increase due to harvest and roading. It should be noted that Swanston and Marion (1991) measured landslide frequency based on large-scale clearcutting of large portions of watersheds that occurred between 1963 and 1983.
[2] Based on the acres of harvest scheduled by the Woodstock model over the first 25 years. These numbers assume that the maximum allowable acres would be harvested during this period, an unlikely scenario. Most likely, fewer acres would be harvested, particularly in the first decade. Any harvest would comply with the Forest Plan standards and guidelines, including buffers, unstable slope restrictions, smaller opening sizes, and BMPs.

The data in Table 3.3-5 assume that the rate of landsliding associated with young-growth timber harvest would be similar to the rate of landsliding associated with old-growth harvest. Areas of young-growth harvest would likely have different rates of landsliding than those following past old-growth harvests for two reasons:

1. The young-growth stands would have had 50 or more years of exposure to storm events and thus unstable areas may have already failed. If landslides have occurred in the young-growth stands, they can be useful for identifying potentially unstable areas to be avoided during the second entry.
2. Landslide rates in young-growth stands may increase due to climate change or other unforeseen changes in soils resulting from a second timber harvest entry in the young-growth stands.

These data limitations and uncertainties should be considered when evaluating the data presented in Table 3.3-5.

As of this writing, the Tongass National Forest has only harvested a few young-growth stands, and none of them on steep slopes. Thus, there is a paucity of monitoring data on the Tongass National Forest pertaining to slope stability following young-growth timber harvest. There are several recent landslide studies following young-growth harvest from British Columbia (Jakob 2000; Guthrie 2002) and the Pacific Northwest (Robinson et al. 1999; Stewart et al. 2013); however, due to the highly variable nature of landslides, regional differences, and other factors, those studies do not provide reliable future landslide rate estimates for the Tongass National Forest following young-growth timber harvest. As a result, the Swanston and Marion (1991) landslide rate estimates in Table 3.3-5 remain the best available estimates for future landslide rates on the Tongass National Forest.

Management induced landslides are considered detrimental soil conditions and are included in soil quality monitoring. The 1997 and 2008 Forest Plans required on-site slope stability analysis for timber harvest proposed on slopes over 72 percent gradient. Application of this standard has resulted in the avoidance of hundreds of acres of unstable areas and a limited amount of timber harvest on slopes over 72 percent. Long-term monitoring of slopes over 72 percent that have been harvested is proposed as part of the forest-wide landslide inventory effort.

As the forest transitions to young-growth management, harvest on slopes over 72 percent will likely become less of an issue. Approximately 5 percent of existing young-growth stands occur on slopes over 72 percent gradient. Since the original timber harvest, the young-growth stands on slopes over 72 percent have experienced numerous storm events. If the slope is unstable, a harvest-related landslide would likely have occurred after 50 or more years of storm events. However, the likelihood of a harvest-related landslide is not constant over time. The highest likelihood of landslides in harvested areas is thought to be 4 to 10 years after timber harvest (Sidle 1991 and 1992; Schmidt et al. 2001), with decreasing likelihood over time. This is because the stabilizing effect of root reinforcement is reduced during the period when the root systems of harvest trees are decaying and new root systems are emerging (Ziemer 1981).

Under all alternatives, there would be no change to the existing standards and guidelines for harvest on steep slopes except for the addition of a Management Approach for conducting slope stability assessments for steep slopes in young-growth stands, as described in Forest Plan Chapter 5. The slope stability analysis is still required for young-growth harvest on slopes over 72 percent but the on-site requirement is dropped unless a slope stability specialist deems it necessary based on remotely sensed data. This change presents a reasonable risk based on the above discussion and will reduce the slope stability specialist's workload in young-growth project planning.

There may be an increase in future landslide rates based on current climate projections. Although climate trends will likely vary within the Tongass National Forest, general trends project increased mean annual temperatures, reduced snowpack, earlier snowmelt, and increasing shift from snow to rain (Wolken et al. 2011). Climate trends may lead to more extreme precipitation events in some areas (NPS 2013) which will be more likely to occur as rain-on-snow events (Rennert et al. 2009). Since the majority of landslides occur over relatively short time periods during high intensity storm events, the predicted climate trends, in particular, more frequent rain-on-snow events, are likely to increase landslide rates over the next 50 to 100 years (EcoAdapt 2014). High flow scour and outburst floods associated with glacial recession are also likely to increase landslide rates and sediment delivery to glacial rivers (Moore et al. 2009).

In limited parts of the Tongass National Forest, soil degradation from steadily increasing off-highway vehicle (OHV) use has been documented (USDA Forest Service 2006). In November 2005, the Forest Service adopted a final rule for managing motor vehicle use, including OHV use, on national forests throughout the United States (36 Code of Federal Regulations 212 – Travel Management – Roads Rule). Avoiding routes that cross saturated soils with low-bearing strength would prevent most resource damage. Under the 2008 Forest Plan, access and travel management (ATM) plans have been developed for each District to designate a system of roads and trails for OHV use, and identify if any areas for cross country travel are appropriate and do not cause resource damage. Each District annually prepares an updated Motor Vehicle Use Map (MVUM). The MVUM displays National Forest System (NFS) routes (roads and trails) or areas designated as open to motorized travel. With limited exceptions, OHV use off of designated MVUM routes is prohibited to limit soil impacts such as rutting, soil compaction, and other resource damages. One exception is that some ATM plans allow travel outside of designated MVUM routes for the purposes of game retrieval, with a permit, if it can be done without causing resource damage. Recent soil quality monitoring by the Yakutat Ranger District identified soil disturbance and resource damage in limited areas associated with game retrieval. It was noted that there were adjacent route alternatives at the sites monitored with better drained soils and that user education could reduce the resource damage (USDA Forest Service 2014b).

A number of proposed renewable energy projects could be built in the future that may have impacts to soils. In June 2014, the Forest Service identified 25 proposed renewable energy projects in Southeast Alaska that are currently active (USDA Forest Service 2014c). Proposed projects are common to all alternatives and include hydropower, geothermal, biomass, and tidal energy development plans. Although many of these are still in the early conceptual planning stage and applications have not been submitted to the Forest Service, many of the proposed projects include transmission lines and in some cases, access roads on NFS lands. Alternatives 2, 3, 4, and 5 would address concerns related to renewable energy sites and utility lines through the addition of new forest-wide Renewable Energy and Transportation Systems corridors plan components standards and guidelines to the Forest Plan.

The environmental effects from proposed renewable energy projects are not known at this time; however, existing and proposed transmission line projects including the Swan Lake-Lake Tyee Intertie Project (completed in 2009) and the Kake to Petersburg Transmission Line Intertie Project (currently undergoing National Environmental Policy Act [NEPA] review) have evaluated soil impacts. In general, project development and maintenance could potentially result in impacts including soil displacement, soil erosion, and loss of soil porosity related to ground disturbance and the increased potential for landslides. Standards and guidelines, BMPs, and other relevant mitigation measures would be applied at the project level to minimize potential adverse effects. Steep slopes, as well as riparian and other sensitive areas should be delineated on project maps to ensure their recognition, proper consideration, and protection during the development of renewable energy projects. Access roads needed for transmission lines should utilize existing transportation corridors, where possible. The potential effects of each proposed project would be evaluated in future analysis during the NEPA permitting process.

Root-wads attached to tree boles are needed for stream restoration projects. Removing trees with the root-wad attached can cause severe soil displacements of the soil duff and topsoil. Beginning in 2009 the forest has had a need to harvest root-wads for stream restoration projects from a few acres each year.

Monitoring of the effects of root-wad removal on soil productivity is ongoing (Foss 2015). In addition, all regeneration harvests are monitored for adequate stocking of conifer species. To date all root-wad harvests that have resulted in a regeneration harvest have met minimum stocking guidelines, indicating that the sites have adequately regenerated. Growth of trees and natural soil recovery is being monitored with photo points (Foss 2015). Following the 2009 root-wad harvest of 6 acres, visual monitoring resulted in the development of guidelines for root-wad harvests (Landwehr 2009). The guidelines for root-wad harvest are used to minimize impacts to soils from root-wad harvest. The amount of root-wad harvest for stream restoration is the same under all alternatives.

Cumulative Effects

Cumulative effects to soils would include both the effects discussed above and other potential effects related to activities outside of NFS lands. Appendix C of this Environmental Impact Statement provides a full list and description of all the projects considered in the cumulative effects analysis including past, present, and reasonably foreseeable future actions. The total area within the Tongass National Forest boundary, including both NFS and non-NFS lands, is about 17.9 million acres. Of this area, non-NFS lands make up approximately 7 percent (1.2 million acres). If all of Southeast Alaska is included, the land area is about 21.6 million acres and non-NFS lands make up approximately 23 percent (4.9 million acres).

Management activities on non-NFS lands are not held to the Region 10 soil standards; however, BMPs are required under the Alaska Forest Resources and Practices Act, including detailed regulations related to providing notification prior to timber harvests and managing riparian areas. The state forester must protect riparian areas from the significant adverse effects of timber harvest activities on fish habitat and water quality. These measures are designed to avoid soil erosion and sedimentation near streams. Martin (1996) compared pre- and post-harvest basins on non-NFS lands and found short-term effectiveness of these BMPs. Martin (1997) evaluated BMP effectiveness, including those designed to reduce soil erosion to mitigate turbidity. The report determined BMPs minimized sediment delivery and effectively maintained turbidity at comparable non-harvest levels. Arians (2003) includes several studies that compared pre- and post-harvest basins and indicated that logging with the BMPs does not result in significant effects to soils that would result in stream sedimentation and damage to fish. Despite these BMPs, some landslides, soil erosion–related to duff removal, and losses in site productivity likely have occurred and will continue to occur on non-NFS lands. However, cumulatively, non-NFS lands represent only 7 percent of all of the soil resources in Southeast Alaska within the Tongass boundary. Potential impacts to the remaining 93 percent of soil resources would be mitigated through implementation of standards and guidelines and BMPs associated with each of the alternatives.

The 2013 monitoring (USDA Forest Service 2014a) found that overall soil and water BMPs were implemented and found to be effective in Tongass timber harvest and road construction activities. Based on monitoring results, no changes were recommended to Forest Plan standards and guidelines for attaining State of Alaska water quality standards. Furthermore, effects of harvest on soil resources would ultimately be considered at the project-specific levels, ensuring minimal adverse cumulative effects to soil resources.

As described earlier under the discussion of the potential direct and indirect effects to soils from roads and landings, at the Forest Plan level, the overall difference in roaded area is a good indication of how site-specific effects are likely to vary among alternatives. This approach also applies to cumulative effects. Standards and guidelines, BMPs, and other relevant mitigation measures are applied at the project level to minimize potential adverse effects.

Under all alternatives, the density of roads would be less than under the 2008 Forest Plan due to the ability to utilize existing roads (i.e., open, closed, or decommissioned) for harvest of young growth, reducing the amount of new road construction. Reductions in soil productivity losses and soil erosion would correlate with lower cumulative road densities.

Roads are more prevalent on non-NFS lands than on NFS lands. In addition to approximately 5,005 total road miles currently on NFS lands, an additional 3,691 miles currently exist on non-NFS lands within the Forest boundary, and most of these roads are associated with timber harvest activities. Projected future road density for existing conditions and under each alternative, for both NFS and non-NFS lands, are shown in Table 3.3-6. Estimated maximum road densities after 100 years of implementation are relatively high (up to 3.551 miles per square mile) on non-NFS lands, resulting in commitment of soil resources; however, cumulative future road densities on NFS lands are considerably lower, ranging from 0.195 miles per square mile under existing conditions to 0.235 miles per square mile under Alternative 2 (see the *Water* section for additional information).

Table 3.3-6
Estimated Maximum Road Density on NFS Lands and Non-NFS Lands after 100 Years under Existing Conditions and by Alternative

Alternative	NFS Lands Road Density (miles per square mile)	Non-NFS Lands within Forest Boundary Road Density (miles per square mile)
Existing	0.195	2.293
1	0.231	3.551
2	0.235	3.551
3	0.233	3.551
4	0.228	3.551
5	0.232	3.551

Other reasonably foreseeable future activities on NFS lands include mining, recreation and tourism, transportation, and renewable energy projects. Alternatives 2, 3, 4, and 5 would address concerns related to renewable energy sites and utility lines through the addition of new forest-wide Renewable Energy Sites and Utility Lines standards and guidelines to the Forest Plan. Overall, the cumulative effects of considered alternative actions combined with other non-NFS lands actions would increase the potential for cumulative effects to soil resources. Potential cumulative effects of harvest, roads and landings, and other actions would be evaluated on a project-specific basis ensuring that any adverse effects to soil resources would be reduced, moderated, mitigated, or eliminated.

Mitigation

Forest-wide standards and guidelines (see Forest Plan Chapters 4 and 5) are followed on site-specific projects to mitigate the effects of management activities. They are designed to minimize accelerated soil erosion and maintain long-term soil productivity. They include soil conservation practices and incorporate the applicable BMPs (see Soil and Water Handbook). Annual monitoring (described in FSM 2554) of BMP implementation and effectiveness helps ensure that water quality goals, and standards and guidelines, are met during project implementation (see Forest Plan, Chapter 6).

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Water

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Affected Environment

The Tongass National Forest can be characterized by its abundance of water. The maritime climate brings precipitation nearly year-round, with the heaviest amounts occurring from September through January. Coastal low-elevation rain forests thrive in this maritime climate. Thousands of miles of shoreline and hundreds of bays and inlets characterize the marine environment of the Tongass. An important consideration for all water-related issues is the effect that changes in water flow and quality have on important aquatic resources, especially fish.

The water environment of the Forest can be described in terms of climate, water quantity, water quality, watershed condition, and water use. There are over 900 sixth-level subwatersheds within the 26,000 square miles that make up the Tongass National Forest. Climate is described in the *Climate and Air* section, with applicable climate change information in the subsections below including cumulative effects. The water quantity, water quality, watershed condition, and water use are summarized in the subsections below. Wetlands are described in the *Wetlands* section. Fish and fish habitat are described in the *Fish* section.

Water Quantity

Streams and rivers on the Tongass produce a large volume of water per unit of land. Much of the flow originates or passes through thousands of small to large lakes. Both glacial and non-glacial river and stream systems occur on the Tongass, and runoff varies greatly between the two stream systems. Runoff from glacially fed streams usually starts in June in response to snow and ice melt, reaching peak flows in July and August. Runoff drops rapidly in October and low flows occur from December through April. Runoff from non-glacial streams tends to respond to high precipitation events; therefore, the highest flows tend to be in October and December and the lowest flows between January and March, and mid-May to August.

Many factors influence how timber harvest and clearing of forest for road construction may affect runoff, and most are site-specific. The combined effects of these activities with site-specific factors can influence the amount and timing of runoff. In studies conducted in the Pacific Northwest, factors, especially those

relating to roads, affect runoff patterns; although site-specific conditions including hillslope gradient, topography, soil type, and rainfall all influence the level of effect (Coe 2004). In general, changes in streamflow following timber harvest and road building are commensurate with the proportion of watershed harvested (Harr 1986; Jones and Grant 1996; Jones 2000; Moore and Wondzell 2005; Grant et al. 2008). In studies on the effects of forest harvest activities on peak flows in the Pacific Northwest, a minimum cumulative harvest of 20 to 40 percent has been shown to result in a 10 percent change in peak flow (Grant et al. 2008). Overall, removal of forest cover increases water yield, though attempts to quantify this at the watershed level show highly variable and unpredictable results (Bosch and Hewlett 1982; Keppeler and Ziemer 1990; Keppeler and Lewis 2007; Grant et al. 2008).

On the Tongass, stream channels and lakes are categorized by class based on their fish production values. Although there are additional details (see the *Glossary* for full definitions), stream classes are generally defined as follows:

- Class I streams and lakes have anadromous or adfluvial fish or fish habitat: or, high-quality resident fish waters, or habitat above fish migration barriers known to provide reasonable enhancement opportunities for anadromous fish.
- Class II streams and lakes have resident fish or fish habitat and generally steep gradients (6 to 25 percent or higher) where no anadromous fish occur, and otherwise not meeting Class I criteria.
- Class III streams are perennial and intermittent streams that have no fish populations or fish habitat, but have sufficient flow or sediment and debris transport to directly influence downstream water quality or fish habitat capability.
- Class IV streams are intermittent, ephemeral, and small perennial channels with insufficient flow or sediment transport capability to directly influence downstream water quality or fish habitat capability. Class IV streams do not have characteristics of Class I, II, or III streams, and have a bankfull width of at least 0.3 meter (1 foot).

Field survey methods to determine stream class follow the Tongass National Forest fish stream identification and classification procedures (USDA Forest Service 2015o). In addition, the Tongass uses a stream channel classification system based on the Alaska Region Channel Type Classification System (Paustian et al. 1992; revised October 2010). Streams are categorized into channel types, which are grouped into nine process groups, or combinations of similar channel types based on major differences in landform, gradient, and channel shapes (see Appendix D in the Tongass National Forest Land and Resource Management Plan [Forest Plan] for a full description). These are used to assess watershed condition, fish habitat production capabilities, and sensitivity to management activities (see the *Fish* section for additional information).

Nearly 46,000 miles of streams have been mapped on National Forest System (NFS) lands (Table 3.4-1). Of those, approximately 63 percent are classified in the high gradient contained process group (Table 3.4-1). Additionally, some 4,300 Class I and II lakes equaling 144,000 acres are also present on NFS lands.

There are also streams that have not been mapped because they require ground surveys to locate. During the planning stages of a specific proposed timber management activity, detailed ground surveys following the Tongass National Forest procedures (USDA Forest Service 2015o) are performed to delineate all such streams within the directly affected proposed project area. Many of these

are small low-flow, high-gradient Class III and IV headwater streams, but others may contain valuable aquatic habitat.

Table 3.4-1
Mapped Stream Miles by Process Group and Stream Class[1] for Each Ranger District Group[2] on NFS Lands

Stream Process Group	Class	Ranger Districts: Northern	Central	Southern	Total
Alluvial Fan (AF)	I	241	50	127	418
	II	597	93	127	817
	III	86	83	107	275
	IV	0	3	2	6
Estuarine (ES)	I	140	112	56	308
	II	1	0	1	2
	III	0	0	0	0
	IV	0	0	0	0
Flood Plain (FP)	I	2,081	624	976	3,681
	II	58	124	69	251
	III	1	11	11	22
	IV	1	0	0	1
Glacial Outwash (GO)[3]	I	388	237	247	873
	II	77	81	6	164
	III	57	48	9	114
	IV	0	1	0	1
High Gradient Contained (HC)	I	83	89	138	310
	II	3,035	840	2,133	6,007
	III	7,626	4,830	8,440	20,896
	IV	375	611	527	1,514
Low Gradient Contained (LC)	I	129	119	157	405
	II	12	26	14	52
	III	0	0	4	4
	IV	0	0	0	0
Moderate Gradient Contained (MC)	I	668	403	972	2,043
	II	351	198	215	765
	III	7	38	76	121
	IV	1	2	2	5
Moderate Gradient Mixed Control (MM)	I	777	806	1,122	2,705
	II	328	313	290	930
	III	7	20	48	76
	IV	5	15	22	42
Palustrine (PA)	I	1,341	414	552	2,307
	II	55	99	105	260
	III	4	8	30	43
	IV	3	7	11	22
Unverified Connectors (UC)[4]	I	72	21	25	118
	II	3	1	3	6
	III	12	1	4	16
	IV	0	5	21	26
Total	**I**	5,918	2,875	4,374	13,167
	II	4,516	1,776	2,962	9,255
	III	7,800	5,039	8,730	21,569
	IV	385	644	586	1,615
Grand Total[4]	**All Streams**	**18,620**	**10,333**	**16,653**	**45,606**

Table 3.4-1
Mapped Stream Miles by Process Group and Stream Class[1] for Each Ranger District Group[2] on NFS Lands

		Ranger Districts			
Stream Process Group	**Class**	**Northern**	**Central**	**Southern**	**Total**

[1] Miles are only those currently mapped and in the GIS database excluding lake miles and channels on all non-NFS lands. Additional unmapped streams are present, but have not been located through on-the-ground surveys, especially Class III and IV streams that are greatly underrepresented in the database. Numbers may not add up precisely because of rounding. See Paustian et al. 1992, as amended in 2010) for a description of the stream process groups and the glossary for a definition of stream classes.
[2] Northern Districts=Admiralty, Hoonah, Juneau, Sitka, and Yakutat; Central Districts=Petersburg and Wrangell; Southern Districts=Ketchikan-Misty Fiords, Thorne Bay, and Craig
[3] Includes all glacial outwash channel types.
[4] Includes unverified connector channels such as ice fields, connector streams, and intertidal channels not field surveyed.
Source: GIS database, March 2016

Water Quality

The State of Alaska sets water quality standards for chemical, physical, and biological parameters for waters on NFS lands. The Alaska Department of Environmental Conservation (ADEC) and the Forest Service have agreed that the Forest Service is the agency responsible for monitoring and protecting water quality on the NFS lands of Alaska for the purpose of meeting the Clean Water Act, as amended. Best management practices (BMPs), as described in the Soil and Water Conservation Handbook (USDA Forest Service 2006), the Alaska Nonpoint Source Pollution Control Strategy, and the Alaska Water Quality Standards (18 Alaska Administrative Code [AAC] 70) together form the "Forest Service Alaska Region Water Quality Management Plan," as agreed to in the Memorandum of Agreement dated April 6, 1992 (ADEC and USDA Forest Service 1992). With implementation of this Plan, the State of Alaska recognizes that the Forest Service BMPs are the primary means to protect water quality from nonpoint sources of pollution. In 1997, the ADEC determined that the Forest Service BMPs meet or exceed the BMPs contained in the Alaska Forest Resources and Practices Act and Regulations (11 AAC 95) (Brown 1997). In 2012, the Forest Service issued National Core BMPs, which are also implemented in the Tongass National Forest.

In addition, the ADEC is responsible for providing a list to the U.S. Environmental Protection Agency (EPA) of the status of water quality within the state. The state makes a determination of which state waters (e.g., streams, rivers, bays) exceed state water quality standards and are limited by point and/or non-point sources of pollution, which may require additional controls to meet state water quality standards. Waters that fit this definition are put on a list as designated under Section 303(d) of the Clean Water Act, which is published by the state and sent to the EPA. State waters in this category are known as waters on the 303(d) list.

The most recent list for 2012 (ADEC 2013) includes Katlian River (on Baranof Island north of Sitka), listed as impaired for non-attainment of the sediment and turbidity standards due to past timber harvest activities, including road maintenance and riparian harvest. An assessment indicated that most sediment sources in the watershed are natural and there are limited opportunities for rehabilitation (USDA Forest Service and Sitka Tribe of Alaska 2003). Five streams along road system 3030 near Sweetwater Lake on Prince of Wales Island had been designated as 303(d) waters due to acid rock runoff conditions from the road construction. Recently, due to remediation actions, monitoring of these streams found they meet most water quality standards including improved biological resources and have been recommended by the ADEC for removal from 303(d) listed streams and placed as Category 2 streams, which are streams

meeting most water quality standards. Marine waters listed near the Tongass National Forest include Hawk Inlet (Admiralty Island), Thorne Bay (Prince of Wales Island), and Ward Cove (Ketchikan). Some streams and log transfer facilities (LTF) that were listed as 303(d) in the past have been removed from this category due to improved water quality conditions. Currently, no LTF facility used by the Forest Service is 303(d) listed.

Stream Temperature

Stream temperatures are affected by solar radiation, evaporation, advection, conduction, and convection (Brown 1983; Adams and Sullivan 1989). Streams have a general tendency to warm as flow moves from upstream to downstream. Higher stream temperatures in the summer are generally the result of natural heating from solar radiation, increases in air temperatures, and decreases in streamflow (Zwieniecki and Newton 1999). Increased stream temperature results in reduced oxygen, but other factors such as decaying organic matter or abundance of salmon in a stream can also have large effects on dissolved oxygen concentrations (Pentec Environmental 1991; Spence et al. 1996; Welch et al. 1998).

Maintaining proper water temperature is critical for the health of aquatic ecosystems. Anadromous fish and other aquatic species are sensitive to water temperature with very low or high temperatures causing adverse conditions. Often in streams with salmon and trout, high water temperature is of greatest concern (see the *Fish* section for additional information). Timber harvest and road construction have the potential to reduce stream-side shade and raise water temperatures. Forest Plan standards and guidelines (see Chapter 4, Chapter 5, and Appendix D of the Forest Plan) minimize riparian harvest (see the subsection on Riparian Areas in the Watershed Condition section below) in order to maintain stream-side shade.

Removal of riparian vegetation can increase stream temperatures, but the magnitude of effects from timber harvest and road construction activities varies. Murphy and Milner (1997) reviewed studies in Southeast Alaska that did not include stream-side buffer practices and found a wide range of temperatures in streams, most with small increases that did not approach lethal levels. Other studies have found that total stream temperature change across a cleared area with no buffer may be greater in small, shallow streams than in large, deeper streams (Beschta et al. 1987; Moore et al. 2005).

In coastal British Columbia, daily maximum stream temperatures in the summer increased in streams with no buffer, while water temperature in streams with 10- and 30-meter (approximately 33 feet to 98 feet) buffers did not (Gomi et al. 2006). In the State of Washington one study of very small streams (most less than 1 meter [3 feet] wide) found stream temperatures increased following logging, with average maximum summer temperatures of about 0.7 to 1.5 degrees Celsius (°C) (33.3 to 34.7 degrees Fahrenheit [°F]) higher in harvested compared to unharvested buffers (Janisch et al. 2012). In contrast, studies in Oregon State forests with restrictive no harvest buffers found no measureable changes in stream temperature in harvested areas relative to control streams (Groom et al. 2011).

Hetrick et al. (1998) determined that stream temperature effects from vegetation removal were mitigated after flow through 150 meters (approximately 492 feet) of stream-side canopy cover; however, other studies (Poole et al. 2001; Moore and Wondzell 2005, Pollock et al. 2009) noted that while water temperature cooling occurred below previous timber harvest, once streams entered forested areas,

the level of cooling and distance to return to unharvested temperature levels was variable. In addition, studies have found for smaller streams that return to pre-harvest temperatures following regrowth of riparian shade is often rapid, with the recovery of stream temperatures in less than 10 years (Moore et al. 2005; Quinn and Wright-Stow 2008).

In comparing stream temperatures in logged versus unlogged watersheds, Konopacky Environmental (1996) did not detect increases that could be characterized as differing significantly. An analysis of legacy stream temperature data collected on Prince of Wales Island in Southeast Alaska was completed in 2004 using data from 1997 to 2002 in harvested and unharvested watersheds (Walters and Prefontaine 2005). In this study, state water quality criteria for stream temperatures were exceeded during warm weather in both harvested and unharvested watersheds. In another study of water temperature in three Tongass National Forest drainages, two with no harvest and one with past harvest, all had exceedances of state water temperature criteria, with effects of past harvest practices on stream temperature not apparent (Tucker and Thompson 2010). Tucker and Thompson (2010) concluded drainage characteristics and local weather may have masked changes in stream temperature from upland and riparian harvest. High stream temperatures in Southeast Alaska are likely to occur under natural conditions during warm, rainless weather, and result in high stream temperatures during low stream flow periods regardless of extent of past riparian timber harvest or watershed harvest.

Factors other than riparian vegetation, such as landslides, debris flows, and overall basin size, may have substantial effects on the significance and magnitude of measured effects on stream temperatures (Ice et al. 2010). In the State of Washington, Janisch et al. (2011) conducted a study of very small streams (most less than 1 meter [3 feet] wide) and found that stream temperature changes varied and were poorly related to stream buffer size, with likely other stream morphological conditions (e.g. wetlands, substrate) having a greater effect on temperature changes than buffer characteristics. Although results from the various studies may vary, most studies suggest that elevated summer stream temperatures are affected more by other environmental conditions than past timber and riparian harvest.

Climate change has the potential to affect runoff and stream temperatures on the Tongass National Forest. Several modeled results presented in recent literature demonstrate that air temperatures and precipitation in Southeast Alaska and the Tongass National Forest will increase this century (EcoAdapt 2014; Shanley et al. 2015), although the degree to which changes occur vary substantially between areas across the Forest. In general, increases in air temperature are expected in the winter months with increases in precipitation expected in the fall and winter (EcoAdapt 2014). These warmer air temperatures would likely result in much of the precipitation occurring as rain instead of snow and contribute to the melting of glaciers, higher peak flows in the fall and winter in most streams other than glacial-fed streams, and lower summer flows primarily in snowmelt- and rain-dominated watersheds (Shanley and Albert 2014; Shanley et al. 2015). Regarding stream temperatures, the warmer air temperatures may result in increased stream temperatures, but the degree to which increases would occur depend greatly on factors such as glacial system, groundwater inputs, presence of lakes and ponds, and stream shading (EcoAdapt 2014). In addition, any potential increase in stream temperatures may be lessened by the potential increases in rainfall occurring in the summer and fall (EcoAdapt 2014).

Changes in any of the physical or chemical properties of water can directly affect water use by people, fish, and wildlife. Factors such as stream temperature and

dissolved oxygen are not expected to change appreciably by alternative, even when effects from climate change are considered, and therefore only limited discussion is provided further in this section.

Sediment and Other Factors

Sediment is solid materials that were derived from the natural weathering of rock or from erosion of areas modified by man, such as roads and landings, agricultural lands, or urban areas. Sediments are carried and deposited by wind, water, and ice, and may be transported as either suspended load or bedload in streams. Suspended sediment is carried within the water column, while bedload material moves via rolling or bouncing along the bottom of the stream or riverbed. Suspended sediment causes water to have a turbid or murky appearance. Under natural conditions, the great majority of suspended load and bedload transport occurs during storm runoff events.

Landslides

Soil mass movements (landslides), streams cutting new channels, and bank erosion are the main natural processes creating sediment. Landslides cause large, but temporary, increases in suspended and bedload sediments. Stream and riverbed or bank erosion may contribute to sediment over long periods of time. Steep terrain and large amounts of rainfall make the soil sensitive to erosion if the organic material covering the soil is disturbed. High rainfall also makes soils sensitive to sediment production by road construction and timber harvest activities.

Stream substrates are replenished by natural process such as landslides (Meehan 1991; Reeves et al. 1995; Wing 2000). Sediments, including gravels, and large woody debris are deposited in stream headwater areas. During high-flow periods, some of that sediment and wood is transported through the stream system, although much wood may be stored in headwater channels.

Timber harvest has the potential to affect stream substrate composition through erosion and slumping of hill slopes following harvest, alternating stream buffer characteristics, road and landings construction, road drainage structures, level of use and maintenance of roads, number of stream crossings by roads, density of roads in the watershed, bank erosion where trees have been removed, and hydrology changes (Everest et al. 1987; Swanson et al. 1987; Furniss et al. 1991; Spence et al. 1996; Sweeney and Newbold 2014). On Prince of Wales Island, more than 300 landslides and debris flows were triggered by an October 1993 storm (Johnson et al. 2000). Eroded soil from these landslides was transported as sediment in nearby channels. Channel bedload sediment was 2 to 10 times greater and relatively finer compared with bedload transport in a channel that had last experienced a landslide and debris flow in 1961 (Gomi et al. 2004).

Swanston and Marion (1991) mapped landslides in the Tongass National Forest during the 21-year period, 1963 through 1983. The rate of landslides during this period was 3.5 times higher on harvested areas than on unharvested (see *Soils* section). Of the 1,277 landslides that occurred on unharvested areas, 37 affected Class I and II streams, while 7 of the 118 landslides on logged areas affected Class I and II streams. It is important to note that clearcut timber harvests conducted between 1963 and 1983 did not include the restrictions that were included in the 1997 Forest Plan. These past harvests often involved logging large portions of watersheds with very large clearcuts and almost no buffers, slope restrictions, or other form of restrictions. There have been multiple

landslide inventories and analyses (Bishop and Stevens 1964; Landwehr 1994 and 1998) completed on the Tongass National Forest that have found similar overall landslide rates to the Swanston and Marion (1991) inventory and greater landslide densities in managed stands than in unmanaged areas. Future landslide potential, even in young-growth harvest areas, will be moderated by the Forest Plan requirement to determine slope stability of slopes over 72 percent. Slopes in those categories are considered of higher risk, and determinations of stability prior to initiating logging would occur for all future actions (see *Soils* section) and aid in reducing the risk of increased sediment to streams.

Roads

Road and related timber landings construction near streams, even where the road does not actually cross the stream, may contribute to increased sediment loads in streams, and poses a potential risk to overall watershed conditions (Reid and Dunn 1984; Furniss et al. 1991; Rashin et al. 1999; Gucinski et al. 2001; Luce and Wemple 2001; Gomi et al. 2005). Road location, or the distance between soil disturbance and a stream, as well as the presence of vegetation (riparian) buffers between roads and streams, affects the amount of sediment delivered to a stream through hill-slope runoff, road-runoff, landing runoff, or roadside ditches (MacDonald et al. 2001; Croke and Hairsine 2006; Rashin et al. 2006; Steel et al. 2007; McCune 2010). Knutson and Naef (1997) summarized literature on riparian function, and suggested a 300-foot maximum vegetative buffer was adequate to control sediment delivery to water bodies. McCune (2010) found that direct connection of flow and associated sediment from roads decreased linearly as distance increased, up to approximately 660 feet.

Maintenance of roads, landings, and roadside ditches, including grading and blading of the road surface and ditches and clearing of roadside and ditch vegetation, can increase sediment and turbidity in streams (Luce and Black 1999, 2001; Coe 2006). The increase in sediment delivered to streams by roads and roadside ditches is also related to the hydrologic connectivity, or the linkage between the sediment source areas and the channel network (Furniss et al. 2000). Although road improvement and maintenance has been shown to temporarily increase sediment and turbidity, regular maintenance can help reduce the adverse effects of roads and road deterioration on streams and salmonid habitats (Furniss et al. 1991). Road improvement and maintenance can also prevent severe erosion and increased sediment yields associated with drainage system failures which can minimize the degree of impact roads have on soil and water resources (Luce and Black 2001; Napper 2008).

Gomi et al. (2005) reviewed suspended sediment sources and transport in small forest streams in the Pacific Northwest region and concluded that vegetation clearing can increase fine sediment supply through soil disturbance and accelerated landslides. In addition, studies have found evidence that increased stream flows following vegetation clearing resulted in increased sediment recruitment from within-channel sources, such as through channel erosion (Grant and Hayes 2000 and Lewis et al. 2001 as cited in Gomi et al. 2005). Clearing large portions of forested land from a watershed has been found to increase peak flow response during rainstorms as a result of vegetation loss (Hewlett and Helvey 1970 as cited in Webster et al. 1992; Hudson 2001; Grant et. al. 2008; Tonina et al. 2008), with the increased peak flows intensifying sediment recruitment from within-channel sources (Webster et. al. 1992; Tonina et al. 2008; Grant and Hayes 2000 and Lewis et al. 2001 as cited in Gomi et al. 2005).

Generally, the effects of timber harvest on peak flows and resulting sediment recruitment and transport are, however, dependent upon multiple factors,

including area of basin harvested, hydrologic regime, topography, soil conditions, road density, and harvest methods (Jones and Grant 1996; Hudson 2001; Gomi et. al. 2005; Karwan et al. 2007; Grant et al. 2008; Tonina et al. 2008). Specific to Southeast Alaska, statistical relationships between fine sediment and watershed disturbance were not found by Bryant et al. (2004) or Woodsmith et al. (2005). Ross (2013) found evidence of smaller median particle size in stream substrate in watersheds with historical timber harvest, which included historical timber practices of removing riparian trees down to the stream bank.

In Alaska, the ADEC has established numeric criteria for turbidity standards (ADEC 2006) to help evaluate the presence of suspended particulates. Turbidity criteria indicate values will not exceed 5 nephelometric turbidity units (NTUs) over natural conditions, when natural values are less than 50 NTUs. Turbidity in Alaska correlates with suspended sediment, although the exact relationship varies by region and stream type (Lloyd 1987; Lloyd et al. 1987) and has not been determined in Southeast Alaska.

In Southeast Alaska, suspended sediment loads in non-glacial streams in undisturbed watersheds are very low. Concentrations of suspended sediments range from less than 10 parts per million (ppm) in the winter to occasionally over 100 ppm in the fall during storm runoff periods (Schmiege et al. 1974). Suspended sediment in glacial streams is highly dependent on the volume of water flow from snow and ice melt. At high flows, concentrations may reach from 200 to more than 600 ppm; at low flows during winter, suspended sediment concentrations seldom exceed 20 ppm (Schmiege et al. 1974).

On the Forest, current road construction methods and culvert installation activities have been found to have little effect on stream turbidity. Turbidity data collected during culvert installation or road construction suggest few instances where the state criteria have been exceeded (USDA Forest Service 2004a). Of 12 replacement culvert installations monitored in 2004, 10 always met the turbidity criteria for drinking water and 11 of the sites met the criteria for fish propagation within 48 hours of the construction activity. Typically, water returned to less than 5 NTUs over background shortly after construction. In Upper Shaheen Creek in 2004, monitoring was conducted to determine effects of road construction (including a bridge) on meeting turbidity criteria (Thompson and Tucker 2005). The results from monitoring suggest some short-term exceedance of the 5 NTU criteria. Of 50 days of continuous monitoring (when upstream and downstream sites were both monitored), 11 days had some exceedance; of these, 9 were short term (less than 15 minute spikes in turbidity), while the remaining 2 exceedances were up to 30 minutes. Similar results were found in 2003, when 32 and 51 of 54 monitored culvert installations met drinking water, and fish production turbidity criteria, respectively (Monitoring Report summary for 2003).

Effects of timber management activities on turbidity levels in two small watersheds were examined over a 5-year period (2004-2008) on Prince of Wales Island (Tucker and Thompson 2010). The study evaluated turbidity levels in the two small adjacent watersheds with similar characteristic; however, one of the watersheds, Chanterelle, was unharvested and the other watershed, Scary, was harvested and roaded. Turbidity in both remained mostly low, similar, and below state water quality standards (5 NTUs) except during storm events that resulted in peak stream flows. While the highest turbidity value (902 NTUs) occurred in the managed watershed (Scary), statistical tests comparing values from 41 coincident peak storm events found no significant differences between peak turbidity in these two watersheds (median during peak events was 16.7 and 15.2 NTUs in Scary and Chanterelle, respectively). In this study, Tucker and

Thompson (2010) found that naturally occurring events (e.g., landslides, bank avulsion) may outweigh any potential turbidity increases resulting from management activities (e.g., harvest, roads) in these watersheds.

The Nakwasina River on Baranof Island, which had been listed as a 303d impaired stream on the state's list based on past timber practices effects on stream sediment and turbidity in 1998, was monitored for turbidity levels in 2008, with turbidity values compared to the Clear River, a nearby mostly unaffected stream (Tucker et al. 2009). Tucker et al. (2009) determined turbidity levels were low in both the Nakwasina River and Clear River, with higher values in the Clear River, but overall some increases occurred in both rivers during higher flows. Overall, long-term effects on increased turbidity values in the Nakwasina River due to past timber practices were not apparent.

Within Fubar Creek (now named Gandláay Háanaa) on Prince of Wales Island, turbidity was monitored due to historic landslides associated with timber management to determine if state standards for turbidity were being met and compare turbidity values to Rio Roberts, a nearby mostly unaffected stream (Tucker 2011). Tucker (2011) determined that frequency of exceedance of the 5 NTU state standard were similar for both Fubar Creek and Rio Roberts (less than 5 NTUs in Fubar Creek and Rio Roberts 96.3 and 97.0 percent, respectively). Although peak values were more often higher in Fubar Creek than Rio Roberts, the values were in the range of natural variability. Overall, long-term effects on increased turbidity values in Fubar Creek due to historic landslides associated with timber management were not apparent.

As noted above, changes in any of the physical or chemical properties of water can directly affect water use by people, fish, and wildlife. Sediment input to streams and turbidity are the two water quality factors most likely to be affected by the alternatives, and therefore are discussed further in this section.

Watershed Condition

In 2011, the Forest Service Watershed Condition Framework (WCF) established a nationally consistent approach for classifying watershed condition (USDA Forest Service 2011a). The approach is designed to foster integrated watershed assessments, target restoration in priority watersheds, enhance collaboration with partners, and improve outcome-based performance measures for documenting improved watershed condition. Twelve core indicators were evaluated to classify watershed condition across the Tongass National Forest in 2011, using available data from national forest lands. Components of these 12 indicators, based on selected metrics within each of the aquatic and terrestrial indicators, representative of the specific National Forest, are determined to be "Good - functioning properly", "Fair - functioning at risk", or "Poor - impaired function." The results of evaluating each of the 12 indicators are averaged by weighting (see USDA Forest Service 2011a for methods) to provide an overall watershed Condition Class rating: Class 1 "functioning properly," Class 2 "functioning at risk," or Class 3 "impaired function." Data from non-National Forest lands were not used; non-National Forest lands were assigned a subjective rating as same, better, or poorer condition using best available knowledge.

Most of the approximately 900 watersheds within the Tongass National Forest are in near natural condition (Condition Class 1). Sixty-eight watersheds were rated "at risk" for maintaining ecological functions and aquatic resources due to past management practices, while none are rated as Class 3. A detailed map showing the status and individual rating of each of the watersheds in the Tongass can be accessed at the Forest Service's Watershed Condition Class and Prioritization Information website

(http://apps.fs.usda.gov/nfs/nrm/wcatt/WCFMapviewer/). Watershed health issues primarily result from historical timber harvest and road building that occurred between 1950 and 1990, prior to our current understanding of the importance of watershed resources and processes. Measures are now in place to protect and maintain watershed health, namely the riparian protections described in the Riparian Areas subsection below. In addition, the watershed condition ratings, along with use and aquatic value criteria, led to designation of Priority Watersheds for restoration focus (see the *Fish* section for restoration).

Of the 12 core indicators from the WCF (USDA Forest Service 2011a) used to assess watershed functional status condition relative to hydrologic and sediment regimes, the percent of road miles within 300 feet of waterbodies indicator is used to evaluate the potential for sediment to enter streams based on road location. Although this WCF indicator provides an approach to evaluate watershed function based on road miles near waterbodies, a bias in this indicator was identified in a recent policy primer (Rissien 2011). Specifically, the primer recommended that the percentage of waterbodies within 300 feet of a road, and not the percentage of road miles within 300 feet of waterbodies, should be used to evaluate watershed function. Using this criterion, the watershed would be considered "properly functioning" if less than 10 percent of the waterbodies' length in a watershed has roads, "functioning at risk" if between 10 and 25 percent, and "impaired functioning" if greater than 25 percent are within 300 feet of water bodies, relative to the effects of this factor on the hydrology and sediment regime. As shown in Table 3.4-2, about 89 percent of all watersheds would currently be considered "properly functioning" and less than 1 percent as having "impaired function." The results influence the overall rating of watershed conditions, but as stated above, these results are considered along with all other indicators to make the complete watershed function rating assessment.

Table 3.4-2
Percent of Subwatersheds on the Tongass National Forest with Waterbodies within 300 Feet of Roads

Percent of Waterbodies within 300 feet of Roads	Percent of Subwatersheds
0	64.8
>0 – 10	24.0
>10 - 25	10.6
>25	0.7

Numbers may not add up precisely because of rounding.

Riparian Areas

Riparian areas represent dynamic, complex, three-dimensional transition zones between terrestrial and aquatic ecosystems. In the Tongass National Forest, Riparian Management Areas (RMAs) are delineated according to stream process group. The RMAs encompass the stream, mandatory no-harvest zones required by the 1990 Tongass Timber Reform Act (TTRA), adjacent site-potential tree-height distances, landscape features such as floodplains, alluvial fans, and v-notches, and associated wetlands (Forest Plan, Appendix D, Paustian 2004). The RMAs are ecologically tailored to ensure the integrity of the stream channel, maintain supply of large wood, and protect other functions critical to soil, water, fish, and wildlife in Southeast Alaska (USDA Forest Service 2015c). Greatest protection is provided to riparian areas associated with alluvial soils and fish streams; fishless headwater streams are also protected as important conduits of clean water, large wood, stream substrate, and food for aquatic organisms.

Under the 2008 Forest Plan, timber harvest is prohibited in RMAs on Class I, II, and III streams, unless stream process group objectives can be met as documented by watershed analysis (Forest Plan Appendix C). Class IV streams do not have RMAs (or mandatory no-harvest buffers), but are protected by BMPs to minimize disturbance during timber harvest. Standards and guidelines considered to be important for protection of watersheds by the Alaska Anadromous Fish Habitat Assessment (USDA Forest Service 1995) have been incorporated into the RMAs, which were further bolstered by literature review for the 2008 Forest Plan (Landwehr 2006; Paustian et al. 2006). These ecologically based RMA buffers are likely an important component to mitigate potential effects of climate change on hydrologic regimes and fish (EcoAdapt 2014).

In addition, reasonable assurance of windfirmness (RAW) must be provided for buffers, which may or may not include additional buffer width depending on site conditions (Forest Plan Appendix D). For 14 consecutive years at 262 sites on the Tongass National Forest, windfirmness at riparian buffers was monitored (USDA Forest Service 2014d). Based on this monitoring, results have found average blowdown in buffers, which include standard buffers to slope break, to be 6.7 percent (median 0.8 percent). Blowdown is skewed in its distribution ranging from 0 to 85 percent, with 74 percent of the sites with less than 5 percent blowdown. This monitoring has found the rate of windthrow decreases over time; however, monitoring of windfirm buffers on second-growth harvest areas has not been occurring.

To date, approximately 57,929 acres of riparian forest (nearly 5 percent of the original 1,262,531 acres of riparian forest on the Tongass) have been harvested (see Table 3.4-3), including approximately 1,000 acres that are now within Wilderness and 1,800 acres that are now in legislated LUD II areas (USDA Forest Service 1997a). The 55,129 acres of harvest riparian forest outside of Wilderness and LUD II represents over 9 percent of the original 599,253 acres of riparian productive old growth (POG) outside Wilderness and LUD II (USDA Forest Service 1997a). Most of this harvest, almost 53,000 acres, took place between 1950 and 1991 and primarily occurred in riparian/wetland soil polygon areas (see Table 3.4-3). This is approximately 1,292 acres per year; however, following implementation of the 1990 TTRA, harvest in riparian areas has been much lower (approximately 201 acres per year). Since 2008, POG harvest in riparian areas has been limited to approximately 34 acres per year.

Table 3.4-3
Total Riparian Management Area (RMA), Productive Old Growth (POG) in RMA, and Past Harvested Areas in RMA by Stream Channel Process Group on NFS Lands

	Riparian Management Area (Acres)			
Stream Process Group	**Total Existing**	**POG**	**Harvested Prior to 19911**	**Harvested in 1991 to Present**
Alluvial Fan (AF)	50,622	23,547	4,958	359
Estuarine (ES)	12,450	3,469	201	0
Flood Plain (FP)	199,299	111,707	9,620	328
Glacial Outwash (GO)[2]	52,890	7,937	698	7
High Gradient Contained (HC)	366,731	167,106	12,960	2,611
Low Gradient Contained (LC)	12,725	8,885	369	16
Moderate Gradient Contained (MC)	75,692	36,801	1,457	150
Moderate Gradient Mixed Control (MM)	118,433	70,394	6,910	501
Palustrine (PA)	63,093	12,955	1,298	60
Unverified Connectors (UC)[3]	25	2	7	1

Table 3.4-3 (continued)
Total Riparian Management Area (RMA), Productive Old Growth (POG) in RMA, and Past Harvested Areas in RMA by Stream Channel Process Group on NFS Lands

	Riparian Management Area (Acres)			
Stream Process Group	**Total Existing**	**POG**	**Harvested Prior to 19911**	**Harvested in 1991 to Present**
Lake[4]	63,480	18,593	233	19
Riparian/ Wetland Soil Polygons	247,092	77,466	14,191	974
Grand Total	**1,262,531**	**538,864**	**52,904**	**5,025**

[1] No TTRA or RMA buffer required during this period
[2] Includes all glacial outwash channel types.
[3] Includes unverified connector channels such as ice fields, connector streams, and intertidal channels not field surveyed.
[4] RMA buffer on lakes and ponds
Numbers may not add up precisely because of rounding.
Source: GIS database, March 2016

As previously noted, the TTRA dramatically reduced riparian harvest after 1990, and the 1997 Forest Plan further reduced riparian harvest. Since 1997, riparian harvest has been predominately limited to road construction clearing. The GIS-modeled RMA over-estimates riparian acres associated with some stream process groups that are determined not to be riparian at the project level; this results in over-reporting riparian harvest at the forest level. Although both the 1997 and 2008 Forest Plans provided a mechanism for adjusting RMA buffers to allow for commercial harvest in riparian areas (Appendix C in the 2008 Forest Plan), this process has been used sparingly.

Young growth riparian ecosystems vary widely, and previously harvested timber stands are now in various stages of secondary plant succession, depending on original plant associations, site quality, complex geomorphic conditions and site disturbance. With the exception of where the ground is highly disturbed, the species composition on these secondary successional riparian areas is very similar to the riparian vegetation prior to timber harvest, with Sitka spruce, red alder, and western hemlock dominating the tree canopy (USDA Forest Service 1997a). On the more disturbed sites, the vegetation is often similar to primary successional species, such as what occurs following deglaciation, with red alder the most common component. The Tongass Young Growth Management Strategy (USDA Forest Service 2014d) describes a range of typical stand conditions and management considerations.

Floodplains

Executive Order 11988 directs federal agencies to provide leadership and take action on federal lands to avoid, to the extent practicable, the long- and short-term adverse impacts associated with the occupancy and modification of floodplains. The Forest's floodplains are typically found in broad, flat, alluvial U-shaped valleys, with high stream flows inundating the floodplain. These floodplains are forested, and usually support plant communities having an overstory of Sitka spruce or Sitka spruce and western hemlock. The shrub understory is variable and may include blueberry, skunk cabbage, devil's club, salmonberry, and alder. Supporting this vegetation are well-, moderately well-, or somewhat poorly drained, deep mineral soils with thin organic surface layers.

Prior to the 1990 TTRA, nearly 10,000 acres of the Flood Plain (FP) process group were harvested (see Table 3.4-3). Due to the common occurrence of high

stream flows inundating the floodplain, areas where harvest occurs can result in channel movement and increased downstream transport of materials, and reduced supply of large trees to streams. The depletion of large old-growth trees from past harvest in RMA is a long-term impact that will continue to affect floodplain and stream function for hundreds of years. Currently, based on channel type characteristics, the FP process group makes up almost 9 percent of the nearly 46,000 linear miles of the streams mapped on the Forest and is typically protected through identification and designation of RMAs and associated Riparian Standards and Guidelines (see Chapters 4 and 5 and Appendix D of the Forest Plan).

Alluvial Fans

The Forest's alluvial fans are typically found in the transitional area between valley floodplains and steep mountain slopes. The alluvial fan channel typically changes course frequently resulting in multiple branches across the valley floor reflecting a fan-like landform. Because of characteristics of alluvial fans, the plant communities typically comprise Sitka spruce or Sitka spruce and western hemlock. The shrub understory is most commonly blueberry and devil's club.

Prior to the 1990 TTRA, nearly 5,000 acres of the Alluvial Fan (AF) process group were harvested (see Table 3.4-3). Approximately 11 percent of Tongass National Forest watersheds have had more than 10 percent of alluvial soil riparian areas clearcut, mostly between 1950 and 1990 (USDA Forest Service 2014d). Based on channel type characteristics, the AF process group makes up over 3 percent of the nearly 46,000 linear miles of the streams mapped on the Forest. Similar to the FP process group, these are typically protected through identification and designation of riparian management areas and associated Riparian Standards and Guidelines (see Chapters 4 and 5 and Appendix D of the Forest Plan).

Other

Although past harvest in FP and AF process group's represent some of the greatest concerns for any potential future harvest due to unique characteristics and frequent channel movement, past harvest in other process groups has occurred in equal or greater amounts prior to the 1990 TTRA. These include the High Gradient Contained (HC) and Moderate Gradient Mixed Control (MM) process groups, with nearly 13,000 and 7,000 acres harvested, respectively (see Table 3.4-3). Harvest within the HC process group has the potential to alter downstream transport of sediment and wood due to its generally steep and confined characteristics. Although the MM process group is typically located on the landscape in the middle to upper valley bottom, harvest associated with the HC or AF process groups that are adjacent to the MM process group has the potential to deposit additional materials. When combined with harvest in the MM process group, these additional materials could affect the process group's transport capacity.

Beach/Estuary Fringe

Currently, there are about 500 miles of beach/estuary fringe adjacent to past shoreline harvest areas, out of about 17,000 miles of shoreline in the Tongass National Forest. Beach/estuary fringe harvest may have an effect on sediment entry to the marine system and nearshore benthic disturbance (see *Fish* section for details of biologic effects). Young-growth area beach/estuary fringe harvest

has the potential to affect the nearshore marine system from the timber removal methods that may be employed.

Water Use

Key water uses on the Forest include public water supply, recreation, growth and propagation of fish, and hydroelectric power generation. The Forest supplies public and private water systems across the Forest. The ADEC classifies public water systems into four categories that are based on the number of individuals served and frequency of water use (i.e., year round or seasonally). The four categories include Community Water System, Non-Transient Non Community Water System, Transient Non Community Water System, and Class C public water system. The Community Water System applies to those systems with greatest number of users that use water year round. This category would apply to larger communities in Southeast Alaska in the vicinity of the Tongass National Forest boundary. Community Water Systems include water supplies for Ketchikan, Petersburg, Sitka, Juneau, Wrangell, Kake, Klawock, Craig, and Hydaburg. The source watersheds for these systems are within the Forest Service Municipal Watershed Land Use Designation (LUD) (see the Forest Plan, Chapter 3, Municipal Watershed). Ketchikan, Sitka, and Petersburg are congressionally designated municipal watersheds, and the other six communities have non-congressionally designated municipal watersheds. All other non-private water users in the vicinity of the Tongass National Forest boundary are designated under the other three ADEC public water system categories. In addition, water is supplied from the Forest to fish hatcheries, industrial sites, and resorts.

Renewable Energy Development

Hydroelectric generation continues to be used in many places throughout the Forest to provide electricity for mining, sawmills, communities, and other uses. There are 24 hydropower installations in Southeast Alaska, about half of which are on Tongass National Forest Lands (USDA Forest Service 2010b). Some of these are major power facilities producing greater than 10 megawatts (MW) of energy for the communities of Juneau, Sitka, Ketchikan, Wrangell, and Petersburg. Some interties have been developed between facilities with additional installations and interties between installations being proposed. The *Renewable Energy* section supplies additional information on existing and planned hydroelectric projects.

Environmental Consequences

Direct and Indirect Effects

This section considers the effects of forest management activities on water quantity, water quality, watershed condition, including riparian beach fringe areas, water use, and cumulative effects. The effects of timber harvest and roads and related harvest landings on fish and fish habitat are discussed in the *Fish* section of this chapter. The effects on potential hydroelectric projects are discussed in the *Renewable Energy* section, and the effects of log transfer facilities on the marine environment are discussed in the *Fish* and *Transportation* section of this chapter.

Forest management activities affect water quantity and quality, as well as the timing of water flows through alteration of canopy cover, soil, and watershed conditions. Most watersheds are in a state of dynamic equilibrium where changes occur naturally because of changes in weather patterns. Because of the overriding influence of climate and watershed resiliency, changes in streamflow and sediment delivery resulting from management activities (e.g., timber harvest and road construction) are difficult to measure.

Water Quantity

As described in the Affected Environment subsection, changes in streamflow following timber harvest and road building are commensurate with the proportion of watershed harvested. Studies from coastal British Columbia suggest that even selective harvesting may result in statistically significant increases in peak flows (Hudson 2001). After harvest has occurred and the forest canopy begins to close, with forest canopy recovery assumed to occur in 30 years (Hicks et al. 1991; Jones 2000), pre-harvest streamflow conditions are also likely to recover.

Little has been quantified about the effects of timber harvest and roads on stream flows in Southeast Alaska watersheds. Of the limited studies, one study in Staney Creek on Prince of Wales Island concluded that timber harvest of 35 percent of basin area may have increased streamflow during dry periods (Bartos 1989). Additional analysis of these data suggests that the change could be due to climatic cycles, not timber harvest (USGS 2000). From analysis of accumulative water yields in Staney Creek and a control watershed (Old Toms), summer minimum stream flow patterns for Staney Creek did not show evidence that potential changes in forest canopy interception rates affected low flow regimes (USGS 2010). Furthermore, Staney Creek exhibited higher variability in minimum streamflow during pre-harvest periods compared to young-growth forest conditions. However, in the case of the Staney Creek investigation, it is likely that climate signals between modes of the Pacific Decadal Oscillation (PDO) have masked any discernable changes in discharge patterns resulting from timber harvest in the drainage. Overall, water yield appears to increase as a function of mean annual precipitation (MAP), but this effect may be short-lived since the revegetation responses will be quicker in areas of higher MAP (Bosch and Hewlett 1982).

In addition to the Bartos (1989) study on the effect of timber harvest on streamflow during dry periods, Bartos (1990) assessed how geologic zones in Southeast Alaska affected low flows after timber harvest. Bartos (1990) found in general that where watersheds were composed primarily of metamorphics, volcanics, and igneous rocks, lower flows are likely to occur because of timber harvest. In contrast, larger flows are likely to occur because of timber harvest where watersheds are composed of sedimentary rocks. In addition to these studies from Southeast Alaska, many studies from the Pacific Northwest have also indicated that in addition to timber harvest and roads affecting runoff timing and quantity of peak flows, other factors including precipitation, soil type and depth, lithology, road design, hillslope gradient, and topography, may play significant role in stream flows (Coe 2004).

Grant et al. (2008) evaluated numerous Pacific Northwest watershed studies to evaluate the effects of harvest practices on peak flow. In this study, Grant et al. (2008) found there to be an increase in peak flow with the portion of watershed harvested. The relationship was affected by the presence of roads and if watersheds were rain dominated, transient snow dominated, or snow dominated. Based on mean reported measurable change in peak flow, Grant et al. (2008) found that watersheds with both harvest and roads had measurable changes in peak flow at about 29 percent of watershed harvested in rain-dominated watersheds and 19 percent for transient snow watersheds. These results were consider conservative in their estimate as studies reporting no change in flow were not included in the analysis.

Besides factors such as soil type and depth, lithology, road design, hillslope gradient, and topography affecting water quantity, climate change has the potential to affect stream flows on the Tongass National Forest this century, although the degree to which changes occur vary substantially between areas

across the Forest (EcoAdapt 2014, Shanley et al. 2015). In general, increases in precipitation are expected in the fall and winter, with much of the precipitation occurring as rain instead of snow (EcoAdapt 2014). These increases in precipitation occurring as rain would further contribute to the melting of glaciers, higher peak flows in the fall and winter in most streams other than glacial fed streams, and lower summer flows primarily in snowmelt- and rain-dominated watersheds (Shanley and Albert 2014; Shanley et al. 2015).

Projected effects on stream flow within watersheds Forest-wide can be generally assessed by the total acreage of timber harvest and road density. The Timber Harvest and Roads subsections below provide estimated timber harvest and road density on NFS lands under existing conditions and after 100 years of full implementation for each of the alternatives. In addition, the estimated timber harvest and road reconstruction miles in beach/estuary fringe and RMA after 100 years of full implementation for each of the alternatives are also provided.

Quantifying the total acreage of timber harvest and road density provides a general approach to assessing projected effects on water quantity. The potential effects of changes in stream flows within watersheds Forest-wide are expected to vary depending on the factors describe above, as well as the relative amount of timber harvest and roads and the applicable Forest-wide standards and guidelines (see Chapters 4 and 5 and Appendix D of the Forest Plan). The effects from changes in stream flows in a particular subwatershed can only be estimated during project planning, at which point the rate of entry into subwatersheds and locations of proposed roads and harvest units would be analyzed. The actual effects on stream flows can only be determined by site-specific monitoring.

Timber Harvest

As described above, timber harvest has the potential to change streamflow by altering processes that control the amount and timing of water delivered to streams. Generally, reduction of forest cover increases water yield, but the response to treatment is highly variable and unpredictable (Bosch and Hewlett 1982; Keppeler and Ziemer 1990; Keppeler and Lewis 2007; Grant et al. 2008). The direct removal of forest canopy affects rain interception (Prussian 2010), evapotranspiration, snow storage, snow melt, and soil moisture (Jones and Grant 1996; Hubbart et al. 2007). After harvest is completed, soil moisture and transpiration changes continue in response to uptake and use of water by remaining and regenerating vegetation. Climate cycles also influence streamflow and probably confound most studies on the relationship between timber harvest and streamflow, which have not occurred over long enough timeframes to account for climate shifts (USGS 2000; Neal et al. 2002).

The complex relationships between these processes, how they are altered by timber harvest, the role other factors play, and the net effects on streamflow have been studied extensively in the Pacific Northwest, with varying conclusions. Nonetheless, the total acreage of timber harvest between alternatives, combined with road density (see Roads subsection below), provides a general indication to assess projected effects on water quantity. Table 3.4-4 provides the estimated maximum acres of harvest by alternative after full implementation (i.e., 100 years) of the Forest Plan.

Table 3.4-4
Estimated Maximum Acres of Timber Harvest after 100 Years of Full Forest Plan Implementation[1]

Alternative	Maximum Likely Harvest (Acres) and Percent of Total				Total Maximum Harvest (Acres)
	Young Growth		Old Growth		
1	209,882	77%	62,851	23%	272,733
2	335,344	91%	32,609	9%	367,952
3	313,216	90%	35,568	10%	348,783
4	234,885	85%	42,597	16%	277,481
5	284,144	87%	42,479	13%	326,623

[1] Based on harvesting at the PTSQ level for 100 years.

As harvested forest areas mature, young growth is predicted to dominate harvest acreage over a 100-year period. Alternatives 2, 3, and 4 would have the highest proportion young-growth harvest with at least 85 percent, while Alternative 5 would be at least 87 percent and, Alternative 1 the lowest proportion with only 77 percent young-growth harvest. Projected acres of young-growth harvest would range from about 209,882 under Alternative 1 to 335,344 under Alternative 2 (see Table 3.4-4).

Included in the estimated maximum acres of timber harvest in Table 3.4-4, young-growth area beach/estuary fringe and RMA harvest have the potential to directly affect the nearshore marine system and stream channels through increased runoff associated with forest clearing. Table 3.4-5 quantifies the estimated amount of harvest by alternative within the beach/estuary fringe and RMA after 100 years of full implementation.

Table 3.4-5
Estimated Harvest (acres) of Young-Growth by All Harvest Methods (e.g., even aged, group selection, commercial thin) in Beach Fringe and Riparian Management Area (RMA) after 100 Years by Alternative[1]

Alternative	Beach/Estuary Fringe	RMA
1	0	0
2	21,871	26,030
3	30,769	0
4	11,114	0
5	3,903	1,089

[1] Alternative 2 allows clearcutting in Beach/Estuary for the first 15 years and then only commercial thinning. Only commercial thinning is allowed in RMA.
Alternatives 3 and 4 allow only commercial thinning in the Beach/Estuary Fringe.
Alternative 5 allows harvest openings up to 10 acres maximum and commercial thinning in both Beach/Estuary Fringe (with a 200 foot no cut beach buffer) and RMA.

Based on Tables 3.4-4 and 3.4-5, Alternative 2 would likely have the greatest effect on water quantity based solely on the acres of harvest across the Forest and within the beach/estuary fringe and RMA. Although Alternative 1 would have no harvest within the beach fringe or RMA, it has the largest amount of acreage within POG. Alternative 3 would be similar to Alternative 2, with the exception of no harvest within RMA (see Table 3.4-5). This would likely reduce the effects on water quantity and watershed condition (see Watershed Condition subsection below) of Alternative 3 relative to Alternative 2. Alternative 4 would have similar effects as Alternative 1, although with a greater extent in young growth, lesser in POG, and much greater in beach/estuary fringe. Alternative 5 would also have similar effects as Alternative 1, with the exceptions of lower harvest in POG and greater harvest in beach/estuary fringe and RMA. Relative to Alternative 4,

Alternative 5 would have similar effects associated with harvest in POG and less effects in beach/estuary fringe, but slightly greater effects within RMA.

As previously described, the effects from changes in stream flows in a particular subwatershed can only be estimated during project planning, during which the rate of entry into subwatersheds and locations of proposed harvest units and roads would be analyzed. The actual effects on stream flows can only be determined by site-specific monitoring. The Watershed Condition subsection below provides further information related to RMA and beach/estuary fringe.

Roads

Compounding the difficulty of identifying streamflow responses to timber harvest is the influence of the road network. Roads can contribute towards increases in peak flow to streams (Grant et al. 2008). Increases in peak flows can result in stream channel erosion and bed scour (Tonina et al. 2008), affecting stream bed and bank stability, and adverse effects on fisheries resources (see the Fish section). Roads can potentially create areas of hillslope instability resulting in landslide generation, contribute fine sediment from surface erosion, and alter surface and subsurface water flow patterns. Some studies suggest that the influence of roads on the hydrologic cycle is just as significant as timber harvest, with the roads interacting positively with the vegetation removal to speed the delivery of water to channels during storm events (Jones and Grant 1996). Furthermore, mid-slope roads intercept subsurface flow paths, converting subsurface waters to surface waters (McGee 2000; Coe 2004), which can further contribute to increased peak flows (Jones and Grant 1996; Wemple and Jones 2003). In addition, road ditches integrate with and extend the stream network, thereby increasing transport efficiency to streams (Montgomery 1994; Wemple et al. 1996).

Removal of forested wetland acres for timber harvest and roads can result in increased soil moisture due to reduced evapotranspiration (Cox et al. 2013), as is expected to occur when forest canopy is removed. Replacement of wetland area with road surface can disrupt flow paths, decrease storage capacity, and increase sedimentation. Based on research regarding the effect of road construction impacts on adjacent wetlands in Southeast Alaska, effects to wetland hydrology and vegetation adjacent to roads are expected to be limited to a few meters of the road (Glaser 1999; Kahklen and Moll 1999; McGee 2000). Although timber harvest and roads on the Tongass National Forest may increase soil moisture, disrupt flow paths, decrease storage capacity, and increase sedimentation, these effects would likely only be measurable in those subwatersheds exceeding road density thresholds identified by the WCF.

The WCF concluded as part of their assessment that watersheds with fewer roads generally have healthier overall resources (USDA Forest Service 2011a). Specifically, the Forest Service (2011a) noted the following: 1) a watershed with road density of less than 1 mile per square mile would be considered “good” or “properly functioning,” 2) watersheds with road density of 1 to 2.4 miles per square mile were “fair’ or “functioning at risk,” and 3) watersheds with road density greater than 2.4 miles per square mile were rated as “poor” or “impaired function.” Based on this information, the frequency of occurrence of road densities exceeding the “properly functioning” value of 1 mile of road per square miles was used as a general index of relative effects of roads on water quantity and quality. Table 3.4-6 provides total road miles and road density under existing conditions and after 100 years of full implementation.

Table 3.4-6
Estimated Road Miles and Percent of 6th Field Subwatersheds in Road Density Categories on NFS Lands under Existing Conditions and after 100 Years of Full Implementation[1]

Road Type	Alternative					
	Existing	1	2	3	4	5
Existing Roads [2] (miles)	5,093	5,093	5,093	5,093	5,093	5,093
New Road Construction (miles)	–	944	1,056	1,020	871	994
Road Construction over Decommissioned Roadbeds (miles)	–	428	600	566	445	527
Road Reconstruction[3] (miles)	–	887	1,191	1,129	900	1,058
Total Roads (miles)	5,093	6,036	6,148	6,113	5,964	6,086
Percent New Road Increase	-	19%	21%	20%	17%	19%
Road Density Categories (Mi/Sq. Mi.)[4]						
0	66.6%	57.1%	54.6%	56.4%	62.4%	60.8%
>0 - 1.0	23.9%	32.4%	34.5%	32.5%	27.0%	27.9%
>1.0 - 2.4	8.4%	8.2%	8.4%	8.6%	8.2%	8.6%
>2.4 - 3.0	0.8%	1.3%	1.4%	1.5%	1.5%	1.5%
>3.0	0.3%	1.1%	1.1%	1.0%	1.0%	1.1%
Percent of watersheds with Average Road Density less than 1.0 mile/sq. mi.	90.5%	89.4%	89.1%	88.9%	89.3%	88.8%
Average Road Density (miles/sq. mi.) for all NFS Lands	0.20	0.23	0.24	0.23	0.23	0.23

[1] Assumes full implementation of Forest Plan at PTSQ levels. Includes adjusted road miles estimated to be needed to harvest all scheduled timber in the alternative.
[2] Note that the 5,093 miles of existing roads consists of 46% open roads, 27% closed roads (i.e., in storage), and 27% decommissioned roads.
[3] Estimated existing road miles that would need to be reconstructed.
[4] Percentages are based on 927 6th field subwatersheds that contain at least 100 acres of NFS lands.

Under existing conditions, the average road density on NFS lands in all subwatersheds is about 0.20 mile per square mile (see Table 3.4-6). This translates into about 91 percent of all subwatersheds with road densities currently in the "properly functioning" range (less than 1 mile of road per square mile) for NFS lands.

Total road miles and road density would increase under all alternatives and follow a similar pattern (Table 3.4-6). The increase in new road miles over 100 years relative to existing conditions could range from 17 to 21 percent for the alternatives. The increase in new road construction would be greatest under Alternative 2 and least under Alternative 4, while the amount of reconstructed roads would be highest under Alternative 2, but lowest under Alternative 1. The percentage of reconstructed roads is lowest for Alternatives 1 and 4 (17 percent for both alternatives) and higher for Alternatives 2, 3, and 5 (21 to 23 percent).

The number of subwatersheds that have no roads on NFS lands is currently about 67 percent (Existing, see Table 3.4-6); this percentage would decrease to between 55 and 63 percent under all alternatives. Increases in road densities would be primarily in subwatersheds that already have roads. Alternative 3 and 5 would have slightly higher frequency of subwatersheds with road densities between 1.0 and 2.4 mile(s) per square mile than the other alternatives. In addition, Alternatives 1, 2, and 5 would have slightly higher frequencies of subwatersheds with road densities greater than 3.0 miles per square mile. Overall, the alternatives would reduce the portion of subwatersheds with road densities less than 1 mile per square mile on NFS lands from 90.5 percent under existing conditions to between 88 and 90 percent (Table 3.4-6). After more than 100 years of Forest Plan implementation, the estimated overall road densities on NFS lands would remain nearly unchanged, increasing slightly from 0.20 to

between 0.23 and 0.24 mile per square mile under all alternatives. On average, all of these densities are within the range of what the WCF (USDA Forest Service 2011a) characterized as "properly functioning" watershed road densities.

Included in the estimated total road miles, young-growth area beach/estuary fringe and RMA roads have the potential to directly affect the nearshore marine system and stream channels through increased runoff associated with the road network. Table 3.4-7 quantifies the estimated amount of road miles by alternative within the beach/estuary fringe and RMA after 100 years of full implementation.

Table 3.4-7
Estimated Road Construction and Reconstruction (miles) in Beach/Estuary Fringe and Riparian Management Area (RMA) after 100 Years by Alternative

	Beach/Estuary Fringe		RMA	
Alternative	Road Construction[1]	Road Reconstruction	Road Construction[1]	Road Reconstruction
1	21	13	110	71
2	116	88	241	179
3	152	116	127	90
4	66	49	105	72
5	39	28	126	88

[1] Includes new road construction and road construction over decommissioned roadbeds.

In beach/estuary fringe areas, Alternatives 2 and 3 would have the highest number of road construction and reconstruction miles (Table 3.4-7). Alternatives 1, 4, and 5 would have substantially lower amounts of road construction and reconstruction in beach/estuary fringe areas than Alternatives 2 and 3, while Alternative 1 would have the least among the alternatives. In the RMAs, Alternative 2 would have substantially more miles of road construction and reconstruction (420 total miles, nearly double the amount of the other alternatives) than any of the other alternatives. Alternatives 1 and 4 and Alternatives 3 and 5 would have similar amounts of road construction and reconstruction within the RMAs, with Alternatives 3 and 5 slightly higher than Alternatives 1 and 4, with all four alternatives much less than Alternative 2.

Potential effects that additional road construction and increases in road densities would have on any specific subwatershed and related watershed condition would ultimately be estimated during project planning, at which point the rate of entry into subwatersheds and locations of proposed harvest units and roads would be analyzed. The actual effects on stream flows can only be determined by site-specific monitoring. The Water Quality and Watershed Condition subsections below provide further information related to roads within the RMA and beach/estuary fringe.

Water Quality

As described in the *Affected Environment* section, changes in stream temperature and sediment and other factors are the two primary environmental consequences associated with proposed timber management activities. The subsections below evaluate the potential effects on stream temperature and sediment and other factors associated with timber harvest and roads for the alternatives.

Stream Temperature

As described in the Affected Environment subsection, riparian vegetation shading helps maintain stream temperature along most streams. Under each of the alternatives, riparian tree retention would be adequate to maintain stream temperatures. DeWalle (2010) examined the effect of riparian vegetation height, width, and density relative to stream width at maintaining adequate shade on streams. DeWalle (2010) concluded that for moderate to high density canopy thickness, a ratio of buffer height to stream width of five would maintain adequate shade to control effects of solar heating on stream temperature. Because on the Tongass National Forest all Class I, II, and III streams have no-cut buffers (except some areas for Class III streams under Alternatives 2 and 5, with at most 35 percent of trees removed in any stand along Class III streams), only Class IV streams in clear-cut units are likely to experience increased solar radiation due to harvest.

Class IV streams are small (between 1 and 5 feet in bankfull width) and are typically only delineated by conducting detailed ground surveys during the planning stages of specific proposed timber management activities. Because Class IV streams are typically only located during a specific proposed project, they are substantially underestimated in the Tongass National Forest streams dataset, in both harvested and unharvested subwatersheds. Due to the underestimate of Class IV streams, effects analysis associated with these streams and subwatersheds are best conducted during the planning stages of a specific proposed timber management activity.

Based on the DeWalle (2010) model, moderately dense vegetation or stream banks with heights of 5 to 25 feet (for streams 1 to 5 feet wide) would be sufficient to adequately prevent solar-induced heating of these streams. Many of these Class IV streams would initially be nearly fully shaded from banks or other remaining vegetation, and would soon be fully shaded from bank brush and sapling tree regeneration following timber harvest. In addition to the DeWalle (2010) model results, Janisch et al. (2012) found that, in Washington coast forests, unbuffered small headwater streams had a maximum summer temperature increase that was only about 1.5°C greater in unharvested control streams than harvested. Janisch et al. (2012) also found that within 3 years of harvest maximum temperatures were further reduced (less than 1.0°C greater than unharvested control streams). These results, combined with the supporting studies in the Affected Environment subsection, suggest that clearing along Class IV streams is not likely to significantly affect stream temperatures.

Although the main concern for potential stream temperature increases is riparian removal associated with direct timber harvest, removal due to road development through riparian areas and crossing of streams, may also be a contributing factor. Generally, road crossings of streams are the most common locations where associated removal of riparian vegetation decrease stream shade and contribute to solar radiation. Such removal would likely have little to no effect on increasing stream temperature at any one site because the clearing area is typically limited and the stream crossing structure (e.g., culvert, bridge) would contribute full shading to the stream. In some studies from other forested areas, stream temperature changes below road-stream crossings have been noted (Story et al. 2003), while other studies have found no change in stream temperature from before and after road crossing installations (Aust et al. 2011).

A study conducted by Tucker and Thompson (2010) on the Tongass National Forest assessed some of the effects of harvest-related actions, including roads, on stream temperature. It was found that all studied drainages had exceedances of state water temperature criteria, with effects of past harvest practices on stream temperature not

apparent. As described in the Affected Environment subsection, Tucker and Thompson (2010) concluded that drainage characteristics and local weather may have masked changes in stream temperature from upland and riparian harvest. Based on these studies and those presented in the Affected Environment section, stream temperature is not expected to change appreciably by alternative, even when effects from climate change are considered, and therefore no further discussion is provided in this section.

Sediment and Other Factors

As described in the Affected Environment subsection, road and timber landings construction near streams, even where the road does not actually cross the stream, may contribute to increased sediment loads in streams, and poses a potential risk to overall watershed conditions (Reid and Dunn 1984; Furniss et al. 1991; Rashin et al. 1999; Gucinski et al. 2001; Luce and Wemple 2001; Gomi et al. 2005). Road location, or the distance between soil disturbance and a stream, as well as the presence of vegetation (riparian) buffers between roads and streams, affects the amount of sediment delivered to a stream through hill-slope runoff, road runoff, or roadside ditches (MacDonald et al. 2001; Croke and Hairsine 2006; Rashin et al. 2006, Steel et al. 2007; McCune 2010).

Projected effects on water quality within subwatersheds Forest-wide can be generally assessed by the amount of timber harvest, road miles and density (including on unstable slopes), landslide potential, and road-stream crossings. This subsection provides estimated landslide potential and road miles on potentially unstable soils. Additionally, and as described in the Affected Environment subsection, the Forest Service Watershed Condition Classification Technical Guide (USDA Forest Service 2011a) uses the percent of road miles within 300 feet of waterbodies as one of the metrics to indicate watershed functional status condition relative to hydrologic and sediment regimes. The estimates of timber harvest and road miles and densities on NFS lands under existing conditions and after 100 years of full implementation for each of the alternatives were discussed above under the Water Quantity subsection.

Although the amount of timber harvest, road miles and densities (including on unstable slopes), landslide potential, and stream crossings provides a general approach to assessing projected effects on water quality, the potential effects on water quality within subwatersheds Forest-wide are expected to vary depending on the relative amount of timber harvest and roads within a given subwatershed and the applicable Forest-wide standards and guidelines (see Chapters 4 and 5 and Appendix D of the Forest Plan). The effects from changes in water quality in a particular subwatershed can only be estimated during project planning, when the rate of entry into subwatersheds and locations of proposed roads and harvest units would be analyzed in further detail. The actual effects on water quality can only be determined by site-specific monitoring.

Landslides and roads are two of the greatest contributors of sediment to stream channels. Landslide debris (e.g., sediment, large wood) that enters streams may block or shift channels, fill pools, and increase the presence of fine sediment in the channel network. Increased sediment yield, including yields during road construction, road use during timber harvest activities, roads on unstable slopes, and lack of sufficient maintenance or proper closure following timber harvest activities, are all viewed as potential areas of risk for increased sediment to stream channels.

Landslides
Timber harvest on high gradient unstable slopes can potentially increase landslides that may add debris and sediment to streams, thereby affecting overall water quality. Unstable soils can cause slumping and mass wasting, and while most of the soil types of highest risk potential would be excluded from timber harvest, some areas may still be harvested. The *Soils* section provides estimates of landslides in the next 25 years. These estimates are used to compare the long-term landslide estimates that may result from the individual harvest levels proposed under each alternative. Based on the data presented in the *Soils* section, all proposed alternatives have a higher landslide potential (i.e., maximum increase in number of landslides over first 25 years) than under the 2008 Forest Plan (Alternative 1) because there are more total acres being harvested in order to transition to young-growth harvest. Alternatives 3, 4, and 5 would have slightly lower potential increase in the number of landslides than Alternatives 2. Alternative 2 has an estimated increase of 13 landslides over 25 years when compared to the 2008 Forest Plan (Alternative 1). See the *Soils* section for additional information.

Roads
Roads built on unstable soils are considered at greater risk of slumping or mass failure, and thereby increasing the chance of large amounts of sediment entering streams. Soils of high risk for landslide or mass wasting failure are those indicated as a mass movement index of 3 (MMI 3) (generally gradient of 55 to 72 percent). The upper ranges of these soils (65 to 72 percent) generally have the higher risk of slope failure. Those soils with slopes greater than 72 percent mass movement index of 4 (MMI 4) are removed from the suitable timber base, but may have small inclusions within the MMI 3 layer. In addition, current standards and guidelines, in consideration of these concerns, recommend avoiding building roads on slopes greater than 67 percent. Based on these recommendations, roads built on soils with slopes greater than 67 percent are considered the greatest risk for affecting water quality.

The miles of road likely to be constructed on soils greater than 67 percent are shown in Table 3.4-8. Although the amount of road miles are small among all alternatives, due to the limited number of new roads and standards and guidelines that restrict construction of roads in regions of this slope category, the differences among the alternatives demonstrate those with the greatest potential to effect water quality. Overall, Alternatives 2 and 3 have the highest portion of new roads on potentially unstable soils, with Alternatives 1 and 4 the least. Alternatives 5 would have intermediate potential effects to water quality, which would be greater than Alternatives 1 and 4, but less than Alternatives 2 and 3.

Table 3.4-8
Estimated Maximum Road Miles on Potentially Unstable Soils Based on Slopes Greater Than 67 Percent over the Length of the Project (approximately 100 years)[1]

	Alternative				
Road Type	**1**	**2**	**3**	**4**	**5**
Road miles > 67% Slope	9	11	11	9	10

[1] Includes both new road construction and road construction on decommissioned roadbeds. Based on the proportion of existing roads on slopes greater than 67 percent.

In addition to sediment contributions from the construction of roads on unstable slope, stream channel erosion has the potential to increase from the construction of roads because of the destabilizing effect of cuts, fills, and drainage alterations, and the lack of protective vegetation cover on road surfaces and other disturbed

areas. In young-growth stands, there are existing legacy roads with detrimental soil conditions that may be reconstructed for future young growth harvests. Table 3.4-6 above provides the amount of reconstructed roads by alternatives and Table 3.4-8 above provides the amount of road miles on slopes greater than 67 percent by alternatives.

The amount of road construction by alternative is used as a measure of both soil productivity losses and erosion potential. In one attempt to quantify road induced erosion, Kahklen and Hartsog (1999) developed a multiple regression analysis based on road induced erosion studies in the Tongass National Forest, but found that road induced erosion was highly variable. The primary variables that correlated with greater sediment yields were heavier traffic volumes, more rainfall, higher road gradients, and lack of road resurfacing. These and other site-specific variables would be evaluated more precisely during project planning, based on the specific conditions found at the project site, and would vary based on soil parent materials, rock durability, slope, location within a subwatershed, mass movement hazard, and other factors.

Paustian (1987) measured short-term effects of road building on soil erosion in the Kadashan watershed that resulted in increased suspended sediment yield equivalent to 2 percent of the estimated annual sediment yields. Potential increases in total estimated sediment yield over a 2-year post-road construction period ranged from 20 to 66 percent in three Kadashan study streams. Montgomery (1994) found that drainage concentration from ridgetop roads caused both landsliding and integration of the channel and road networks. Road drainage concentration increased the effective length of the channel network and strongly influenced the distribution of erosional processes in Southeast Alaska.

As discussed in the Affected Environment subsection, Bryant et al. (2004) and Woodsmith et al. (2005) did not find a statistical relationship between fine streambed sediment and subwatershed disturbance in Southeast Alaska. Ross (2013) found evidence of smaller median particle size in stream substrate in watersheds with historical timber harvest along stream banks. Cederholm et al. (1981) conducted a study on Washington's Olympic Peninsula that found that the accumulation of fine sediment in streambeds was highest in basins where the road area exceeded 2.5 percent of the basin area. Road construction near streams, even where the road does not actually cross the stream, may contribute to increased sediment loads in streams, and poses a potential risk to overall watershed conditions (Reid and Dunn 1984; Furniss et al. 1991; Gucinski et al. 2001; Luce and Wemple 2001; Gomi et al. 2005).

Roads in beach/estuary fringe and RMAs have the potential to more directly affect water quantity and quality than those in other areas due to their proximity to nearshore marine system and stream channels. As noted in the Affected Environment subsection, the percentage of waterbodies within 300 feet of roads is considered an indicator for watershed conditions: the higher the percentage, the more likely the watershed function, relative to hydrology and sediment, would be reduced. All alternatives propose road construction and reconstruction within both the beach/estuary fringe and RMA, where waterbodies would be present (Table 3.4-7). Alternatives 2 and 3 propose the most road construction and reconstruction miles within both the beach/estuary fringe and RMA. Alternative 1 has the least amount of road miles within both the beach/estuary fringe and RMA, while Alternatives 4 and 5 have greater road miles than Alternative 1, but less than Alternatives 2 and 3. Because roads in most beach/estuary fringes and RMAs would be within 300 feet of streams, Alternatives 2 and 3 would likely have the greatest increases in the percent of subwatersheds with waterbodies within

300 feet of roads. This could increase the risk of sediment entering waterbodies, affect overall water quality, and ultimately reduce watershed function level.

While riparian protection (e.g., buffers) can greatly reduce sediment delivery to streams (Chamberlin et al. 1991; Belt et al. 1992), they provide little reduction in the risks to stream channels caused by roads during construction or reconstruction. Road construction and reconstruction practices require additional attention and adherence to BMPs to ensure that risks to fish (see the *Fish* section) and stream channels are minimized. The effects in a particular subwatershed can only be estimated during project planning, after which point the rate of entry into subwatersheds and locations of proposed roads and harvest units would be analyzed in further detail. The actual effects on water quality can only be determined by site-specific monitoring.

In addition to the effects of roads near waterbodies, the number of road crossings of streams increases the risk of adding sediment to streams. Generally, the greater the number of road crossings by alternative the greater the chance of increased sediment to streams, with new crossings on average having a greater risk of affecting sediment than rebuilt crossings. Currently, about 6,102 Class I, II, and III stream crossings exist on the Tongass National Forest. The various alternatives would add between 1,714 and 2,177 new stream crossings on Class I, II, and III streams, and a similar number of reconstructed stream crossings, increasing the risk of introducing sediment to streams (see Table 3.6-4 in the *Fish* section). The relative ranking of the alternatives for potential sediment effects to streams based on the number of new crossings is discussed in the *Fish* section.

The specific effects in a particular subwatershed at any individual site would be influenced by the existing conditions at the crossing. Some existing crossings needing reconstruction may require minimal changes because the stream crossing structures are fully adequate to meet new road uses. Conversely, other crossings may require complete reconstruction. An index of risks of added sediment from road crossings based primarily on new crossing is shown in the *Fish* section. The application of BMPs found in the National Core BMP Technical Guide FS-990a (USDA Forest Service 2012b) and the Alaska Region Soil and Water Conservation Handbook, FSH 2509.22 for all alternatives combined with the Fish and Riparian Standards and Guidelines (see Chapters 4 and 5 and Appendix D of the Forest Plan) would help minimize or prevent adverse effects on water quality from the amount of riparian area with forest clearing (only Alternatives 2 and 5) and road construction (all alternatives), yarding corridors, and stream road crossings, and from any non-commercial timber harvest that may occur.

Watershed Condition

As described in the Affected Environment subsection, the WCF established a nationally consistent approach for classifying watershed condition (USDA Forest Service 2011a). Based on this approach, indicators associated with water quantity and quality were evaluated in the previous sections. Using this approach, watershed function associated with existing conditions and each of the proposed alternatives were evaluated. The Riparian Areas and Beach Fringe subsections below provide further evaluation of watershed conditions specifically within the RMAs for existing conditions and each of the proposed alternatives.

Riparian Areas

Riparian areas, as a component of aquatic and riparian ecosystems, would continue to be protected through use of the Fish and Riparian Standards and

Guidelines (see Chapters 4 and 5 and Appendix D of the Forest Plan) under all alternatives, which protects water quality parameters such as stream turbidity, temperature, and nutrients. This protection includes the no-harvest buffers included in the past Forest Plans to reduce impacts and risk of impacts to water quality and fish bearing streams. As previously described, these areas include the 1990 TTRA 100-foot buffers and additional distances intended to preserve the functions of the riparian areas with the sum of both designated as RMA. These RMA buffers, including the RAW buffers, reduce sediment runoff and instability from steep slopes adjacent to streams, and are included in riparian management to reduce windthrow.

For the FP process group, the RMA allows for stream channel braiding, migration, and storage of flood flows. For the AF process group, the RMA allows adequate buffer for channel movement, sediment deposition, and peak flow dispersion. Timber harvest and road construction within an RMA buffer reduce the function of the riparian areas, especially for floodplain and alluvial fan channels, but also have the potential to affect riparian/wetland soil polygon areas. Effects in general from harvest within the RMA include reduction in available large woody debris (LWD) and direct sediment contribution to riparian/wetland soil polygon areas.

As part of the no-harvest TTRA buffers included in the past Forest Plans reducing impacts and risks of impacts to water quality and fish-bearing streams, these buffers helped ensure adequate LWD is supplied to streams. LWD contributes towards sediment sorting and routing and fish habitat structure (see the *Fish* section). Nearly all LWD to streams is supplied from a stream-side distance of one site potential tree height (SPTH) (McDade et al. 1990). The SPTH along Tongass streams generally ranges from about 85 to 140 feet depending on process group, with nearly all LWD supplied within the 100 foot of the stream bank (Murphy and Koski 1989; Martin et al. 1998). In addition, most other important functions, such as allochthonous input, shade, overland sediment trapping, occur within the SPTH (Murphy 1995).

Although most of the LWD (generally greater than 90 percent) recruited to stream channels would occur from the TTRA buffer, some reduction in LWD in stream channels could occur over time if harvest occurs in RMAs outside of the TTRA buffer. This has the greatest potential to affect LWD for FP and AF process groups due to the mobility of these channel types and possibilities of re-alignment within RMA harvested areas. Collins et al. (2011) noted that in floodplain channels, structure and maintenance is dependent on development of mature trees in the floodplain. Latterell and Naiman (2007) found in a floodplain river system in Washington that large wood was contributed from all across the floodplain width over time. Floodplains in some larger channels in the Tongass can be over 200 feet wide (Appendix D of the 2008 Forest Plan). This suggests that, over the long term, floodplain channel movement has the potential to result in wood sources entering from outside of a TTRA buffer. Removal of trees from the floodplain tends to destabilize the areas (Collins et al. 2011). Similar to the FP process group, the loss of large wood outside of the TTRA buffer could destabilize the areas and alter channel characteristics.

Riparian soils may be one of the more sensitive to ground-disturbing actions in the Tongass (USDA Forest Service 2015c). The harvesting methods within the RMAs associated with FP and AF process group areas are likely to include tractor logging (Landwehr et al. 2012). Soil disturbance would have local long-term effects on future development of large trees, as red alder dominate these disturbed areas inhibiting growth of large conifers, especially in the alluvial soils found in floodplain and alluvial fan channels (USDA Forest Service 2014d).

Future disturbance of similar areas would likely also be recolonized with red alder. The function of these areas is important to overall watershed condition.

In addition to the FP and AF process groups, should harvest occur in RMA buffers along channels associated with the HC process group, increased sediment to downstream MM, FP, and AF process group's may occur from upslope harvest and loss of bank stability as these streams typically have no TTRA buffers. For other riparian/wetland soil polygon areas, such as lakes, the RMA buffers supply some of the same functions as on streams (e.g. reducing sediment input, adding allochthonous input). These areas have no TTRA buffer, so RMA harvest could occur to the lake shoreline under Alternatives 2 and 5 which could result in increased sediment entry to lakes. Regardless of process group, because the RMAs are ecologically tailored to ensure the integrity of the stream channel, maintain supply of large wood, and protect other functions critical to soil, water, fish, and wildlife in Southeast Alaska (USDA Forest Service 2015c), any timber harvest or roads within the RMA have the potential to decrease the overall watershed condition.

The 2008 Forest Plan indicates that site-specific adjustments to the RMA Standards and Guidelines may be changed, but only if the adjustments will achieve channel process group objectives. A determination of whether the objectives can be maintained by modification of RMA buffers can only be made through a watershed analysis (see Forest Plan, Appendix C). For Alternatives 1, 3, and 4, no harvest is proposed within the RMA. For Alternatives 2 and 5, some timber harvest and road construction in young-growth RMA outside of TTRA buffers is proposed (see Table 3.4-9). The largest portion (approximately 49 percent for both Alternatives 2 and 5) of projected harvest of RMA would occur in the "other" category (i.e., riparian/wetland soil polygon), which includes likely wooded suitable wetland habitat not directly adjacent to any stream process group. However, a portion of RMA affected under these two alternatives would occur on some of the most sensitive and productive alluvial soil areas (i.e., floodplains and alluvial fans). The function of these areas in providing LWD supply to streams is important to maintaining stream channel processes, which would be reduced where timber harvest occurs. Although there is some uncertainty regarding the outcome of the proposed treatments in Alternatives 2 and 5, silvicultural treatments that defer late seral forest conditions of large, widely spaced conifers would not achieve the desired future condition of these riparian areas (USDA Forest Service 2015c). Although functions associated with floodplain and alluvial fan channels would be impacted where timber harvest occurs, the overall areas affected under Alternatives 2 and 5 (see Table 3.4-9) would be small relative to the portions of these floodplain and alluvial fan channel types available on the Forest. The effects associated with timber harvest in the RMA are quantified under the Water Quantity and Water Quality subsections above, with additional information provided in Table 3.4-9 and below.

No RMA harvest would occur and current Riparian Management objectives would be maintained as proposed under Alternatives 1, 3, and 4 (see Table 3.4-9). Alternatives 2 and 5 require that management in young-growth riparian areas accelerate POG characteristics to improve riparian function, but would allow some harvest in young-growth RMA outside of TTRA buffer areas (see Table 3.4-9). Alternative 5 would allow up to 10-acre maximum open cut areas and commercial thinning of up to 35 percent of the total stand acres, while Alternative 2 would allow only commercial thinning of up to 33 percent of the stand in these RMAs outside of TTRA buffers. Alternative 5 has the highest potential to reduce stream function in primarily FP and AF channels through group selection harvested areas plus commercial thinning where it occurs. Overall, the area harvested under Alternative 5 would be small, because this would only occur in

development LUDs and temporarily within the Old-growth Habitat LUD, and planned selections of harvest in RMAs would have to meet stream process group objectives. The estimated overall area affected over a 15-year period, with no additional harvest occurring in the remainder of a 100-year projected harvest period, would be low (1,089 acres) under Alternative 5 (see Table 3.4-9).

While the estimates (see Table 3.4-9) suggest that overall harvest area in the RMA for Alternative 5 would be relatively small, if this harvest type were widespread it could have more pronounced effects on water quantity and quality, although there are no current plans for this to occur. As previously described, this could reduce wood supply and channel stability in primarily FP and AF channels by removing trees in the RMA outside of the TTRA buffers. Because these channels migrate, the associated process groups require expansive floodplain extents. If through migration these channels re-align into the group selection harvested areas (i.e., up to 10-acre clearings), the area would be set back from achieving its management objectives of meeting old-growth characteristics. Old-growth areas would supply the larger pieces of wood needed to develop “key pieces” for the formation of structural wood jams, and associated bars and large pool formation, all necessary for a functioning watershed condition in these systems. In addition to harvest-related effects, access to these areas would likely be through shovel logging that could cause additional impacts to these sensitive FP and AF areas. Although Alternative 5 has the potential to have more pronounced effects on water quantity and quality, it includes restrictions to only occur in the first 15 years and no more than 35 percent of the current stand. With these restrictions, the overall areas affected would be small relative to the portions of these process groups available in the Tongass.

Table 3.4-9
Riparian Management Area (RMA) Acres and Past and Future Young-Growth Harvest (see note) by Process Group by Alternative

Total/Harvest Period	Process Group (acres)												
	AF	ES	FP	GO[1]	HC	LC	MC	MM	PA	UC	Lake[2]	Other[3]	Grand Total
Total RMA	50,622	12,450	199,299	52,890	366,730	12,726	75,692	118,433	63,093	25	81,243	229,329	**1,262,531**
Harvest—1991-2015	359	0	328	7	2,611	16	150	501	60	1	19	975	**5,025**
Harvest—Pre TTRA	4,958	201	9,620	698	12,960	369	1,457	6,910	1,298	7	254	14,171	**52,904**
Total Past Harvest in RMAs[4]	5,317	201	9,948	705	15,571	385	1,607	7,411	1,358	8	273	15,145	**57,928**
Alternative 1 – Harvest	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Alternative 2 – Harvest (CT)[5]	1,504	37	3,317	134	6,968	3	51	1,077	21	1	230	12,688	**26,030**
Alternative 3 – Harvest	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Alternative 4 – Harvest	0	0	0	0	0	0	0	0	0	0	0	0	**0**
Alternative 5 – Harvest (OC and CT)[6]	62	0	140	6	291	0	2	45	1	0	1	540	**1,089**

See Table 3.4-1 for process group definitions
Note that young-growth harvest is conducted on past harvest so no additional RMA is added to the total harvest area.
[1] All glacial outwash channel types included under the GO designation.
[2] Lake = RMA lake buffers
[3] "Other" includes riparian/wetland soil polygon designations adjacent to other stream RMAs.
[4] A total of 30,291 (52%) of the Grand Total past RMA harvest occurred in RMA areas outside of the TTRA buffers.
[5] Commercial thinning.
[6] Open cut (up to 10 acre openings) and commercial thinning, except no RMA harvest within 100-foot buffer around all lakes and a 200-foot no-cut beach buffer.

There would be some potential for reduced function in Alternative 2 through thinning due to potential loss of organic matter and LWD input, should channels move to areas of harvest before forest regrowth occurs. However, because RMA harvest would also occur in non-development LUDs, the area of RMA affected would be much larger (26,030 acres) under Alternative 2. This could result in a loss of LWD to primarily FP and AF channels over a large area, but with relatively low overall loss per acre because future growth may augment some of the loss, although ground disturbance, which could affect future tree large conifer tree development affecting LWD supply, may be substantial.

Although the overall RMA affected under Alternatives 2 and 5 would be small (see Table 3.4-9) relative to the portions on the Forest, a watershed analysis (as described in the Forest Plan Appendix C) would still be needed for implementing any alternative that proposed to enter the RMA. In addition, the application of BMPs found in the National Core BMP Technical Guide FS-990a (USDA Forest Service 2012b) and the Alaska Region Soil and Water Conservation Handbook, FSH 2509.22 for all alternatives combined with the Fish and Riparian Standards and Guidelines (see Chapters 4 and 5 of the Forest Plan) would minimize or prevent adverse effects on water quality from the limited amount of riparian area with forest clearing (only Alternatives 2 and 5) and road construction (all alternatives), yarding corridors, and stream road crossings, and from any non-commercial timber harvest that may occur.

Beach Fringe

Beach fringe harvest under Alternatives 2 through 5 may have an effect on water quantity and quality, and thereby overall watershed condition, due to proximity to the marine system and potential for nearshore benthic disturbance (see *Fish* section for details of biologic effects). Young-growth area beach fringe harvest has the potential to affect the nearshore marine system from the timber removal methods that may be employed. Some of the potential harvest areas would not be directly accessible by new or reconstructed roads, or be harvested by helicopter. The result would be that some harvest activity could occur directly from beach areas. This would be less for Alternative 5 than Alternative 2 because Alternative 5 would have a 200-foot no-cut beach buffer.

Harvest in the beach fringe may include shovel logging or A-frame yarding to or across the beach (see *Timber* section). This could include logging equipment directly traveling over intertidal areas, landing craft affecting these areas, and, in the case of floating or beached A-frame harvest, possible subtidal disturbance from anchors. These activities may cause increased local sediment runoff to the nearshore waters, which could exceed water quality criteria in local areas. The amount of harvest by alternative in the beach fringe is shown in Table 3.4-5. Generally, the greater the harvest, the higher the potential impact on water quantity and quality, although the type of harvest that is permitted would influence the level of impact to overall watershed condition.

As previously described, the effects from changes in water quantity and quality, and thereby watershed condition, in a particular subwatershed can only be estimated during project planning, after which point the rate of entry into subwatersheds and locations of proposed harvest units and roads would be analyzed. The actual effects on watershed condition can only be determined by site-specific monitoring. See the *Fish* section for overall alternative ranking of potential biological and fish effects.

Water Use

The Municipal Watershed LUD is applied to 45,236 acres in 11 watersheds serving the 9 incorporated cities and boroughs (Ketchikan, Petersburg, Sitka, Juneau, Wrangell, Kake, Klawock, Craig, and Hydaburg [see the Forest Plan, Chapter 3, Municipal Watershed]). All of the alternatives would include the same protections to these watersheds. Watersheds serving the Community Water System category and the other three water system categories would be managed under Forest-wide standards and guidelines (see Chapters 4 and 5 of the Forest Plan). None of the alternatives propose timber harvest in the Municipal Watershed LUD. While most of the public water systems across the Forest have LUD designations that do not allow timber harvest and road construction under any alternative, some watersheds and the associated stream network that supply water may have LUD designations that allow timber harvest. Effects on water supply in a particular watershed can only be estimated during project planning. In addition, prior to actions in any of these watersheds, the Forest Plan (Chapter 4, Soils and Water Standards) requires the Forest Service to conduct a watershed analysis and consult with the ADEC, as well as with owners and operators of public water systems, prior to authorizing management activities that may cause pollution.

Renewable Energy Development

All renewable energy development projects in Southeast Alaska have to meet detailed local, state, and, in most cases, federal laws, regulations, and requirements to be developed and operated. Additionally, the Tongass National Forest applies land use restrictions for energy development, which would remain in place under Alternative 1, but these restrictions would be removed under all other alternatives (Alternatives 2 through 5) and replaced by new Plan direction for Renewable Energy. The *Renewable Energy* sections supplies the details of the alternatives.

Renewable energy projects include a variety of ways to produce energy that include wind, solar, geothermal, tidal, wave, biomass, and hydroelectric. Most energy projects on the Forest are hydroelectric, supplying 96 percent of all energy in Southeast Alaska. Future plans of development are mostly hydroelectric (see *Renewable Energy* section for details of type and number).

The types of effects from renewable energy projects, including hydroelectric projects, on water and fish resources are discussed in more detail under the *Fish* section. In summary for hydroelectric projects, these types of projects can have effects on flow quantity and timing from water diversion and storage (e.g., lakes and reservoirs) and sediment from construction of roads and other facilities (e.g. dams, powerhouse, diversion structures). Furthermore, hydroelectric projects can have effects on water quality, such as temperature, dissolved oxygen, and nutrient levels, from water storage and diversion practices. In addition, the construction and maintenance of transmission lines for a project has the potential to reduce streamside vegetation from right-of-way clearing over streams (e.g., affecting local runoff and stream temperatures) and increase the miles of roads in watersheds (e.g., affecting runoff and sedimentation) (see *Fish* section for more details).

Although there is some potential for increasing the number or timing of projects and related effects from changes in the standards and guidelines (see Chapters 4 and 5 of the Forest Plan) over the current conditions (Alternative 1), the chance of this is low as projects are still likely to be built under the 2008 Forest Plan standard and guidelines. The largest effect from Alternatives 2 through 5 is in

the permitting process for the developer; the process would likely be less burdensome and result in more rapid permitting for a site, but not a substantial increase in the number of sites developed. Regarding the current number of new projects, these are widely distributed across the Forest. The spread of these projects across the Forest would likely reduce cumulative effects of these actions on any specific watershed. Overall, Alternatives 2 through 5 would likely have little effect to water quantity, use, and quality on the Forest relative to current conditions (Alternative 1).

Cumulative Effects

One of the main cumulative factors affecting water quantity, quality, and use, in addition to actions taken on NFS lands, is ongoing and additional regional land development actions on non-NFS lands. These actions, in addition to the various effects of the considered alternatives, may have compounding effects on water resources. While BMPs applied on NFS lands would moderate these effects, some effects on water quantity, quality, and use may remain, and with the addition of other actions, may increase risk to water resources. Appendix C provides a full list of all the projects considered in the cumulative effects analysis.

Factors associated with potentially adverse effects to water resources are timber harvest, roads, including culvert and bridge installation, and potential hazardous substance spills. While the main factor contributing toward potential adverse effects on water resources in and near the Tongass National Forest is potential future timber harvest-related activity, other expected future activities have the potential to contribute toward cumulative effects to water and watershed resources. As listed in the *Introduction* and Appendix C, these other potential contributing cumulative effects could include activities such as mining, transmission line interties, future transportation facilities, hydroelectric site developments, watershed restoration actions, and a variety of miscellaneous land development–related actions and natural conditions like windthrow and climate change.

Mining, which is occurring or may be developed at more than five locations on the Tongass, includes the development of roads, water use, and potential discharge of sediment and potentially hazardous substances like heavy metals to streams. Some transboundary mining issues, including at least three mines in Canada, could potentially affect water quality relative to potentially toxic substances, including possibly heavy metals, in transboundary waters. Transmission interties, like that proposed for Kake to Petersburg, can include the development of roads, culverts, and forest clearing along a linear route that could potentially influence sediment and temperature in streams. Transportation projects, primarily roads, are anticipated to be developed in several community areas; these would add to road density in watersheds that could have cumulative local affects in some areas. Approximately nine hydroelectric projects are proposed for future development (see Table 3.12b-3) and these projects can modify water flow in a subwatershed and potentially lead to the development of small reservoirs in stream habitat. Watershed restoration activities are occurring and will continue in the future based partly on the WCF rating of watershed conditions in 2011. Some of these restoration activities, which may include road maintenance and improvements, road closures, and/or stream habitat improvements (e.g., LWD additions, riparian plantings), could, in the short-term, add sediment to streams. In the long term, restoration activities could result in higher quality and function in watershed conditions by improving overall water quality. Climate change, which was incorporated in the preceding subsections, may contribute to varied watershed and water quantity and quality changes, including negative effects. Although these other potential contributing cumulative effects could contribute to lower water quality and watershed conditions in the Tongass cumulatively, these actions would occur in relatively limited areas and the permitting process would greatly restrict future effects from these activities and developments on water resources.

As a partial indicator of cumulative effects region-wide to water resources, the amount of timber harvest provides an indication of cumulative effects to water quantity, use, and quality because of potential effects on stream flows, sediment and stream detritus input, and flow patterns. Tree harvest areas in the Tongass National Forest are primarily characterized as POG vegetation regions. POG in 1954 accounted for about 35 percent of the land area within the Tongass National Forest boundary, which includes NFS lands as well as state and private lands. Therefore, land disturbance related to harvest is primarily limited to a small portion of the total land area. Non-POG areas include areas with small trees, muskeg, or wetlands; all regions where streams may be common; and ice fields and rocky mountainous areas where few streams may be present.

Table 3.4-10 indicates the cumulative portion of POG area that would be harvested within the Forest boundary (including all non-NFS lands) under each alternative, and the portion of all lands inside the Forest boundary that would potentially be disturbed by forest clearing. This latter calculation represents an index of overall watershed disturbance associated with vegetation removal by forest clearing and does not consider roads outside of harvest units, urban areas, etc., which are a minor portion of the total disturbance area.

Table 3.4-10
Percent of Original POG Remaining on All Lands within the Tongass Forest Boundary and Percent of All Lands inside the Boundary that are Not Directly Disturbed by Timber Harvest after Full Implementation of the Forest Plan (approximately 100+ years)[1]

Alternative	Percent of All Original POG Remaining [2]	Approximate Percent of All Lands Not Disturbed by Timber Harvest [3]
Existing	86%	95%
1	83%	94%
2	83%	94%
3	83%	94%
4	83%	94%
5	83%	94%

[1] Assumes full implementation of Forest Plan plus future non-NFS harvest for 100 years.
[2] Original POG equals about 35 percent of all land area (17,934,000 acres) of this region.
[3] Value represents the percent of all 17,934,000 acres inside the Tongass boundary (plus Annette Island) covering Biogeographic Provinces 1 through 21, that would be disturbed by timber harvest and is used as an index of overall watershed disturbance associated with timber harvest. It does not include the acreage of other forms of ground disturbance (e.g., roads, towns) beyond the harvest of POG.

Currently, most (86 percent) of the POG acreage within the Forest boundary has not been harvested. Considering all lands inside the Forest boundary, 95 percent of the total land base has not been harvested (Table 3.4-10). Alternative 1, including non-NFS harvest, would result in a reduction in POG area to 82 percent of the original acreage; 94 percent of all lands inside the Forest boundary would remain undisturbed by direct timber harvest. Alternatives 2 through 5 would also result in 83 percent of the POG remaining; 94 percent of all lands would remain undisturbed by direct timber harvest after 100 years of projected harvest. It is likely some local effects on water quantity and quality from all alternatives. On a Forest-wide basis, however, the overall effects would be very minor for all alternatives. As noted above for roads, lesser riparian protections on state and private lands would have a greater likelihood of causing adverse effects to water quantity and quality in watersheds on non-NFS lands, which could be compounded if NFS lands are harvested in the same watersheds. Potential cumulative effects of timber harvest, road construction, and other actions would be evaluated at the project-specific level in order to ensure that any adverse effects to water resources would be reduced, moderated, mitigated, or eliminated.

In addition to the amount of timber harvest as a partial indicator of cumulative effects region-wide to water resources, the amount of roads provides an indication of cumulative effects to water quantity, quality, watershed condition, and water use because of potential effects on stream flows, sediment and stream detritus input, and flow patterns. While the effects would vary with location and type of activity, the amount of road miles is a partial indicator of cumulative effects region-wide. Table 3.4-11 shows the change in road miles on a regional basis, including non-NFS roads. Currently, there are about 5,093 total road miles (including all authorized and non-system roads) on NFS lands and an additional 4,258 miles on adjacent non-NFS lands (Table 3.4-11). Many of these roads are associated with non-NFS timber harvest activities. In general, timber harvest activities on non-NFS areas are not as protective of stream riparian areas. Reduced protection of these areas has a greater risk of increasing impacts to water quality and resident fish species. Therefore, roads constructed on non-NFS lands may be associated with greater water quantity and quality impacts per mile of road than on NFS lands. Generally, however, the amount of roads (i.e., existing, new, and reconstructed) may be an indicator of cumulative effects on water resources of the Tongass National Forest and adjacent areas; therefore, the cumulative effects to water resources would generally be proportional to overall changes in road miles.

Table 3.4-11
Estimated Number of Road Miles on All Lands within the Tongass Forest Boundary for Each Alternative after Full Implementation of the Forest Plan for approximately 100 years[1]

		Alternative				
Road Categories	**Existing**	**1**	**2**	**3**	**4**	**5**
Total New Miles on NFS Lands	0	944	1,056	1,020	871	994
Total Miles on NFS Lands	5,093	6,036	6,148	6,113	5,964	6,086
Total Miles on Non-NFS Lands[2]	4,258	6,593	6,593	6,593	6,593	6,593
Total Miles on All Lands	**9,351**	**12,629**	**12,741**	**12,705**	**12,556**	**12,679**

[1] Assumes full implementation of Forest Plan plus future non-NFS harvest.
[2] Assumes an increase of 2,335 road miles on non-NFS lands by state, private, and municipalities over 100 years. Annette Island is included because it is surrounded by areas within the Forest boundary.

Road development on NFS lands under Alternative 4 would have the lowest contribution to cumulative effects by increasing total road miles on NFS lands by about 16 percent over existing conditions after 100 years; however, road construction on both NFS and non-NFS lands together would result in a total increase in road miles of about 34 percent because non-NFS road development would likely increase substantially. Alternative 2 would have the largest cumulative effect when including all roads, resulting in an increase in cumulative road miles equal to about 36 percent over existing conditions. The other alternatives (1, 3, and 5) would result in a cumulative increase in road miles equal to about 35 to 36 percent over existing conditions, when both NFS and non-NFS roads are included.

In addition to total road miles, the greater the density of roads in a subwatershed, the greater risk there is water quantity, quality, and use. As previously described, “properly functioning” watersheds are defined as 1 mile per square mile, with increased risk to watershed condition as road densities increase beyond this value. The average road densities by alternative and for the region are shown in Table 3.4-12. For the purposes of this cumulative effects evaluation, an increase in road miles on non-NFS lands for the life of the project (100+ years) was assumed. The average road density on non-NFS lands is much higher than on NFS lands. This higher average density is partly the result of the high number of road miles in city areas, as well as concentrated timber harvest areas. Even though the amount of non-NFS land area is relatively low, high road density on

these lands results in the overall average densities increasing sharply relative to NFS lands. Even with these increases, overall averages remain relatively low and consistent for all alternatives at 0.45 mile per square mile.

Table 3.4-12
Estimated Average Total Road Density on Tongass NFS Lands and Non-NFS Lands within the Tongass National Forest Boundary by Alternative over 100+ years[1]

	Road Density as Miles/Square Mile		
Alternative	**Road Density on NFS Lands**	**Road Density on Non-NFS Lands[2]**	**Total Road Density All Lands**
Existing	0.20	2.29	0.33
Alternative 1	0.23	3.55	0.45
Alternative 2	0.24	3.55	0.45
Alternative 3	0.23	3.55	0.45
Alternative 4	0.23	3.55	0.45
Alternative 5	0.23	3.55	0.45

[1] Assumes full implementation of Forest Plan at PTSQ levels plus future non-NFS harvest. Includes adjusted roads miles estimated to be needed to harvest all scheduled timber in the alternative. Annette Island is included because it is surrounded by areas within the Forest boundary.). Annette Island is included because it is surrounded by areas within the Forest boundary.
[2] Assumes an estimated the increase in non-NFS road miles within the Forest boundary from 4,258 miles at present to 6,593 after 100 years.

Although overall averages remain relatively low for any alternative, there are watersheds that have higher road densities that are increased by the addition of roads from the alternatives (Table 3.4-13). Currently, most (66.6 percent) of the watersheds on NFS lands have no roads and only just over 10 percent have road densities exceeding 1 mile per square mile. The inclusion of non-NFS lands reduces the percentage of watersheds with no roads to 60.2 percent and increases the portion of watersheds exceeding 1 mile per square mile by approximately 15.4 percent. Under Alternative 3 for all lands combined, the percentage of watersheds exceeding 1 mile per square mile would increase by 20 percent after 100 years. In contrast, under Alternatives 1, 2, 4, and 5, the percentage of watersheds exceeding 1 mile per square mile would increase between 19.6 and 20.2 percent.

Table 3.4-13
Estimated Road Miles and Percent of Watersheds in Road Density Categories on NFS Lands and on All Lands Combined within the Tongass National Forest Boundary by Alternative after 100+ years of Full Implementation[1]

Road Density Categories[2]	Alternative					
	Existing	**1**	**2**	**3**	**4**	**5**
Road Miles Per Sq. Mi.	**NFS Lands**	**NFS Lands**	**NFS Lands**	**NFS Lands**	**NFS Lands**	**NFS Lands**
0	66.6%	57.1%	54.6%	56.4%	62.4%	60.8%
>0 - <1.0	23.9%	32.4%	34.5%	32.5%	27.0%	27.9%
1.0 - 2.4	8.4%	8.2%	8.4%	8.6%	8.2%	8.6%
>2.4 - 3.0	0.8%	1.3%	1.4%	1.5%	1.5%	1.5%
>3.0	0.3%	1.1%	1.1%	1.0%	1.0%	1.1%
New Road Construction	-	944	1,056	1,020	871	994
Construction on Decom. Roads & Reconstruction	**-**	1,315	1,791	1,695	1,345	1,585
Total Miles (after 100 years)	**5,093**	**6,036**	**6,148**	**6,113**	**5,964**	**6,086**

Table 3.4-13 (continued)
Estimated Road Miles and Percent of Watersheds in Road Density Categories on NFS Lands and on All Lands Combined within the Tongass National Forest Boundary by Alternative after 100+ years of Full Implementation[1]

Road Density Categories[2]	Alternative					
	Existing	1	2	3	4	5
Road Miles Per Sq. Mi.	All Lands	All Lands	All Lands	All Lands	All Lands	All Lands
0	60.2%	50.5%	49.1%	48.8%	51.5%	51.0%
>0 - <1.0	24.5%	29.8%	30.9%	31.0%	28.9%	29.2%
1.0 - 2.4	12.8%	13.7%	14.1%	14.3%	13.6%	13.8%
>2.4 - 3.0	1.6%	3.0%	2.9%	2.9%	3.1%	3.0%
>3.0	1.0%	2.9%	3.0%	3.0%	2.9%	3.1%
New Miles Constructed	-	3,278	3,390	3,335	3,206	3,328
Total Miles	**9,351**	**12,629**	**12,741**	**12,705**	**12,556**	**12,679**

[1] Assumes full implementation of Forest Plan at PTSQ levels plus future non-NFS harvest for 100+ years. Estimated the increase in non-NFS road miles within the Forest boundary from 4,258 miles at present to 6,593 after 100+ years. Annette Island is included as a VCU because it is surrounded by areas within the Forest boundary.
[2] For NFS lands, percentages are based on 927, sixth-field watersheds that contain at least 100 acres of NFS lands. For all lands, percentages are based on all 932, 6th field watersheds inside the Forest boundary, including Annette Island.

Climate Change

Climate change has the potential to affect water quantity and quality on the Tongass National Forest. Several modeled results presented in recent literature demonstrate that precipitation and air temperatures in Southeast Alaska and the Tongass National Forest will increase this century (EcoAdapt 2014; Shanley et al. 2015), although the degree to which changes occur vary substantially between areas across the Forest. In general, increases in air temperature are expected in the winter months with increases in precipitation expected in the fall and winter, with much of the precipitation occurring as rain instead of snow (EcoAdapt 2014). The warmer air temperatures would likely result in much of the precipitation occurring as rain instead of snow and contribute to the melting of glaciers, higher peak flows in the fall and winter in most streams other than glacial-fed streams, and lower summer flows primarily in snow-melt and rain dominated watersheds (Shanley and Albert 2014; Shanley et al. 2015). In addition, the warmer air temperatures may result in increased stream temperatures, but the degree to which increases would occur depend greatly on local factors (e.g., glacial systems, groundwater inputs, presence of lakes and ponds, and stream shading) and any potential increase may be lessened by the potential increases in rainfall occurring in the summer and fall (EcoAdapt 2014).

Southeast Alaska is characterized by high rainfall, so small reductions in precipitation have limited potential to significantly reduce stream flows. Because Southeast Alaska is dominated by high rainfall, increased precipitation as rain instead of snow in the fall and winter has the potential to increase peak flows in most streams and alter the overall timing and frequency of events in a given watershed. Although increased peak flows and altered timing and frequency are likely, the degree to which water quantity in a given watershed is affected by climate change will be based primarily on local factors. Whether water quantity will be affected by the combination of climate change and the cumulative effects associated with timber harvest and road construction between each alternative is uncertain; however, because the cumulative effects do not differ substantially amongst the alternatives, changes in water quantity Forest-wide will likely be dictated more by climate change locally than by the alternatives. In addition, given the short-term that the Forest Plan will be in place before being modified

again (likely 10 to 15 years), large magnitude changes in water quantity are highly unlikely.

Streams on the Tongass National Forest, both in harvested and unharvested watersheds, have occasionally been documented with brief periods of temperature criteria exceedances. Theoretically, if air temperature changes were large enough, these exceedances could become more frequent. Currently, there are no 303(d) streams listed for temperature exceedance. Whether temperature changes associated with climate change, even when combined with the cumulative effects associated with forest clearing and road construction between each alternative, would be large enough to cause changes to this level are unknown. However, in the short-term that the Forest Plan will be in place before being modified again (likely 10 to 15 years), large magnitude changes in stream temperature are highly unlikely.

In summary, there is general agreement that the climate is warming, precipitation will increase, flows will increase in the fall and winter, but decrease in the summer in snow- and rain-dominated watersheds. However, there is considerable uncertainty surrounding specific predictions of when and the magnitude, and even more uncertainty regarding the effect of these changes on water quantity and quality.

Wetlands

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Affected Environment

Definition and Regulatory Aspects

The U.S. Environmental Protection Agency (EPA) and the U.S. Army Corps of Engineers (Corps) jointly define wetlands as "those areas that are inundated or saturated by surface or groundwater with a frequency and duration sufficient to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted for life in saturated soil conditions. Wetlands generally include swamps, marshes, bogs, and similar areas." Wetlands are considered to be important for the physical, biological, chemical, social and/or economic functions they provide. These functions include flood flow moderation, groundwater recharge and discharge, nutrient cycling, wildlife and fish habitat, and water quality protection.

The Corps of Engineers Wetlands Delineation Manual (Environmental Laboratory 1987) and the Regional Supplement to the Corps of Engineers Wetland Delineation Manual: Alaska Region (Version 2; USACE 2007), collectively, "The Manual," provide the standards for determining areas of wetlands and deepwater habitats. Areas are defined as wetlands when soil, hydrology, and vegetation all meet the technical criteria defined in The Manual for identifying wetlands.

For federal regulatory purposes, wetlands are considered a subclass of Special Aquatic Sites (40 Code of Federal Regulations [CFR] Section 230.3) and most, but not all wetlands, have been deemed Waters of the United States (33 CFR 328.3). All waters of the United States are subject to regulation through the Clean Water Act by the Corps and EPA. Sections 404 and 401 of the Clean Water Act were created specifically with the intent "to restore and maintain the chemical, physical, and biological integrity of our Nation's waters." Executive Order 11990, as amended (42 United States Code 4321 et. seq.), requires federal agencies "to avoid...adverse impacts associated with the destruction or modification of wetlands...wherever there is a practicable alternative" and to "include all practicable measures to minimize harm to wetlands." Further, the agencies are required to preserve and enhance the natural and beneficial values of wetlands in carrying out their responsibilities.

Wetland Mapping, Classification, and Distribution

On the Tongass, wetlands may be found from sea level to alpine elevations, and in marine, estuarine and riparian settings. The U.S. Fish and Wildlife Service's (USFWS) National Wetlands Inventory (NWI) has mapped wetlands on the Tongass National Forest based on aerial photo interpretation and limited ground verification. The NWI classifies wetland types using a classification system (described below), developed by Cowardin et al. (1979).

Palustrine wetlands include the vegetated wetlands traditionally referred to as marshes, swamps, bogs, fens, and prairies. They include all nontidal wetlands dominated by trees, shrubs, persistent emergent plants, mosses or lichens, and all such wetlands where salinity due to ocean-derived salts is below 0.5 percent. Palustrine wetland classes on the Tongass include emergent wetlands (including

peatlands), scrub-shrub wetlands, forested wetlands, and other palustrine classes. Classes are described in the following paragraphs.

Forested class. Over half (52 percent) of the NWI-mapped wetland acres on the Tongass are forested wetlands. Forested wetlands are characterized by woody vegetation greater than 20 feet tall. Vegetation ranges from scrubby mixed conifer forests to mixed conifer, western, or mountain hemlock stands. Shrubs and forbs dominate the understory.

Emergent class. Approximately 25 percent of the NWI-mapped wetland acres on the Tongass are classified as emergent. The emergent class is characterized by erect, rooted herbaceous plants, and mosses and lichens. Peatlands (muskegs) are included in the emergent class of wetland. In Southeast Alaska, all relatively open bogs that have a groundcover high in sphagnum mosses and/or sedges are called "muskegs," and are a type of peatland.

Scrub-Shrub class. Approximately 13 percent of the NWI-mapped wetland acres on the Tongass are scrub-shrub. Scrub-shrub wetlands include wetlands dominated by woody vegetation less than 20 feet tall. This class is the most vegetatively varied wetland class in Southeast Alaska. Plant species may include true shrubs, young trees, and tree and/or shrubs that are small or stunted because of environmental conditions. Scrub-shrub wetlands are associated with three broad wetland plant communities: scrub-shrub alder/willow, scrub-shrub evergreen/emergent, and forested scrub-shrub evergreen/emergent.

Other classes. Approximately 1 percent of the NWI-mapped wetland acres on the Tongass consist of other palustrine classes including aquatic bed, open water, unconsolidated bottom, and unconsolidated shore. Aquatic bed wetlands include areas dominated by floating or submerged vegetation (i.e., plants that grow primarily on or below the surface of the water for most of the growing season in most years). Open water includes small bodies of water such as ponds. Both unconsolidated bottom and unconsolidated shore include wetlands with varying substrates, but both types have less than 30 percent cover of vegetation.

Lacustrine wetlands include all permanently flooded lakes, reservoirs, and tidal lakes with ocean-derived salinities below 0.5 parts per thousand, larger than 20 acres. Approximately 4 percent of the NWI-mapped wetland acres on the Tongass are lacustrine.

Estuarine wetland system. Estuarine wetlands are those areas that are predominantly intertidal, and are those parts of the rivers or streams or other bodies of water having an unimpaired connection with the open sea, where the sea water is diluted with freshwater derived from land drainage. Approximately 2 percent of the NWI-mapped wetland acres on the Tongass are estuarine.

Riverine wetland system. The riverine wetland system includes all channel-contained streams and rivers. These areas are bounded by uplands, channel banks, or palustrine wetlands dominated by trees, shrubs, emergent mosses or lichens. In braided streams, the riverine wetland system is bounded by the banks forming the outer limits of the depression within which the braiding occurs. Approximately 1 percent of the NWI-mapped wetland acres on the Tongass are riverine.

Table 3.5-1
Mapped Acres of Wetlands on the Tongass National Forest by Wetland System and Class

Wetland Systems	Wetland Classes	Acres
Palustrine	Forested	2,114,432
	Emergent (including peatlands/muskegs)	1,015,739
	Scrub-shrub	535,922
	Palustrine - other	51,465
Lacustrine		187,224
Estuarine		82,759
Riverine		59,779
Total Wetlands		**4,047,320**

Source: National Wetland Inventory Database, USFWS 2006a, and Tongass National Forest GIS database.

Past Wetland Impacts

Due to the prevalence of wetlands in Southeast Alaska, total avoidance of wetlands during timber harvest, road construction, and other activities (e.g., utility line projects, mining) on the Tongass has not been possible. Past timber harvest has impacted approximately 35,156 acres of wetlands (Table 3.5-2). Additionally, there are approximately 1,193 miles of roads within wetlands on the Tongass, including non-system roads and closed roads (Table 3.5-2). This represents 23 percent of the 5,155 total road miles on the Tongass. The majority of these roads were constructed as part of forestry activities and the majority of these roads (877 miles) have impacted forested wetlands (Table 3.5-2). Previously logged forested wetlands are in the process of regenerating and support young forests. Past road construction; however, in wetlands is considered a permanent wetland impact.

Table 3.5-2
Past Acres of Timber Harvest and Existing Miles of Roads in Wetlands on the Tongass

	Palustrine Wetlands							
	Forested	Scrub-Shrub	Emergent (including peatlands / muskegs)	Other[1]	Lacustrine Wetlands	Estuarine/Marine Wetlands	Riverine Wetlands	Total Wetlands[2]
Timber Harvest (Acres)[3]	27,188	2,552	3,714	240	70	1,074	415	**35,253**
Existing Roads (Miles)	877	62	225	5	1	12	11	**1,193**

[1] "Other" includes aquatic bed, moss-lichen, unconsolidated bottom, and unconsolidated shore.
[2] Totals may not appear to sum correctly due to rounding.
[3] Acres are based on NWI wetland data superimposed on harvest unit data; this results in numerous small inclusions of non-forested wetland types being included in the harvest units. These non-forested wetland areas are avoided during harvest.
Source: NWI database (USFWS 2006a) and Tongass National Forest GIS database.

Environmental Consequences

Direct and Indirect Effects

The physical, biological, and chemical integrity of wetlands on the Tongass has been, and is currently, affected primarily through timber harvest operations, which includes the construction and maintenance of roads, landings, stream crossing structures, marine access points, and log transfer facilities (LTFs). The magnitude of timber harvest-related effects to wetlands depends, in part, on the intensity, location, and duration of the timber harvest activity or road construction. In addition to timber harvest and road construction, development of renewable energy (e.g., hydroelectric power) projects have impacted, and will continue to impact, wetlands on the Tongass.

Limited research has been conducted on the effects of timber harvest, road construction, or renewable energy and utility line projects on wetlands in Southeast Alaska. Research on the effects of timber harvest on wetland systems have been primarily focused on regeneration of trees (Julin and D'Amore 2003; Duncan 2002). Studies on road construction on wetland sites have been focused on the effects to hydrology, and only a few wetland sites were studied (Glaser 1999; Kahklen and Moll 1999; McGee 2000).

Silvicultural operations, such as harvesting trees, are generally exempt from Corps' permitting requirements (33 CFR 323.4). The construction or maintenance of forest roads in support of silvicultural practices, and temporary roads for moving mining equipment, are also generally covered under this exemption for the discharge of dredged or fill material into waters of the United States. This exemption is contingent on construction and maintenance being conducted in accordance with the Corps' Best Management Practices (BMPs) as stated in 33 CFR 323.4(a)(6). These practices have been incorporated into BMP 12.5 of the Alaska Region's BMP Handbook (Forest Service Handbook 2509.22). Construction of roads not associated with silvicultural operations is not exempt and requires a Section 404 permit.

Under each of the alternatives, project-level analysis and planning would be used to avoid construction in wetlands, and would provide site-specific plans to minimize effects. Additionally, Forest-wide standards and guidelines (including BMPs) are applied to activities in and around wetlands. All Alternatives would follow the 2008 Tongass Land and Resource Management Plan (Forest Plan) standards and guidelines for wetlands which provide direction to avoid development activities in wetlands to the extent feasible, minimize effects on wetlands, and locate and design roads to minimize effects on wetlands. However, under Alternatives 2 through 5, additional guidelines specific to young-growth timber harvest, as well as development of renewable energy projects are proposed (see Chapter 5). These objectives, standards, and guidelines would allow and/or facilitate young-growth timber harvest and renewable energy development in areas that currently would restrict these areas (e.g., beach and estuary fringe). Effects to wetlands from the Alternatives are discussed in more detail below.

Effects Common to All Alternatives

Timber Harvest

Timber harvesting on wetland sites would have direct effects on the wetlands themselves and indirect effects on adjacent or nearby wetlands. The effects would potentially include altering hydrology, changing nutrient pathways, removal of nutrients, increased sedimentation (which can diminish water quality), increased soil temperature, alteration in water yield and stream flow patterns,

change of plant species composition and growth, and reductions in available wildlife habitat.

Removal of the forest canopy through timber harvest can increase the amount of precipitation reaching the ground surface and lower evapotranspiration rates, which can lead to an increase in soil moisture and slower growth in seedlings and saplings (USDA Forest Service 2013). Additionally, removal of vegetation also allows precipitation to reach the soil surface faster, resulting in soil saturation occurring more rapidly, which can result in accumulation of water on the surface of the wetland (Sheldon et al. 2005). Effects on soil moisture within harvested wetlands are less in partially harvested stands.

Forested wetlands in Southeast Alaska have been found to successfully regenerate and grow into dense, differentiated stands after clearcutting (Julin and D'Amore 2003; Duncan 2002). According to a study on regeneration of forested wetlands, tree growth was slow but consistent on histosols (wet, organic soils), and exceeded the minimum USDA Forest Service volume-production standard for commercial timberland (Julin and D'Amore 2003). Revegetation of forested wetland sites is expected to occur in the same timeframe as other forested sites. Site quality on wetland soils; however, may be lower than on sites with better drainage, and may require additional time for trees to reach merchantable size on wetlands compared to drier sites.

Although timber harvest can result in a short-term reduction in hydrologic and biogeochemical wetland functions, these functions begin to return as soon as there is tree revegetation. The habitat functions provided by forest areas may require more time and forest regrowth to return. Some of the habitat functions are dependent on, or related to, characteristics of the old-growth ecosystem. Habitat values for many species using forested habitat are discussed in the *Wildlife* section of this chapter.

Road Construction and Reconstruction

Construction of roads within wetlands permanently removes the wetland area and wetland functions under the roadbed itself. Within the disturbed soil corridor wetland soils are excavated, buried, and/or compacted and water movement over and through soils within the disturbed soil corridor is altered (Landwehr 2011). Constructing roads across wetlands can also affect hydrologic connectivity across the wetland due to road ditches or road fills (USDA Forest Service 2013). Additionally, crossing wetlands with roads without adequate provision for cross-drainage could lead to sedimentation from road construction or changes in hydrologic patterns.

In deep peat wetlands, road construction can crush "soil pipes" (subsurface flow paths) that allow the wetland to process extra water without surface erosion. This can result in saturation of the site and increased water on the surface of the wetland (Landwehr 2011). It may take many years, up to 30 years, for the resulting hydrologic and vegetation changes to become evident (Holden et al. as cited in Landwehr 2011). Road construction can also directly impact wetland vegetation through the removal of vegetation within the road clearing and grubbing limits and indirectly impact wetland vegetation as a result of changes in soil hydrology adjacent to road clearing limits or grubbing and fill areas (Landwehr 2007).

As stated above, there are approximately 1,193 existing road miles on wetlands on the Tongass. There has been limited research on the effects of forestry roads constructed in the past on wetlands or uplands in the Tongass National Forest. The results of the wetland and upland studies on the Tongass suggest that the

hydrologic effects of roads remain within a few meters of the road (Glaser 1999; Kahklen and Moll 1999; McGee 2000). In Southeast Alaska, this limited hydrologic effect appears to be primarily due to the low hydraulic conductivity of peat wetlands and relatively high rainfall through the year (Landwehr 2011). Studies conducted in other areas with similar climates (cool, moist, and year-round precipitation) have found similar results. In northern England, researchers studied the effects of ditching on peatlands and found that the measurable effects of ditches on peatland hydrology were limited to less than 3 meters from the ditches (Stewart and Lance 1991; Coulson et al. 1990). Data collected during wetland implementation and effectiveness monitoring on the Tongass have indicated that the impacts to wetland vegetation from road construction is also limited, typically to less than 5 meters beyond the physically disturbed soil corridor (Landwehr 2011).

Monitoring was conducted on the Tongass in 2006, 2008, and 2011 to document whether BMPs have been implemented during road construction activities on the Tongass and whether these BMPs were effective at minimizing or avoiding impacts to wetlands (Landwehr 2007, 2008b, and 2011). The most recent 2011 monitoring assessment indicates that wetlands were avoided to the extent practicable while meeting project goals and objectives and impacts to wetlands were minimized (Landwehr 2011).

Reconstruction of a road for timber harvest maintains the original investment and makes it suitable and safe for the intended use. Reconstruction involves rehabilitation of the original roadbed and can include cleaning ditches, replacing drainage structures, reinstalling bridges, and grading and shaping. Generally, reconstruction of existing roadbeds for timber harvest would not add impermeable surface to wetlands. However, some reconstruction can include upgrading a road and widening the roadbed. Widening an existing roadbed in wetlands adds to the impermeable surface and increases the total effects to wetlands.

Some road reconstruction activities, such as replacing drainage structures or cleaning road ditches, have potential to affect wetland hydrology. These activities may have a positive or negative effect on wetland hydrology depending on the condition of the existing road in the wetland. Road maintenance can include reconditioning the original road template, grading the road surface, cleaning roadside ditches, and removing vegetation that may encroach upon the road or block vision. In general, this would have no effect, or it could improve wetland hydrology in areas where drainage has become blocked.

Renewable Energy Development

In addition to timber harvest and road construction, wetlands on the Tongass would also be impacted by development of renewable energy sites (e.g., hydroelectric) under each of the alternatives. There are 11 renewable energy projects in Southeast Alaska that are currently actively being proposed (see *Renewable Energy* section). Six of these projects are hydroelectric projects, three are non-FERC hydroelectric projects, one is a geothermal project, and one is a wave energy project. All 11 active projects are either on or considered likely to affect National Forest System (NFS) lands. Additionally, many of the proposed projects include associated transmission lines and in some cases, access roads on NFS lands.

Hydroelectric power projects can be either a reservoir or “run-of-the river” system. For reservoir projects, a dam is constructed across the entire stream and a reservoir is created behind the dam. For run-of-the river (or streaming) projects, either a diversion system (also called a diversion dam) diverts a portion

of the stream or river through the hydroelectric turbines, or a relatively small impoundment with limited storage is created by a dam, known as pondage. Run-of-the river hydroelectric power projects may divert flow which could result in a reduction in stream water flow, or they could rely on an upstream larger reservoir or reservoirs. Construction of dams may involve impoundment of stream flow and creation of ponds or reservoirs. These ponds or reservoirs could flood adjacent wetlands, if present, and wetland resources could be permanently and/or seasonally lost due to inundation. Over time, similar wetland communities may develop adjacent to the new reservoir margins depending on steepness of the adjacent slope. Rising and/or fluctuating reservoir levels due to operation of the hydroelectric power facility could alter hydrology and wetland functions of non-inundated adjacent wetlands and indirectly alter the nature, composition, and stability of the adjacent wetland vegetation. Alteration of species composition and hydrologic regimes in these wetlands could also result in the loss or modification of wetland habitat. Although the impacts would likely be less, diversion of stream flow for run-of-the river hydroelectric projects could also affect wetlands adjacent to the riverine system where flow is diverted. Wetland hydrology and, in turn, wetland vegetation could be affected by run-of-the river hydroelectric projects depending on the timing and magnitude of stream flow being diverted, as well as the length of the diversion.

In addition to creation of a reservoir or diversion of stream flow, facilities and activities that could directly or indirectly affect wetlands, depending on the project, include construction and operation of a dam and/or diversion dams, intake structures, power plants (powerhouse), surge tanks, pipeline (penstock), access spur roads, and temporary staging areas. Impacts to wetlands from construction and operation of hydroelectric projects could include temporary and permanent loss of wetlands, vegetation removal, soil disturbance, and hydrologic changes. In addition to the permanent loss of wetlands, introduction of fill material for construction of permanent facilities could affect surface or subsurface hydrology.

Impacts to wetlands from utility line construction and operation could result from structure installation, construction of new access roads and access spur roads, reconstruction of existing access roads, construction of helicopter pads, and/or right-of-way clearing and maintenance. Impacts to wetlands from these activities include temporary or permanent fill of wetlands, soil disturbance, and vegetation clearing. Effects to wetlands from access and spur roads would be similar to those described for road construction above.

Right-of-way clearing for utility lines would primarily affect forested wetlands. The effects of right-of-way clearing on wetlands would be similar to effects resulting from timber harvesting as described above. Where removed for construction, shrubs and trees would be expected to quickly revegetate the right-of-way allowing soil moisture levels and hydrology to partially return to normal. However, unlike timber harvest, future vegetation maintenance would prevent trees from growing to maturity in areas along the right-of-way needed for maintenance of the utility line. This vegetation maintenance might not convert wetlands to uplands; however, it could convert forested wetlands to shrub or emergent wetlands.

Renewable energy sites, under all alternatives, would be subject to analysis under the National Environmental Policy Act (NEPA) and may require a Section 404 permit. Additionally, mitigation measures to reduce impacts to wetlands would be implemented. Mitigation measures for hydroelectric power projects may include:

- Siting project facilities (including utility lines) to avoid wetlands to the extent possible;
- Ensuring project design minimizes the amount of wetland fill required to the extent practicable;
- Revegetating temporarily disturbed areas and slopes subject to erosion to minimize erosion and sedimentation;
- Implementing sediment prevention measures;
- Stockpiling materials in upland areas; and
- Implementation of BMPs and Forest Service Standards and Guidelines.

Effects Specific to Each Alternative

The difference between alternatives on the effects to wetlands generally falls within three categories: 1) short-term or long-term effects due to timber harvest, 2) loss of wetland acres and function due to road construction, and/or 3) short-term or long-term effects and/or loss of wetland acres from construction and operation of renewable energy sites. The effects to wetlands from these activities under each alternative are discussed below.

Timber Harvest and Road Construction

Acres of timber harvest and miles of road construction in wetlands can be used to provide comparisons between alternatives. However, actual acres of harvest in wetlands are likely to be lower, particularly in scrub-shrub and emergent wetlands, when acres are dropped in units with poor timber volume. Miles of road would likely be less than shown in this analysis because road layout for individual projects would avoid wetlands to the extent feasible, as required in the Forest-wide standards and guidelines.

Alternative 1, the No-Action Alternative, would follow the 2008 Forest Plan which includes standards and guidelines to protect beach and estuarine, riverine, and lacustrine areas. Under the 2008 Forest Plan, the beach and estuary fringe, an area of 1,000 feet slope distance around all identified estuaries and from all saltwater shorelines, is classified as unsuitable for timber activities and roads are discouraged. Additionally, the standards and guidelines include riparian area protection. Riparian area protection varies depending on the classification of the stream and include restrictions on programmed timber harvest in riparian management areas (RMAs) and within 100 feet of Class I fish-bearing streams as well as Class II streams that flow into Class I streams. These standards and guidelines would provide further protection for wetlands that occur in estuarine, riparian, and lacustrine areas under Alternative 1.

Alternatives 2 through 5 would allow for young-growth timber harvest in the beach and estuary fringe (Table 3.5-3). Alternative 2 would allow young-growth clearcut timber harvest in the beach and estuary fringe for 15 years; thereafter, timber harvest would be restricted to commercial thin harvest in the beach and estuarine fringe. Under Alternatives 3 and 4, young-growth commercial thin harvest would be allowed in beach and estuary fringe and under Alternative 5, young-growth group selection harvest, with the size of harvest openings limited

to less than 10 acres, would be allowed within beach and estuary fringe areas. However, under Alternative 5, young-growth harvest is not allowed within a 200-foot buffer area extending from the shore.

Young-growth timber harvest would also be allowed in RMAs under Alternatives 2 and 5. Alternative 2 would allow young-growth commercial thin harvest and Alternative 5 would allow group selection harvest in RMAs but would restrict harvest openings to less than 10 acres and limited harvest to one entry. Commercial young-growth timber harvest would not be allowed within RMAs under Alternatives 1, 3, and 4. Thus, Alternatives 2 and 5 do not provide the same level of protection for wetlands in beach, estuarine and riparian areas as Alternatives 1, 3, and 4.

Table 3.5-3
Alternatives that Allow for Harvest in Beach and Estuary Fringe and RMAs

Conservation Strategy Component	Harvest Allowed (Yes/No)?				
	Alt 1	Alt 2[1]	Alt 3[2]	Alt 4[3]	Alt 5[4]
Harvest in Beach Buffer	No	Yes	Yes	Yes	Yes
Harvest in RMA	No	Yes	No	No	Yes

[1] Alt 2 Prescriptions: Young Growth - Clearcutting is permitted in Beach Buffer for first 15 years; thereafter, only Commercial Thinning is permitted. Only Commercial Thinning is permitted in RMAs.
[2] Alt 3 Prescriptions: Young Growth - Only Commercial Thinning is permitted in Beach Fringe.
[3] Alt 4 Prescriptions: Young Growth - Only Commercial Thinning is permitted in Beach Fringe.
[4] Alt 5 Prescriptions: Young Growth - Group Selection and Commercial Thinning are permitted in Beach Buffers and RMAs subject to a one time entry limitation; thereafter, no harvest is permitted; Harvest openings would be restricted to less than 10 acres in RMAs. Harvest in the beach fringe must leave a 200 foot buffer along the seaward edge.

The alternatives also differ in the maximum acres of timber harvest and miles of road construction that would potentially occur in wetlands. Table 3.5-4 displays the proposed maximum acres of young-growth and old-growth timber harvest within mapped wetlands under the proposed alternatives.

Timber harvest activities would impact the fewest acres of wetlands under Alternative 4 (maximum harvest of 31,291 acres over 100+ years); whereas, timber harvest activities under Alternative 2 would have the greatest impact on wetlands (maximum harvest of 36,625 acres over 100+ years). However, old-growth harvest within wetlands under Alternative 2 would be lower (9,200 acres) than under any of the other alternatives. Alternative 1 would conduct harvest activities on a maximum of 34,416 acres of wetlands, less than Alternatives 2, 3, and 5; however, it would result in the greatest acres of old-growth harvest (17,672 acres) of all the alternatives. Alternatives 3 and 5 would conduct harvest activities on a maximum of 35,805 acres and 33,815 acres of wetlands, respectively (Table 3.5-4).

Over time, Alternative 2 would have a higher risk of direct and indirect effects to wetlands due to timber harvest activities than the other alternatives. However, Alternative 1 would result in the greatest acres of old-growth harvest in wetlands than the other alternatives. Return to pre-harvest conditions following old-growth timber harvest in wetlands would take longer than a return to pre-harvest conditions following young-growth harvest within wetlands. Alternative 4, which would result in the lowest total maximum acres of harvest in wetlands, would have the lowest overall risk of effects to wetlands from timber harvest activities.

Table 3.5-4
Maximum Harvest Area in Mapped Wetlands by Alternative after 100+ Years of Full Implementation[1]

		Palustrine Wetlands							
Alternative		Forested	Scrub-Shrub	Emergent (including peatlands and muskegs)[2]	Other[3]	Lacustrine Wetlands[2]	Estuarine/ Marine Wetlands[2]	Riverine Wetlands	Total Wetlands[1]
1	OG	14,746	557	2,300	20	3	36	10	17,672
	YG	14,562	428	1,675	31	3	26	19	16,744
	Total	**29,308**	**985**	**3,975**	**51**	**6**	**62**	**29**	**34,416**
2	OG	7,689	289	1,187	10	2	18	5	9,200
	YG	21,694	1,786	2,807	165	39	770	165	27,425
	Total	**29,383**	**2,075**	**3,994**	**175**	**41**	**788**	**170**	**36,625**
3	OG	8,474	432	1,525	11	2	10	3	10,457
	YG	20,787	1,139	2,528	136	9	718	31	25,348
	Total	**29,261**	**1,571**	**4,053**	**147**	**11**	**728**	**34**	**35,805**
4	OG	10,595	355	1,711	12	2	17	5	12,697
	YG	15,950	464	1,808	30	4	329	9	18,594
	Total	**26,545**	**819**	**3,519**	**42**	**6**	**346**	**14**	**31,291**
5	OG	9,217	291	1,430	11	2	15	5	10,975
	YG	18,790	1,402	2,330	122	11	43	142	22,840
	Total	**28,007**	**1,693**	**3,760**	**133**	**13**	**58**	**147**	**33,815**

[1] Totals may not appear to sum correctly due to rounding.
[2] Fractional acres mapped as marine wetlands occur within the alternatives.
[3] "Other" includes aquatic bed, unconsolidated bottom, and unconsolidated shore.
Source: NWI database, USFWS 2006a; Tongass National Forest GIS database.

The alternatives also differ in the maximum miles of new roads that would potentially be constructed within wetlands. Table 3.5-5 displays the maximum miles of new roads in wetlands under the proposed alternatives. Alternative 1 would result in the most miles (160 miles) of new road construction in wetlands; whereas Alternatives 2 and 5 would result in the least miles (130 miles) of new road construction in wetlands. Alternatives 3 and 4 would be in the middle of the alternatives with a maximum of 133 and 131 miles of roads constructed in wetlands, respectively.

Table 3.5-5
Maximum Miles of New Roads in Wetlands by Alternative after 100+ Years[1]

	Palustrine Wetlands							
Alternatives	Forested	Scrub-Shrub	Emergent (including peatlands/ muskegs)	Other[2]	Lacustrine Wetlands	Estuarine Wetlands	Riverine Wetlands	All Wetlands
1	135	5	20	+[3]	+	+	+	160
2	105	6	15	+	+	2	+	130
3	108	6	16	+	+	2	+	133
4	111	4	16	+	+	1	+	131
5	108	5	15	+	+	+	+	130

[1] Totals may not appear to sum correctly due to rounding.
[2] "Other" includes aquatic bed, unconsolidated bottom, and unconsolidated shore.
[3] A "+" indicates >0 but <0.5 mile of new roads.
Note: This assumes that the full Projected Timber Sale Quantity is harvested each year for 100 years and that wetland avoidance is not practiced.
Source: NWI database (USFWS 2006a) and Tongass National Forest GIS database.

Over time, Alternative 1, the No-Action Alternative, and Alternative 5 would have a higher risk of direct and indirect effects to wetlands due to road construction than the other Alternatives. Alternatives 2 and 3 would have the lowest risk of effects to wetlands from road construction.

Renewable Energy Development

Development of renewable energy sites would occur under all alternatives; however, Alternatives 2, 3, 4, and 5 would include new management direction (i.e., plan components) in the Forest Plan that improves flexibility in renewable energy development. Alternative 1 would not facilitate the development of renewable energy sites to the extent that Alternatives 2, 3, 4, and 5 would. Therefore, these alternatives could result in greater impacts to wetlands than Alternative 1 from development of renewable energy sites. Under all alternatives, however, renewable energy site development would be subject to site-specific environmental analysis under NEPA and will also be subject to Section 404 permitting.

Cumulative Effects

When considering cumulative effects to wetlands, it is important to look at incremental effects of past, present, and reasonably foreseeable future activities both on and off NFS lands. Individual wetlands provide important physical, biological, and chemical functions, and are not isolated from each other or from other resources when viewed on a larger scale. Surface and subsurface water, along with many organisms, move through the landscape. As discussed in the direct and indirect effects section, changes to or loss of functions in an individual wetland can have effects that extend beyond individual wetlands as they contribute to the overall functioning within a watershed and landscape.

Each landscape area or watershed has different physical, chemical, and biological characteristics and vegetation patterns. The importance of incremental effects of past, present, and reasonably foreseeable future activities to individual wetlands would depend on the amount and type of disturbance in the analysis area, wetland locations and distribution in the watersheds, the distance to other wetlands and waterbodies, and connectivity of hydrology and habitat between them. Assessing cumulative effects to wetlands will be done for individual projects for the relevant analysis area as part of the NEPA process under all alternatives. However, past plus expected timber harvest, road construction for forestry and other uses, and development of renewable energy sites on all land ownerships within the Tongass National Forest boundary can be used to compare the risk of the alternatives adding to cumulative effects to wetlands.

Appendix C provides a full list of all the projects considered in the cumulative effects analysis.

Impacts from Timber Harvest and Road Construction

Non-NFS lands comprise approximately 6 percent of the lands within the Tongass National Forest boundary and 22 percent of Southeast Alaska. Silviculture on NFS and non-NFS lands are generally exempt from the Corps' permitting requirements contingent on the construction and maintenance of roads being conducted in accordance with the general Corps' BMPs as stated in 33 CFR 323.4(a)(6). Timber harvest on state, municipal, and private land is also governed by the Alaska Forest Resources and Practices Act (AS 41.17). Alaska Forest Resources and Practices Regulations (Alaska Department of Natural Resources [ADNR] 2013) includes regulations designed to prevent adverse impacts to fish habitat and water quality from timber operations. The regulations are less extensive than the standards and guidelines that direct activities on the Forest. The state regulations provide direction to avoid and minimize road building, sedimentation, establishment of landings, and damage to vegetative

cover of marshes and non-forested muskegs. The regulations also provide buffers for forested wetlands if classified as anadromous water bodies or tributaries to anadromous water bodies. Harvest and associated activities are not specifically regulated on forested wetlands that are otherwise classified.

As stated above, timber harvest can alter wetland function and type but is not expected to convert wetlands to uplands. The hydrologic and biogeochemical functions begin to return as soon as there is tree revegetation, but the habitat functions provided by forested areas may take longer and more forest regrowth to return. This is especially true for timber harvest activities within forested wetlands in old-growth. Some of the habitat functions are dependent on, or related to, characteristics of the old-growth ecosystem, which would not develop during the life of the Forest Plan (10 to 15 years). Therefore, the effects of a project may add to cumulative effects to wetlands or their functions, particularly habitat functions in an area. Habitat and habitat changes are discussed in greater depth in the *Biodiversity* section.

To compare the potential for cumulative effects due to timber harvest activities on wetlands, past, present, and future harvest within wetlands was analyzed for all lands, regardless of ownership, within the Tongass Forest Boundary (plus Annette Island, which is surrounded by the Forest). Table 3.5-6 displays the potential cumulative impacts to wetlands from past, present, and reasonably foreseeable timber harvest on the Tongass and adjacent non-NFS land under each of the alternatives. Without any future harvest on NFS land, an estimated 2.0 percent of all wetlands on NFS and non-NFS lands will have been harvested after 100 years. With implementation of one of the alternatives, the percent of wetlands harvested will range from 2.1 to 2.4 (Table 3.5-6).

Table 3.5-6
Estimated Cumulative Percent of each Wetland Category Harvested on All Ownerships within the Forest Boundary under each Alternative after 100 Years[1]

	Palustrine Wetlands							
Alternative	**Forested**	**Scrub-Shrub**	**Emergent (including peatlands / muskegs)**	**Other[2]**	**Lacustrine Wetlands**	**Estuarine/Marine Wetlands**	**Riverine Wetlands**	**Total Wetlands[1]**
1	3.5	1.2	1.1	1.2	0.1	1.7	1..8	**2.4**
2	3.1	1.1	1.0	1.1	0.1	1.7	1.7	**2.1**
3	3.2	1.2	1.0	1.1	0.1	1.7	1.7	**2.2**
4	3.3	1.1	1.0	1.2	0.1	1.7	1.7	**2.2**
5	3.3	1.1	1.0	1.2	0.1	1.7	1.7	**2.2**

[1] "Totals may not appear to sum correctly due to rounding.
[2] Other" includes aquatic bed, unconsolidated bottom, and unconsolidated shore.
Source: NWI database (USFWS 2006a) and Tongass National Forest GIS database.

Increases in impervious surfaces, such as through construction of roads, alters the movement of water through the watershed by increasing surface runoff and reducing infiltration. This typically reduces the time that water resides in wetlands or streams in a watershed and can lead to more severe flooding or more dry spells in streams. Research has observed that the percent of impervious area and percent of forested cover governs the extent of alteration of hydrologic process and impacts to aquatic habitats, including wetlands, within a watershed (Sheldon et al. 2005).

No documentation was found regarding a threshold at which impervious surfaces (such as roads) interact to an extent to have a qualitatively or quantitatively substantial effect on wetlands in Southeast Alaska. Research in the State of Washington and in southern Ontario has indicated that impacts to the integrity and functions of wetlands and streams occurred when impervious surfaces reached 10 to 20 percent within a watershed (Steedman 1988; Taylor 1993 as cited in Sheldon et al. 2005; Booth and Jackson 1997). However, many scientists hold the opinion that there is no accurate threshold and that deterioration begins immediately (Booth et al. 2002; Sheldon et al. 2005).

On the Tongass, impervious surfaces are generally forestry roads. The cumulative effect of road construction in an individual wetland, when added to other alterations to the hydrology in an area, could result in significant alterations in hydrologic process and functions of wetlands and streams within the watershed (Azous and Horner 2001 as cited in Sheldon et al. 2005). Thus, road density (miles per square mile) within the National Forest Boundary regardless of land ownership can be used to examine cumulative effects from road construction.

Table 3.5-7 shows the existing and maximum average future road density for each for all land ownerships within the Forest boundary under each alternative. It includes forestry and other roads proposed for construction on NFS land and reasonably foreseeable roads on non-NFS lands. All alternatives would result in approximately the same maximum future average road density. Therefore, management actions under all alternatives, would have similar risks of cumulative effects to wetlands from impervious surfaces.

Table 3.5-7
Existing and Estimated Future Maximum Road Density (miles per square mile) for NFS Lands and for All Ownerships within the Forest Boundary by Alternative after 100+ Years[1]

	Existing Road Density (miles per square mile)	Estimated Future Road Density by Alternative (miles per square mile)				
		1	2	3	4	5
National Forest System Land	0.20	0.23	0.24	0.23	0.23	0.23
All Ownerships	0.33	0.45	0.45	0.45	0.45	0.45

[1] Road density is for all lands of all ownerships within the Forest boundary, not just roads within wetlands.

Impacts from Renewable Energy Site Development and Other Activities
Other past, present, and foreseeable activities also need to be considered when determining cumulative effects to wetlands. These activities include mineral extraction, renewable energy site projects, transportation developments, and urban and recreational site development.

Existing mining includes Greens Creek on Admiralty Island, Kensington Gold Mine north of Juneau, as well as other existing locations. Potential future mining sites include the Bokan Mountain and Niblack sites on the southern end of Prince of Wales Island. There are also several regional transportation projects and regional energy and utility line projects planned for construction, including the Kake to Petersburg Transmission Line Intertie Project, regional transportation development defined in the Southeast Alaska Transportation Plan and Forest Service Alaska Region Long Range Transportation Plan, road paving on Prince of Wales Island, and construction of the Angoon Airport. Urban and recreational site development includes the growth in the cruise ship and guiding industries,

development of fishing, other lodges, and recreational cabins, and expansion of cities including Juneau and Ketchikan.

Existing and foreseeable renewable energy projects within the Tongass National Forest Boundary include the potential geothermal development at Bell Island, potential hydroelectric development at Angoon, Sweetheart Lake, and Soule River, and expansion of the Swan Lake hydroelectric facility.

Each of the activities described above could include impacts to wetlands during construction and operations. Therefore, these activities have the potential to affect wetlands and their functions and these effects would be considered during individual project analysis. The effects of these projects would be the same for each alternative.

Impacts from Climate Change

Changes in Southeast Alaska's climate (discussed in the *Climate and Air* section) could affect the size, type, and functions of wetlands and, therefore, could add to cumulative effects. While the models do not fully agree on the climate change predictions for Southeast Alaska, they generally predict warmer weather, increased rainfall, and a decrease in snowfall in some areas. Recent research by Shanley et al. (2015) predicted an increase in mean annual temperature of approximately 3 to 10°F, a 3 to 18 percent increase in mean annual precipitation, and a 22 to 58 percent decrease in snowfall in Southeast Alaska by the 2080s (Shanley et al. 2015). These changes would potentially result in lower soil moisture due to increased evaporation during warmer summer months. Also, a precipitation shift from snow to rain could lead to more water running off the landscape rather than being stored as snow. Snowmelt is an important water source for wetlands in the spring and summer. Thus, increased evaporation and less water storage could lead to drier meadows or bogs and, possibly, fewer wetlands. Additionally, sea level is projected to rise under current climate change scenarios, which could lead to the loss of tidal wetlands (Shanley et al. 2015).

Changes in temperature could favor some plants and stress others. Longer growing seasons with warmer temperatures would likely result in faster growth. Those conditions would also favor increased rates of decomposition that could lead to changes in the organic matter in wetland soils. Changes in climate could shift wetlands from being carbon sinks to sources of aerial and aquatic carbon due to more rapid decomposition during warmer summers. All of these factors could lead to changes in wetland types, such as shifts in vegetation from herbaceous to shrub, from shrubs to trees, or from bogs to more productive forests. However, as discussed in the *Climate and Air* section, the models do not always agree and the predictions for total precipitation in portions of Southeast Alaska differ.

Fish

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Affected Environment

Fish and the aquatic resources on the Tongass National Forest provide major subsistence, commercial, and sport fisheries, as well as support traditional and cultural values. Abundant rainfall, streams with glacial origins, and watersheds with high stream densities provide an unusual number and diversity of freshwater fish habitats. These abundant aquatic systems of the Tongass provide spawning and rearing habitats for the majority of fish produced in Southeast Alaska. Maintenance of this habitat, and associated high-quality water, is a focal point of public, state, and federal natural resource agencies, as well as user groups, Native organizations, and individuals.

Through involvement of private and public groups and agencies, a number of watersheds and Value Comparison Units (VCUs) in the Tongass have recently been evaluated for relative importance for several metrics relating to fish and wildlife. Included among these are conservation priority areas identified by the The Nature Conservancy (TNC) and Audubon Alaska (Audubon Alaska and The Nature Conservancy 2007), and the "Tongass 77" (T77)[1] watersheds identified by Trout Unlimited. Audubon Alaska and TNC identified conservation priority watersheds that include high-value intact watersheds in primarily intact conditions and generally encompass the highest current ecological values within each province; these areas were recommended to be managed for intact ecological values and habitat productivity. Trout Unlimited's evaluation

[1] The Tongass 77 (T77) refers to VCUs, which approximate major watersheds located on National Forest System lands that Trout Unlimited, Alaska Program, identified as priority salmon watersheds. Four watersheds were removed from the T77 in 2014 as a result of the Sealaska Land Entitlement Finalization in the Carl Levin and Howard P. "Buck" McKeon National Defense Authorization Act for Fiscal Year 2015 (Public Law 113-291).

concluded that, based on their outstanding habitat values, fish production, and diversity of fish species present, the highest and best use of these TNC/Audubon conservation priority areas and T77 watersheds should be for the production of salmon and trout (Trout Unlimited undated; The Tongass 77 undated). Further assessment, considering land use designations and land transfer, resulted in some changes to the ranking. Some watersheds were removed and some added, with the final number of the T77 changing to 73. (See Chapter 2, Alternative 5 description; Hieronymus 2016).

About 46,000 stream miles and 213,000 acres of lakes and ponds are present on Tongass National Forest lands (Table 3.6-1). Of these, approximately 14,900 stream miles and 3,300 lakes and ponds are mapped as Class I water bodies (based on Tongass Geographic Information System [GIS] data); these water bodies are considered to be anadromous or high-value resident fish habitat. Another 9,500 stream miles and 1,000 lakes and ponds are mapped as resident fish habitat. Most of the Forest's streams and rivers empty into bays or estuaries, which are important during some life stages of anadromous species, as well as for many saltwater fish species. Marine invertebrates, such as clams and crabs, are commonly found in the estuaries and nearshore marine environment of Southeast Alaska. Some marine animals, including Dungeness crab (*Cancer magister*), butter clams (*Saxidomes giganteus*), and other benthic and epibenthic organisms primarily in nearshore or estuarine areas, may be affected by upland management activities, such as timber harvest, road construction, and related log transfer and storage facilities.

Table 3.6-1
Mapped Amount of Streams, Lakes and Ponds on the Tongass National Forest Lands

	Classification[1]					
Water Type	**Anadromous**	**Resident**	**Non-Fish (Class 3)**	**Non-Fish (Class 4)**	**No Designation**	**Total**
Stream Miles	14,873	9,478	21,691	1,619	375	48,036
Number of Lakes/Ponds	3,268	993	849	39	15,512	20,661
Acres of Lakes/Ponds	123,173	21,081	40,279	149	28,813	213,495

[1] Some small streams may not be included, mostly class 4, as their locations require ground surveys, which have not occurred in all areas.
Lake class determined by GIS stream layer in lake, so "no designation" lakes have no associated stream layer.
Values are only on National Forest System Lands.

Subsistence, commercial, and sport fisheries are all important to the way of life for Southeast Alaskan residents. Sport fishing is a favorite activity of residents and visitors. Hatcheries, and the enhancement of wild fish, among other aquaculture projects, contribute to resource availability and abundance. The primary fish species harvested in these fisheries are shown in Table 3.6-2.

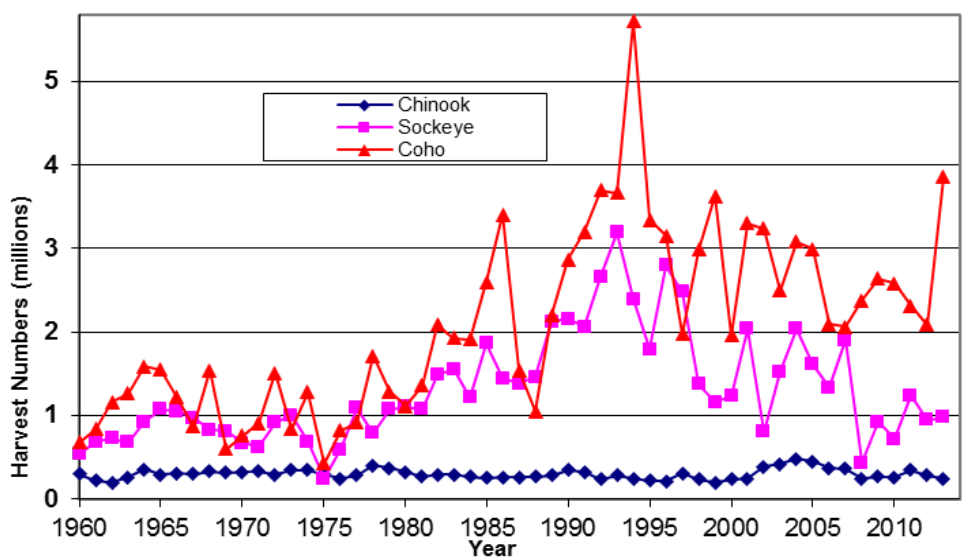
Table 3.6-2
Commonly Caught or Harvested Sport, Subsistence, and Commercial Fish

Species[1]	Sport	Subsistence	Commercial
Pink salmon (*Oncorhynchus gorbuscha*)	X	X	X
Chum salmon (*Oncorhynchus keta*)	X	X	X
Coho salmon (*Oncorhynchus kisutch*)	X	X	X
Sockeye salmon (*Oncorhynchus nerka*)	X	X	X
Chinook salmon (*Oncorhynchus tshawytscha*)	X	X	X
Cutthroat trout (*Oncorhynchus clarki*)	X	X	
Rainbow trout and steelhead (*Oncorhynchus mykiss*)	X	X	
Dolly Varden char (*Salvelinus malma*)	X	X	
Eulachon smelt (*Thaleichthys pacificus*)		X	

[1] Alternate names commonly used for the same species include pink or humpback; chum or dog; coho or silver; sockeye or red; Chinook or king; and eulachon, hooligan, or candlefish.

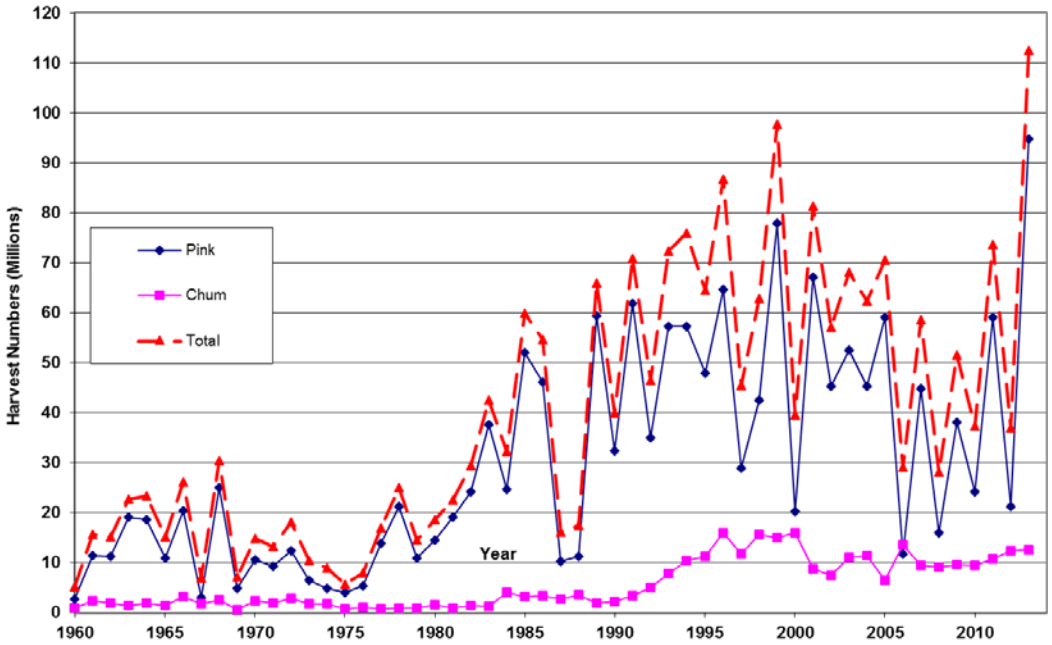
Commercial fish harvest in the waters of Southeast Alaska (includes Yakutat area harvest) can fluctuate widely from year to year. For example, salmon harvest in Southeast Alaska averaged approximately 50 million fish between 1935 and 1940. It then declined steadily to less than 20 million fish in 1950. From 1950 to 1975, harvests were generally low, falling below 6 million fish in 1975 (Figures 3.6-1 and 3.6-2). Since 1975, harvest has generally increased in Southeast Alaska. Peak annual harvests since Alaska statehood have all occurred since 1975. Record harvest occurred for each of the main species: Chinook (2004), sockeye (1993), coho (1994), pink (2013), and chum salmon (1996) (Conrad and Gray 2014a). Record harvest of total salmon occurred in 2013, when 112 million salmon were captured (Conrad and Gray 2014a). Overall, commercial salmon harvest since early to mid-1990s has generally been high but with large fluctuations in the last decade due to the relatively weak returns of pink salmon in even years. This species has averaged 76 percent of total commercial harvest since 1962 (Conrad and Gray 2014a) (Figures 3.6-1 and 3.6-2).

Figure 3.6-1
Commercial Harvest of Chinook, Sockeye and Coho Salmon in Southeast Alaska 1960–2013



Data Sources: Bachman et al. 2005; Conrad and Gray 2014a

Figure 3.6-2
Commercial Harvest of Pink, Chum, and Total Salmon in Southeast Alaska 1960-2013

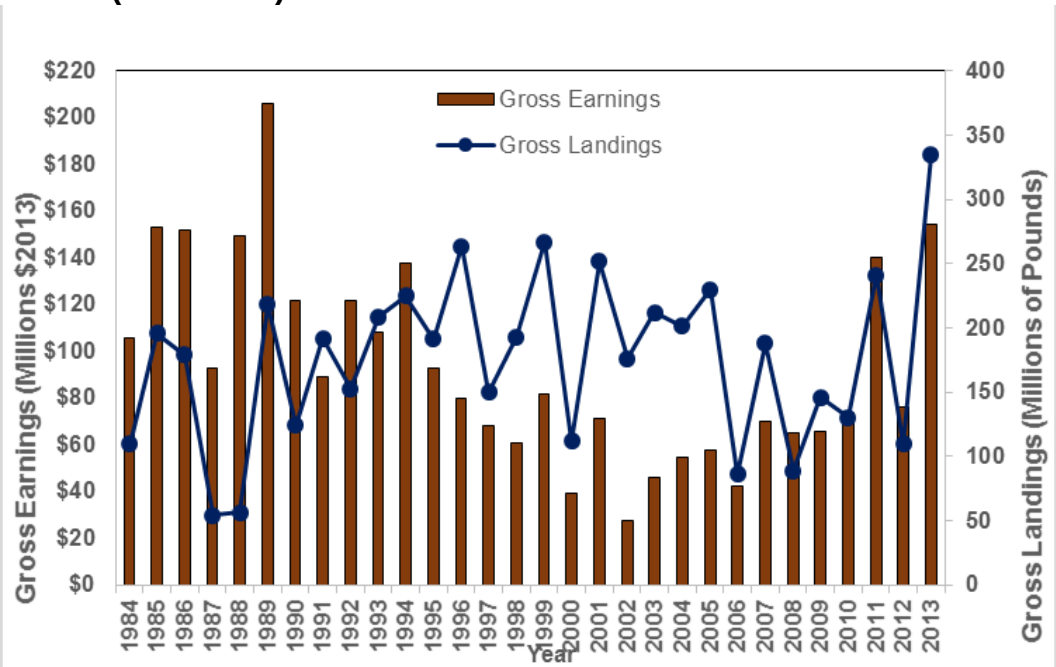


Data Sources: Bachman et al. 2005; Conrad and Gray 2014a

Based on the estimated portions of each species originating from the Tongass National Forest, about 80 percent of the total harvested fish began their life in streams and lakes within the Forest boundaries. Fluctuations in commercial harvest trends are partly attributable to changes in ocean productivity. The productivity of marine waters in the Gulf of Alaska, and the survival of salmon and steelhead trout, is both highly variable and cyclic. From the mid-1970s into the mid-1990s, favorable ocean currents have resulted in high productivity and, consequently, high marine survival of salmon (USDA Forest Service 1995). Survival, growth or production of varied southeast Alaska salmon stocks have correlated with changes in indexes of ocean conditions and have been more variable in recent years (Malick et al. 2009; Wertheimer et al. 2013; Beamish et al. 2009; Shaul et al. 2008 and 2011).

Based on the estimate of salmon produced from streams originating in the Tongass National Forest, estimated annual average commercial salmon harvest (1984 to 2013) was over 176 million pounds, with a wholesale value (ex-vessel value) over $93 million (adjusted to 2013 dollars) (Figure 3.6-3). The harvesting and processing of these salmon provided a substantial number of direct and indirect jobs in Southeast Alaska. In the most recent year reported, 2013, more than 335 million pounds of salmon were harvested worth more than $153 million in Southeast Alaska (Figure 3.6-3). The contribution of commercial fishing to the regional economy is discussed in more detail in the *Economic and Social Environment* section of this document.

Figure 3.6-3
Commercial Harvest and Wholesale (Ex-vessel) CPI Adjusted Value of Salmon Produced from the Tongass National Forest, Southeast Alaska (1984-2013)



Data Sources: Martin 2006; Bachman et al. 2005; Jacobson 2014

Hatchery production has also contributed substantially in overall fish production regionally. Hatchery production statewide has greatly increased since 1977 with releases of more than 1 billion fish occurring annually since 1988, peaking in 2012 with about 1.7 billion juvenile fish released statewide (Vercessi 2014). A substantial portion of hatchery production and harvest occurs in Southeast Alaska, with juvenile salmon releases equaling over one-third of total state release in 2013 (Vercessi 2014). Harvest of hatchery fish is a substantial portion of total salmon harvest in the Southeast Alaska region. Overall, an increasing period of hatchery-produced fish occurred from 1977 to about the mid-1990s. From 1994 through 2013, commercially harvested fish (including cost recovery harvest) in Southeast Alaska averaged about 22 percent of the total number of commercially harvested fish, or about 12 million fish annually (Alaska Department of Fish and Game [ADF&G] 2004; Vercessi 2014). Chum salmon have been the most intensively cultured salmon species in Southeast Alaska, averaging over 80 percent of all commercial harvest of this species from 1994 to 2013. Average hatchery fish harvest of other species was 30 percent or less over this same period.

State subsistence and personal use salmon fisheries averaged 50,000 fish from 2004 to 2013 for Southeast Alaska and Yakutat, down from an average of 61,000 fish in the 10 years prior (1994–2003). Sockeye salmon account for approximately 83 percent of the reported harvest for Southeast Alaska and Yakutat combined since 1994 (Conrad and Gray 2014b). Subsistence and/or personal use permits issued averaged 3,374 in Southeast Alaska and Yakutat combined from 2004 to 2013 and 3,931 in the 10 years prior to that (1994–2003). This includes Haines management area subsistence permits (Conrad and Gray 2014b).

In addition to the State managed subsistence and personal use salmon fisheries, federal subsistence fishing permits for salmon have been issued in Southeast Alaska and Yakutat since 2002. In 2004, a subsistence fishery for salmon on the Stikine River was established under terms of a separate federal subsistence permit. Federal harvest is typically far lower than harvests reported on state-issued permits, as federal jurisdiction does not include marine waters (Reeves 2016). Federal subsistence salmon fisheries averaged 2,511 fish from 2004 to 2013 for Southeast Alaska and Yakutat. Sockeye salmon account for approximately 64 percent of the reported federal harvest for Southeast Alaska and Yakutat combined since 2004. Federal subsistence permits issued averaged 299 in Southeast Alaska and Yakutat combined from 2004 to 2015 (Office of Subsistence Management 2016).

Approximately 85 percent of Southeast Alaska's sport fishing occurs in the vicinity of the Tongass National Forest. Sport fishing for salmon has been substantial over the last two decades (averaging over 400,000 fish per year) without distinctive trends in number harvested (ADF&G Sport Fish Survey data 1996-2013, at https://www.adfg.alaska.gov/sf/sportfishingsurvey/index.cfm?ADFG=region.home).

With more than 46,600 miles of streams and 212,000 acres of ponds and lakes (based on GIS measurements), the Forest provides abundant fish habitat. The habitat has been inventoried and classified, and estimates have been made of fish production. This section begins with a description of key habitat components, then presents a review of information on the effects of past harvest in Southeast Alaska on salmonid stocks, includes a description of how fish habitat is mapped and classified on the Tongass, and finishes with a summary of fish habitat enhancement and restoration.

Fish Habitat

Important Components of Fish Habitat

Stream Temperature and Dissolved Oxygen

Salmon and trout have optimum temperature ranges for rearing, spawning, and adult migration. Generally, salmonid require cool stream temperature to thrive in most stream conditions (Bjornn and Reiser 1991). While very cool water conditions can be a limiting factor to salmon and trout survival and production, warmer temperatures are most often the more limiting condition within most of the range of Pacific salmon. However, in much of Southeast Alaska, increased summer temperature is much less of a concern than for more southerly regions due to the normal cool climatic conditions (Murphy and Milner 1997). Heating of streams reduces the amount of dissolved oxygen in the water, which can be detrimental to salmonid production and survival. Past and potential effects of timber harvest on stream temperature are discussed in the *Water* section.

Situations where elevated temperature and low dissolved oxygen have been found to occur, and associated with fish die-offs, have been related mostly to the characteristics of stream morphology, hydrology, season, and number of fish present, not past timber harvest (Pentec 1991; Murphy 1985; Murphy and Milner 1997). Generally, small basins of low elevation, low stream flow, confined intertidal conditions, with high numbers of adult fish during warm weather periods were areas that occasionally had die-offs of adult salmon due to low oxygen (Murphy and Milner 1997).

Sediment

Sediment includes both the coarse (gravel, cobble, bolder, bedrock) and fine (sand, silt) substrate composition in the stream channel. The relative composition affects many factors in stream production, including spawning areas

and spawning success for salmon and trout, and benthic organism composition, which is an important food resource for fish. The amount of coarse sediment affects available spawning habitat and influences pool filling and bank stability (Spence et al. 1996). High levels of fines also affect pool filling, but also greatly influence survival of eggs and fry in spawning nests of salmon and trout (Chapman and McLeod 1987; Chapman 1988; Iwamoto et al. 1978; Gregory and Bisson 1997; McNeil 1964). Generally, the greater the portion of fines in spawning areas, the lower the survival of eggs and fry (McNeil 1964; Koski 1972; Chapman 1988). Increased fines in streams also reduce interstitial spaces in large substrate that are important habitat for many common cool water mountain stream aquatic insects. Effects that timber harvest may have on sediment levels in streams are provided in the *Water* section.

Large Woody Debris

Large woody debris (LWD) in stream channels includes entire trees, rootwads, and larger branches. LWD is an important component of good trout and salmon habitat, especially in heavily wooded regions (Swanson et al. 1976; Bisson et al. 1987; Naiman et al. 1992; Beechie and Sibley 1997; Spence et al. 1996; Murphy et al. 1986). LWD provides channel complexity, cover, and is especially important in the formation of pools (Bisson et al. 1987; Sullivan et al 1987; Benda et al. 2003). LWD has been found to form over 70 percent of all pools in a typical Alaskan valley bottom stream (Heifetz et al. 1986). The benefits of LWD in streams include critical sediment retention (Keller and Swanson 1979; Sedell et al. 1988), structural diversity (Ralph et al. 1994), gradient modification (Bilby 1979), nutrient production (Cummins 1974), and protective cover from predators. Its presence is often critical for overwinter habitat for various salmon and trout (Murphy and Milner 1997; Murphy et al. 1985; Koski et al.1984). Wood controls sediment movement downstream, minimizing the risk of debris flows in small headwater streams. In large streams, coarse sediment accumulated behind LWD often provides spawning gravels (Bilby and Bisson 1998; Montgomery et al. 2003). LWD has been found to increase spawning habitat and use for both coho salmon and steelhead (House and Boehne 1985). Newly entered LWD plays an important role in streams by providing inputs of leaf litter and needles and, as it ages, enhances nutrient dynamics.

Sources of LWD to streams include a variety of processes such as windthrow, stream bank erosion, natural tree mortality, and debris slides, deep-seated mass soil movement, and input from upstream areas (Swanson and Lienkaemper 1978; Benda et al. 2003). Small headwater streams can provide wood to larger channels downstream (Potts and Anderson 1990; Prichard et al. 1998; Coho and Burges 1991; Benda et al. 2003; Reeves et al. 2003).

Debris flows and dam-break floods during high flow occurrences can cause the transport of wood from upstream to downstream regions (Swanson and Lienkaemper 1978). Because of the large size of much of the wood that enters streams, its ability to float during this type of event is limited to larger third- to fifth-order streams (Swanson and Lienkaemper 1978). While much less frequent than high-flow events, large amounts of LWD can be added by debris torrents (Lamberti et al. 1991). The entry of LWD and coarse sediment at tributary junctions by debris torrents can form complex habitat, including pools and cover, and add spawning gravel to the main channel (Benda et al. 2003).

In streams of the Tongass, Murphy and Koski (1986) found that 40 percent of LWD in streams originated within 3 feet of the bank and 99 percent within 100 feet of the stream channel. Martin et al. (1998) found similar results estimating that 94 percent of LWD entered streams in unharvested Southeast Alaska areas originated within 98 feet of the stream channel. There may be exceptions to this

in certain streams. Reeves et al. (2003) found that about 65 percent of the LWD pieces in Oregon coastal streams originated in upslope areas, primarily from steep slopes intersecting stream channels. Reeves et al. (2003) noted that similar conditions were observed in California and Washington states. The width of the stream valley and the slope of intersecting tributaries were the main factors determining the portion of wood entering from side streams. Reeves et al. (2016) summarized information developed in Washington and Oregon Cascade and coastal forests that indicated 95 percent of wood in streams originated from 0.46 to 0.82 of site potential tree height. While there are some areas that have trees over 100 feet tall along Alaska streams, a buffer of 100 feet would, in nearly all cases, maintain complete LWD supply to these streams, especially the larger size pieces that are most critical to habitat development and maintenance.

The primary timber-related actions that may affect LWD supply to streams include buffer width along streams, stream class and channel characteristics that buffers are placed on, size of trees remaining in the buffer area, and effects on windthrow from adjacent harvest.

Murphy and Koski (1989) used a model to estimate that, for moderate-sized valley bottom streams in Southeast Alaska with no buffers, LWD would decrease to about 30 percent of pre-harvest levels in about 90 years. Some studies have documented reduced LWD in Alaska clearcut streams relative to old-growth stream channels over time (Heifetz et al. 1986; Johnson et al. 1986, Murphy et al. 1986; Murphy and Milner 1997; Tucker and Caouette 2008). In the short term, however, LWD may be higher in clearcut areas (Lisle 1986) and may persist at elevated levels in some areas for years (Gomi et al. 2001). Limited long-term monitoring has occurred on Southeast Alaska streams to document changes. However, it was found that Maybeso Creek had a decrease in number and size of LWD 30 years after harvest (Bryant 1980) with similar changes in Harris River (Bryant 1985, cited in Murphy and Milner 1997). Some Tongass forest-wide monitoring has found statistically significant lower LWD values in streams of past harvested areas relative to unharvested area streams (Tucker and Caouette 2008). However, most of these watersheds were intensively logged under conditions that had no buffer strips on streams; buffers were almost completely absent during timber harvest until the late 1980s. Buffer strips have greatly increased in frequency and size since then.

Ross (2013) also compared habitat factors in streams from past harvest practices (harvest to stream banks primarily 1980-1990) with streams in unharvested area in Southeast Alaska. While Ross did not examine differences in LWD composition between harvested and unharvested streams, he noted that remnant wood entering the stream prior to harvest was still common in the harvested reaches and, based on riparian conditions, future wood entering the streams would be smaller and less functional at forming habitat than is currently present. His assessment of stream habitat factors typically controlled by LWD in streams in Southeast Alaska found no significant differences in major pool characteristics (residual depth, pool area, pool density) between harvested and unharvested riparian stream reaches, but noted this was likely affected by the presence of remnant wood in harvested streams.

Buffer strip blowdown affects timing of LWD entry to streams. Several studies have shown that blowdown in buffers increases after harvest, primarily in the short term (Pentec 1996; Martin 1996). Effects were short term, however, with rate of blowdown decreasing over time and the effects on total LWD loading to streams slight. There has been some documentation of a large increase in rootwads in a stream due to blowdown, which was considered beneficial to fish habitat (Murphy and Milner 1997). Recent monitoring of newly harvest areas

(between 2000 and 2007) has found highly variable rates and amounts of windthrow adjacent to harvest units currently averaging about 7 percent (median 1 percent) of the trees in the monitored buffer areas, with decreasing rates of windthrow over time; however, effects on stream LWD supply were not assessed (USDA Forest Service 2014a). However, Martin and Grotefendt (2007) found that windthrow on non-National Forest System (NFS) lands with 20-meter buffers would, on average, reduce the long-term LWD supply in Southeast Alaska forest streams by about 5 percent relative to unharvested areas (an additional 5 percent would be lost due to harvest).

Thinning or partial cutting in older even-aged stands can greatly reduce windfirmness (Harris 1989). This vulnerability might be offset through light thinning treatments that begin early in the life of the stand. In addition to consideration of topographic variability and stand species composition factors, young-growth stands with high height-to-diameter ratios and/or low live crown ratios that are exposed to prevailing winds or local winds will be at higher risk of windthrow. This is especially true for those stands that have not been previously thinned and consist of trees that have adapted their crown ratios and roots to stand conditions of competition mortality. These stands are relatively unprepared for clearcut harvest edges and are vulnerable to windthrow. To aid in reducing the chance of loss of buffer due to windthrow, the Reasonable Assurance of Windfirmness (RAW) buffer documents by Landwehr (2007) and Harris (1989) are used to provide guidance when establishing these buffers during planning and final layout.

Food Sources

Food sources for stream fish can originate directly within the stream or enter from the adjacent terrestrial environment, upstream aquatic environment, or returning salmon. The main sources are from leaf and litter deposits from the adjacent riparian vegetation, algae growth and production on the stream bottom, and from returning salmon carcasses. This is ultimately the food base for smaller aquatic organisms (e.g., aquatic insects) that become food sources for stream fish. Detrital input is the main source from heavily shaded small- and medium-sized streams (Richardson 1992; Gregory et al. 1991). Larger streams in contrast derive much more of their food sources from algae production. Nutrient and organic input from returning salmon are also important but highly variable (Wipfli et al. 1998; Tiegs et al. 2009; Ruegg et al. 2011; Janetski et al. 2009). Past timber harvest has been found to influence the contribution of this nutrient input from returning salmon, with a greater watershed timber harvest rate corresponding to reduction in the quantity of salmon nutrient influence in Southeast Alaska river systems studied (Tiegs et al. 2008). The primary mechanism is likely a change in substrate size in harvested systems, which overall is still within that of unharvested systems (Tiegs et al. 2008). Small streams, many of which are not fish-bearing, also supply nutrients that contribute substantially to larger streams (Independent Multidisciplinary Science Team 1999). When riparian trees are removed, the primary source of food is initially shifted to algae production within the stream and is derived less from leaf and needle organic matter (Murphy and Milner 1997). Basin timber harvest may also contribute to increased dissolved plant nutrients downstream (Gravelle et al. 2009). Overall production along many streams with canopy removal in Southeast Alaska actually increased (those where light was limiting), while in some there was no change (Murphy and Milner 1997; Hernandez et al. 2005). When second-growth areas regrow, however, production may be reduced due to increased shade compared to shade produced by the original old growth. Small streams in Alaska have also been found to substantially contribute food for fish to larger streams through downstream transport of terrestrial and aquatic prey

directly and detritus resources indirectly for fish (Wipfli 1997, Wipfli and Gregovich 2002, Piccolo and Wipfli 2002, Wipfli et al. 2007). The type of riparian forest along these small streams affects both the amount and type of resources passed downstream. In some cases, the regrowth of alder trees along streams following harvest has resulted in higher amount of resources both locally and to downstream fish streams (Piccolo and Wipfli 2002, Hernandez et al. 2005). While changes to riparian vegetation on fishless streams will alter the composition of the food sources transported downstream, the overall effect on downstream fish streams over the long term is not clear, as actions near these small stream may have additional effects (e.g. sedimentation) on stream production (Wipfli and Gregovich 2002).

Habitat Access and Passage

Fish passage and access to suitable habitat in streams and lakes is critical to fish stocks. Natural falls and barriers in systems have been found in some areas to prevent the use of suitable fish habitat especially for anadromous stocks in some natural systems. Man-made barriers in the form of dams, diversion, and road crossing structures have been common partial or complete barriers to fish movement in much of the developed areas where fish are present. Road crossings (e.g., culverts) over much of the range of salmonids in the Pacific Northwest have often reduced or eliminated access to substantial portions of habitat to migratory fish use.

Effects of Past Forest Management Practices on Salmonid Fish Stocks

Past timber harvest practices and related actions in many regions of native Pacific salmon distribution range have been associated with declines of fish stocks (Everest and Reeves 2007). Reductions in salmon stocks have not been observed in Alaska (Bryant and Everest 1998). This may be partly because other human-induced disturbances (e.g., agriculture, dams, urban development), which are common in other regions, are rare in Southeast Alaska. As noted above, older forest practices (mostly prior to 1980) in the Tongass National Forest have had documented adverse effects to anadromous fish habitat conditions, including spawning habitat, rearing habitat, and migration conditions (Murphy and Milner 1997). Harvest during this timeframe accounts for about 60 percent of all timber harvest on the Tongass National Forest. In one study of multiple streams in Southeast Alaska, numbers of summer fry coho salmon increased in clearcut areas, but fall and winter stages of juvenile coho had reduced numbers similar to old-growth systems (Murphy et al. 1986). In another study, increased summer abundance of coho salmon juveniles in clearcut areas had reduced the number of outmigrating coho salmon smolts relative to old-growth areas (Thedinga et al. 1989). Similarly, juvenile steelhead abundance, while high in unbuffered clearcut streams in the summer, became very low in the winter as these fish moved to buffered and old-growth habitats where cover was higher (Johnson et al. 1986). One study of a historically heavily harvested Tongass watershed (Staney Creek), showed with modeling, that improving watershed and stream conditions to pre-harvest status would more than double current average coho salmon production (Stillwater Science 2012).

However, studies addressing potential long-term effects of timber harvest and related actions on actual numbers of fish produced are rare within the range of Pacific salmon, including Alaska (Bryant and Wright unpublished manuscript). Bryant and Wright (unpublished manuscript) compiled and analyzed the data from multiple juvenile fish studies in 26 streams in Southeast Alaska in an attempt to determine what long-term effects past harvest management actions have had on fish production by comparing fish abundance in managed and old-growth watershed streams. The managed watershed all had timber harvest

activity prior to 1980, which generally included clearcutting of riparian trees. Partly because most studies examined were not specifically designed to address long-term effects, overall results of this analysis were limited. They examined population densities of juvenile fish from studies conducted from 1978 to 2000, including data on coho salmon, Dolly Varden char, steelhead, and cutthroat trout. Even with the variability of data, they found statistically significant differences between the managed and old-growth watersheds. Coho salmon and Dolly Varden densities were significantly lower in harvested areas, while steelhead density was greater in harvested areas. Where long-term trends were significant, they were downward in harvested areas. There were many differences in overall production among regions, differences between seasons, and morphological differences among streams that contributed to much overlap in abundance between treatment groups and the lack of clear results. Overall, this study suggests some negative effects on some populations from older harvest practices (prior to 1980). New forest practices in the Tongass National Forest are intended to prevent the habitat degradation in riparian areas and headwater streams that have contributed to these adverse effects on populations (Bryant and Wright unpublished manuscript).

Monitoring of resident stream fish populations (Dolly Varden and cutthroat trout) was performed beginning in 1999, based on specific sampling designs intended to assess effects of recent timber harvest practices under forest management standards and guidelines for fish habitat as outlined in the Tongass Land and Resource Management Plan (Forest Plan) (USDA Forest Service 2014a). However, after 11 years of data collection (1999-2009), an insufficient number of the monitored streams had timber harvest treatments completed to meet the criteria of the sample design. The result was that monitoring plan changes were needed in design and protocol to represent the range and degree of management prescriptions across the Tongass. These new designs and sampling have been implemented but statistical results of past monitoring and the new design results are not yet available. Thus, determinations cannot yet be made about effects of management practices on resident fish populations (USDA Forest Service 2014a).

As shown earlier (Figures 3.6-1 and 3.6-2), overall trends in Southeast Alaska commercial harvests from 1960 to 2013, including coho, pink, chum, and sockeye salmon, do not indicate specific downward trends in these populations, or specific trends that could be correlated with amounts of timber harvest activity. In addition, wild coho salmon abundance estimates, excluding hatchery coho salmon, have remained fairly constant over the time (1997–2013), and Southeast Alaska stocks are considered in excellent condition (USDA Forest Service 2014a) which may suggest limited affects to these fish from any land based activities. While many factors outside of forest management practices in Southeast Alaska (e.g., ocean conditions, weather, hatchery releases, harvest management, watershed conditions in other areas) influence these numbers, no obvious effects can be discerned from harvest or escapement data. However, the effects of these moderating factors may be too great to permit harvest data to demonstrate any effects on fish populations resulting from timber harvest in specific Southeast Alaska watersheds, particularly if they are relatively small (Bryant and Wright unpublished manuscript; Bryant and Everest 1998).

Stream Classification on the Tongass

Fish habitat on the Tongass is classified, for management purposes, using two classification systems (see the *Water* section of this chapter). The first is stream class, which relates primarily to presence or absence of fish, type of fish, and water quality. The second category is stream process group, which

characterizes streams based on channel and drainage basin morphological conditions.

Stream Class Inventory
Streams are categorized by stream class, a classification system designed to categorize stream channels based on their fish production values. The value classes do not imply either ecological importance or prioritization of fish harvest over maintenance of watershed function. Class I streams are anadromous and high-value resident fish streams or habitat upstream of fish migration barriers known to provide reasonable enhancement opportunities for anadromous fish, Class II streams are other resident fish streams, Class III streams have no fish populations or fish habitat but have immediate influence on downstream water quality and fish habitat capability, and Class IV streams are small streams that do not directly influence downstream water quality or fish habitat capability. Refer to the *Water* section for more detailed descriptions (also see the *Glossary* in the Forest Plan volume for more complete definitions.)

Channel Type Inventory
Perennial and many intermittent streams on the Forest have been inventoried for channel type. The channel types provide a system to estimate the amount and quality of fish habitat, and can be used to predict their physical response and sensitivity to different management activities. Channel types have been categorized into distinct groups, called "stream process groups." Process groups describe the interrelationship between watershed runoff, landform relief, geology, and glacial or tidal influences on fluvial erosion or depositional processes. They are described in Channel Type User Guide Tongass National Forest Southeast Alaska (Paustian et al. 1992, as amended in 2010). Process groups, in conjunction with stream class, are used for assigning the Riparian Standards and Guidelines. The estimated miles of stream by process group and class within the Tongass National Forest are shown in Table 3.4-1 in the *Water* section of this chapter.

Fish Habitat Enhancement and Restoration

Fisheries Habitat Enhancement
Much emphasis has been placed on the enhancement of fish habitat on the Tongass National Forest. From 1980 to 1995, the Forest Service implemented 148 fisheries habitat enhancement projects on the Tongass (USDA Forest Service 1997a, Appendix H). In more recent years, enhancement projects have continued with 53 total project completed between 1996 and 2014 (Table 3.6-3). Future known planned or evaluated projects include similar project types and are noted as part of the Tongass Integrated Plan on the Tongass National Forest web site (http://www.fs.usda.gov/detail/tongass/landmanagement/?cid=stelprd3812864 [Accessed September 2015]).

Table 3.6-3
Tongass National Forest Fish Habitat Enhancement and Restoration Projects Completed During 1996-2014

Activity	Number of Projects
Fishways	7
Falls Modification	9
Spawning Channels	1
Debris Removal Sites	0
Lake/Stream Fertilization	5
Lake Stocking	7
Stream Stocking	8

Table 3.6-3 (continued)
Tongass National Forest Fish Habitat Enhancement and Restoration Projects Completed During 1996-2014

Activity	Number of Projects
Rearing Ponds	16
Incubation Boxes	0
Total Enhancement Activities	**53**
Restoration Activity	
In-stream Large Wood Debris Management	70
Culvert Replacement and Removal [1]	513
Total Restoration Activities	**583**

[1] Number of culverts since 1998.

Many of the fish habitat enhancement projects implemented on the Tongass National Forest are cooperative projects involving multiple agencies and organizations, including the Forest Service, ADF&G, Regional Aquaculture Associations, timber companies, and other non-profit hatcheries. Types and numbers of enhancement projects prior to 1996 are presented in Appendix H of the 1997 Forest Plan Environmental Impact Statement (EIS). Similar project types have been developed since than as shown in Table 3.6-3.

The anticipated salmon production from fish habitat enhancement projects on the Tongass National Forest is calculated based on site-specific habitat conditions and an analysis of limiting factors for salmon production. The test for these habitat production estimates consists of monitoring conducted on individual projects and the subsequent feedback of the monitoring results into the project planning process.

The 1997 Tongass Land Management Plan Revision Final Environmental Impact Statement (FEIS) identified 158 potential projects for initiation during the first 10 years of implementation of the Forest Plan (USDA Forest Service 1997a). The plan was part of the Forest Service implementation of the Alaska National Interest Lands Conservation Act (ANILCA) process in forest planning and has not been modified since its initial development. The extent of implementation of these projects has been varied across the Forest. The public continues to expect the maintenance or improvement of fish habitat values. Public interest for subsistence, commercial, and sport-harvested fish remains high.

Demand for subsistence fish is discussed in the *Subsistence* section of this chapter, while commercial and sport fish demand is reviewed in this section. Commercial fish demand is calculated based on goals set by Regional Salmon Planning Teams for annual fish production for several species. Some of the “year 2000” harvest goals, were set in 1981 in the Comprehensive Salmon Plan for Southeast Alaska, Phase I (Joint Southeast Alaska Planning Team 1981). The updated Comprehensive Salmon Enhancement Plan for Southeast Alaska: Phase III (ADF&G 2004) did not specifically carry these harvest objectives forward. Comparison of annual harvest numbers to these original harvest objectives did, however, supply a metric to evaluate how recent harvest compares to these values. Annual commercial harvest usually achieved these harvest objectives for pink salmon (70 percent), but infrequently for coho salmon (44 percent), and sockeye salmon (17 percent), and chum salmon (26 percent) for the period of 1991 through 2013 (ADF&G 2004; Vercessi 2014; other ADF&G annual reports). Harvest has been highly variable during this period. Tongass rivers, lakes, and streams produce 80 percent of the commercial salmon annually harvested from Southeast Alaska, which is about 49 million salmon per year (USDA Forest Service 2015d).

Given the abundant fish resources in the fresh and marine waters of Southeast Alaska, there has been considerable sport fishing effort in this area, as indicated by both license sales and overall fishing effort. Alaska sport fishing licenses sold have exceeded 400,000 since 1994 (Jennings et al. 2011a). The number of anglers in Southeast Alaska has had an increasing trend from about 60,000 in 1984 to about 110,000 in 1994. Numbers remained fairly stable from 1994 through 2003 at 105,000 to 115,000, followed by a sharp increase to about 130,000 from 2004 to 2008, before falling back to about 110,000 in 2009–2010 (Mills 1991; Howe et al. 1995; Walker et al. 2003; Jennings et al. 2011a; Jennings et al. 2011b). However, the number of Southeast Alaska resident anglers has had a slight declining trend from a high of about 37,000 in 1991 to 28,000 in 2010, mostly ranging from 28,000 to 32,000 per year from 2001 to 2010. In contrast, non-resident licenses in Southeast Alaska have been on an increasing trend from 1991 numbers (about 59,000) to a high of about 100,000 for 2004-2008, with a sharp decline again in 2009–2010, possibly related to the national economic downturn (Mills 1991; Howe et al. 1995; Walker et al. 2003; Jennings et al. 2011a; Jennings et al. 2011b).

The sport fishing effort in Southeast Alaska from 1996 through 2014 followed somewhat similar trends where data are comparable to that of license sales. Effort was lowest during the 1996–1998 period ranging from about 370,000 to 440,000 angler days (ADF&G 2016). Effort increased in 1999 and remained fairly constant through 2009, ranging from 469,000 to 568,000 angler days, peaking in 2005 when license sales were also high. Effort decreased in 2010, similar to license sales, but has been on an increasing trend through 2014 ranging from 444,000 to 564,000 angler days.

Fish Habitat Restoration

Along with enhancement, substantial effort and funding have been directed at restoring or supplying access to habitat that was affected by past timber harvest practices. This effort has included in-stream and road-related activities. The restoration efforts have included primarily in-stream and stream bank restoration based primarily on LWD addition and replacement or removal of road-stream crossing structures, primarily culverts that failed to meet current juvenile fish passage design criteria. From 1980 to 1995, the Forest Service implemented 28 fisheries habitat restoration projects on the Tongass (USDA Forest Service 1997a, Appendix H). In more recent years, restoration projects have continued with 70 LWD projects and 266 fish culvert replacements or removals completed between 1996 and 2014 (Table 3.6-3). Like enhancement projects, these may be cooperative projects involving multiple organizations.

Restoration actions have been partly based on watershed condition ratings, use, and aquatic value criteria (see the *Water* section for more on watershed condition). This led to designation of Priority Watersheds for restoration focus. The Forest Supervisor formally established seven Priority Watersheds (Harris River, Twelvemile Creek, Staney Creek, Luck/Eagle Creek, Saginaw Creek, Sitkoh River, and Sitkoh Creek) in 2011. Watershed improvement activities include a variety of actions that were primarily direct stream habitat restoration (e.g., LWD placement), riparian vegetation improvement, upland vegetation improvement, road storage and decommissioning, and improved road drainage structures to reduce sediment entry to streams and improve fish passage. A variety of these actions have occurred and continue in the Priority Watersheds noted above. Watershed condition has since been restored and is considered “functioning properly” in the Harris River and Twelvemile Creek watersheds on Prince of Wales Island and Sitkoh River and Sitkoh Creek watersheds on Chichagof Island. Restoration also continues in the other Priority Watersheds. Another Priority Watershed (Iris Meadows/Shelikof Creek on Kruzof Island) was

added to the list in 2014. Other watersheds are slated for improvement actions as funding becomes available.

Large Wood Debris Management including In-Stream and Streambank Restoration

LWD structures are sometimes constructed in stream channels and on floodplains to stabilize spawning gravels, form and maintain pools, provide cover and temperature regulation, produce aquatic insects, and capture plant litter, all of which are important to the various life stages of wild salmon and other fish and organisms. Although individual structures can be low in cost, costs vary depending on construction technique utilized, channel size, and site access. Larger stream channels need to utilize excavators and/or helicopter for wood placement and construction, while smaller streams might utilize hand crews to place wood.

Culvert Replacements/Removals at Road-Stream Crossings

Providing for fish passage at stream and road intersections to ensure fish migration is an important consideration when constructing, reconstructing, or storing forest roads. Improperly located, installed, or maintained stream crossing structures can restrict these migrations, thereby adversely affecting fish populations. These structures can present a variety of potential obstacles to fish migration. The most common obstacles are excessive vertical barriers, debris blockages, and extreme water velocities that can inhibit fish passage, especially for smaller or juvenile fish. Fish passage standards and guidelines including drainage structure design criteria have evolved over time, and are still evolving as information on fish swimming performance, fish movement patterns, and culvert hydraulics is improved.

Culvert replacement and repair has been an ongoing activity to improve access for anadromous and resident fish that were cut off from full access by the culvert designs that did not meet current juvenile fish passage design criteria. A survey of most of the approximately 5,000 miles of Forest Service roads (4,055 miles permanent and 953 miles of temporary roads) found about 3,700 fish stream crossings (Jacobson 2016; USDA Forest Service 2014a). About 90 percent of all fish stream road crossings (about 55 percent of the crossings are culverts) have been assessed as to their suitability to ensure juvenile fish passage. About 1,100 of the assessed crossings, or 35 percent of all crossings (mostly culverts), did not meet current juvenile fish passage standards (Jacobson 2015). Of those not meeting standards, more than 83 percent were on Class II streams. Habitat upstream of the crossings with passage problems was estimated to equal about 0.5 percent and 2.0 percent of all Class I and Class II stream miles on the Tongass National Forest, respectively. However, the amount of habitat actually prevented from use by resident and anadromous fish by structures (e.g., culverts) is likely much less than these estimates. For example, about 66 and 72 percent of the habitat reaches upstream of culverts, estimated to be passage barriers for anadromous and resident fish, respectively, have resident or anadromous fish present (Alaska Forest Association undated). Additionally, the criteria used to indicate a passage structure is a blockage is conservative, meaning during many flow conditions various life stages of fish would be able to pass many of these structures, which is confirmed by fish presence upstream of many of these structures. Considering these factors, the overall habitat area completely restricted to fish access from road crossing structures is slight.

Nevertheless, even though the habitat area may be small, averaging about one-quarter mile of fish habitat upstream of each crossing, the effect on an individual stock may be important. Most of these culverts were installed prior to implementation of the 1997 Forest Plan standards and guidelines for culvert

installation. Since 1998, about 513 crossing structures (mostly culverts) have been removed, replaced, or retrofitted. About half of the recently installed culverts have been monitored for suitability of meeting fish passage criteria. About 95 percent of these meet present criteria (USDA Forest Service 2014a). Many of those not meeting passage criteria were installed on streams not considered, at the time of installation, as being fish streams. Culvert replacement, removal, or retrofitting is an active, ongoing process.

From 1998 through 2014, about $18.5 million (2015 dollars) has been spent on stream crossing remediation, about $11.1 million just on culvert replacement (Jacobson personal communication 2015). This has included repair or removal of about 513 structures (mostly culverts) to improve known fish passage issues. The removal and repair rate of known or potential fish passage barrier structures has been fairly consistent over this period, averaging about 31 structures a year.

Special Status and Invasive Species

Fish Management Indicator Species

National Forest Management Act (NFMA) regulations direct the use of Management Indicator Species (MIS) in forest planning to help display the effects of forest management. MIS are species whose population changes are believed to indicate the effects of land management activities. For the 1997 Forest Plan, pink salmon, coho salmon, Dolly Varden char, and cutthroat trout were selected as MIS. Pink salmon were selected to represent anadromous fish that are limited in their freshwater life period by spawning gravel quality and quantity; coho salmon to represent anadromous fish that are generally limited in their freshwater life period by stream and lake rearing area; Dolly Varden char because of their ubiquitous distribution in freshwater habitats; and cutthroat trout because of their dependency on small freshwater stream systems, which are most susceptible to effects from management activities. These MIS, and their habitats, are described in the 1997 Forest Plan Revision FEIS (USDA Forest Service 1997a).

A series of workshops were held in 2011 with representatives from ADF&G, National Marine Fisheries Service (NMFS), U.S. Fish and Wildlife Service (USFWS), and the Forest Service to evaluate the current Tongass MIS and develop a set of proposed MIS that would more effectively serve the needs of the Tongass concerning indicators of land management practice effects. After following a structured process used to revise MIS lists elsewhere on NFS lands (Hayward et al. 2004), the group recommended retaining coho salmon, Dolly Varden char, and cutthroat trout on the current aquatics species MIS list, and dropping pink salmon (Hayward and Jacobson 2011).

Threatened and Endangered Fish Species

Federally listed threatened and endangered species are those plant and animal species formally listed by the USFWS or NMFS, under authority of the Endangered Species Act (ESA) of 1973, as amended. An endangered species is defined as one that is in danger of extinction throughout all or a significant portion of its range. A threatened species is defined as one that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

No federally listed fish species or stocks originate from Alaska streams. However, some federally listed fish stocks may occur in marine waters within the boundary of the Tongass National Forest (NMFS 2015a). These fish include the following:

Endangered species:

- Snake River sockeye salmon
- Upper Columbia River spring-run Chinook salmon

Threatened species:

- Upper Columbia River steelhead
- Snake River spring/summer Chinook salmon
- Snake River fall Chinook salmon
- Puget Sound Chinook salmon
- Lower Columbia River Chinook salmon
- Upper Willamette River Chinook salmon
- Hood Canal summer chum salmon
- Lower Columbia River coho salmon
- Snake River Basin steelhead
- Lower Columbia River steelhead
- Upper Willamette River steelhead
- Middle Columbia River steelhead
- Green Sturgeon – Southern DPS

These listed stocks of salmon and steelhead do not spawn in Alaska, but are known to seasonally inhabit marine waters on the outside coast to the west and occasionally in inside waters of the Tongass National Forest (McNeil and Himsworth 1980; Trudel et al. 2004; Trudel et al. 2009; Burgner 1991; Haggerty 2009; Groot and Margolis 1991; Tucker et al. 2011). They may feed on fish that are dependent on coastal marine waters of the Tongass National Forest at some stages of their lives. The southern distinct population segment (DPS) of the green sturgeon is an anadromous species that spawns in the Sacramento River in California (NMFS 2015b). Green sturgeon also do not rear or spawn in freshwaters of Southeast Alaska but have been rarely found to be present in marine waters of Southeast Alaska and may feed on benthic organisms found in these waters, likely in waters less than 100 meters deep (Lindley et al. 2008; Huff 2012; Colway and Stevenson 2007). One tagged green sturgeon was detected at an acoustic array in the Cape Spencer area (Lindley et al. 2008). Several specimens have been collected in the Taku River/Stephens Passage area of Southeast Alaska (Mecklenburg et al. 2002). Green sturgeon could be present in the inside waters of Southeast Alaska, particularly during the winter.

Pursuant to Section 7 of the ESA, a Biological Assessment (BA) was prepared to assess the effects of the 1997 Forest Plan revision on the endangered Snake River sockeye salmon and the threatened Snake River spring/summer Chinook salmon and Snake River fall Chinook salmon, and submitted to NMFS for review and concurrence in the Tongass Forest Plan process (Appendix J of the 1997 Tongass Forest Plan Revision EIS). This assessment was updated to address the listed fish species relative to the alternatives considered in the Forest Plan amendment of 2008 (see Appendix F of the 2008 Forest Plan Amendment).

BAs evaluating the effects of the selected alternative of this Forest Plan amendment on listed species have been prepared (one containing fish and wildlife species to NMFS and another containing one wildlife species to USFWS) and are included in the planning record. In accordance with Forest Service Manual 2670, a Biological Evaluation (BE) covering federally listed threatened and endangered and Region 10 sensitive species (no sensitive fish species) was also prepared (Krosse 2016); this BE contains an evaluation and comparison of all alternatives and is also in the planning record.

Essential Fish Habitat

The *Magnuson–Stevens Fishery Conservation and Management Act* mandates that agencies initiate consultation with NMFS for any activities that could affect essential fish habitat (EFH). EFH has been broadly defined by Congress for federally managed species to be "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity."

NMFS (2005) clarified what the specific definition is for EFH in Alaskan waters. EFH is the general distribution of a species described by life stage. It is generally the habitat area that includes 95 percent of that life stage, where it is known, to occur. Where distribution data is unknown, surrogate species may be assumed. Maps were presented in NMFS (2005) defining EFH for species and life stages; other than for salmon species, little EFH is present in the inside waters of Southeast Alaska. Those groundfish species that are present include some sole species life stages only. Several other species, however, have some life stages located in the marine waters offshore of Southeast Alaska and some enter outer nearshore waters. In general, EFH for marine groundfish species (e.g., rockfish, sablefish, sole, plaice, cod, pollock), are extremely limited near Tongass waters. EFH information underwent a thorough review in 2010 in the 5-Year EFH Review (NMFS 2011). EFH amendments were made to five of six federal fishery management plans. The 2010 modifications are modest and slightly refined EFH, better aligning the Habitat Areas of Particular Concern process schedule, and included updated research priorities.

Salmon EFH covers freshwater, estuarine, and marine waters from the high tide level to 200 meters deep and out to the 200 nautical mile U.S. exclusion zone, depending on life stage. The freshwater EFH is defined primarily by what is present in the ADF&G's Catalogue of Waters Important for Spawning, Rearing, or Migrations of Anadromous Fishes (Johnson and Litchfield 2015). Freshwater EFH for salmon in the Tongass would include all streams, lakes, ponds, and wetlands currently or historically accessible to salmon. The shallow marine waters adjacent to forest lands are considered EFH for salmon, but little of this area is EFH for most groundfish species.

Sensitive Fish Species

Sensitive species are those plant and animal species identified by the Regional Forester for which population viability is a concern on NFS lands within the region. The goal of the Forest Service Sensitive Species Program (Forest Service Manual 2670) is to ensure that species numbers and population distribution are adequate so that no federal listing will be required and no extirpation will occur on NFS lands.

The Alaska Region Sensitive Species List was updated in 2009 (USDA Forest Service 2009b). There currently are no fish species designated as sensitive species in the Alaska Region.

Invasive Aquatic Species

Species are considered invasive if they are not native to an ecosystem, and if they are likely to cause harm to human health, the economy, or the environment (Executive Order 13112). Due to its remote landscape, northern climate, small human population, and few concentrated disturbed habitat areas, Alaska has relatively few invasive species compared to the rest of the United States. However, as of 2008, Alaska has 116 non-native species according to ADF&G's Alaska Aquatic Nuisance Species Management Plan (Fay 2002; Alaska Invasive Species Working Group 2010). However, factors such as altered disturbance patterns, constant flow of marine-based shipping and cruise ships, fishing and recreational boating traffic, and climate change may increase the prevalence of invasive aquatic species. The most significant vectors for transport of invasive species in Alaska marine waters include oil and liquid natural gas tanker traffic, military vessels, oil and gas drilling rigs, cruise ships and other commercial recreational barges and vessels (Alaska Invasive Species Working Group 2010). Global climate change may create conditions suitable for new invasives, as well as range expansions, by altering geographic range limits and making habitats no longer as suitable for existing native species.

Invasive aquatic species can affect native species by eating them, competing with them, hybridizing with them, disrupting or destroying their habitat, or introducing pathogens or parasites that sicken or kill them (Schrader and Hennon 2005). In addition to natural range extension, several potential pathways exist for introduction of invasive aquatic species. These pathways included fish farms, international and local movement of bait and game fish, trade in live seafood, aquaculture, and contaminated sport angle gear brought into Alaska, as well as ballast discharge from international vessels (Fay 2002; Schrader and Hennon 2005). Several aquatic species have been noted as potential threats to Alaska, including fish (northern pike, Atlantic salmon, yellow perch, ornamental aquarium fish), invertebrates (green crab, New Zealand mudsnail, Chinese mitten crab, zebra mussel, signal crayfish, spiny water flea), plant (cordgrass and Elodea), and several additional miscellaneous taxa (Fay 2002; Schrader and Hennon 2005). Additionally, eastern brook trout (non-native) and non-endemic rainbow trout have been stocked in many areas where they were not native and compete or hybridize with native trout (Schrader and Hennon 2005). Of these fish, transplanted northern pike and Atlantic salmon are the two fish species of greatest concern (Fay 2002).

Even though the invertebrates Chinese mitten crab, green crab, and New Zealand mudsnail have not been found in Alaska, they are of major concern because of their potential to do serious damage to the Alaskan ecosystems (Hines et al. 2004; Schrader and Hennon 2005). The green crab, while not in Alaskan marine waters, has been reported to be in British Columbia coastal waters (ADF&G 2015a). Atlantic salmon that have escaped from fish farms off British Columbia and Washington State pose a threat to native salmon by competing for habitat and introducing diseases and parasites. This species has been observed in Southeast Alaska marine waters and, rarely, in streams (Fay 2002). Also, northern pike, which has not appeared in Southeast Alaska (with the exception of a native stock in Yakutat), have caused widespread damage to resident trout where they have been introduced, and could potentially affect coho salmon through predation. Northern pike have the potential to cause serious environmental and economic damage to highly productive salmon streams in Southeast Alaska (Fay 2002). In the Tongass, there is a risk that these and possibly other non-native sport fish may be introduced into lakes and rivers by individuals seeking to increase sport fishing opportunities. As the road network is extended into more areas and have more of Southeast Alaska and have greater

use, this risk increases. Refer to the ADF&G Aquatic Nuisance Species Management Plan (Fay 2002) for additional details.

Renewable Energy Projects

Hydroelectric projects are the major non-diesel energy development project in Southeast Alaska and are an abundant renewable energy resource for the region. There are about 22 hydropower faculties currently in operation. Powerlines are associated with all of these projects. Currently, no other renewable facilities are in operation but some are planned. The deployment and operations of these and their infrastructure have the potential to affect fish resources including potential fish blockage, flow modification, sediment input and loss of stream side vegetation. The details of current facilities are provided in the *Renewable Energy* section.

Environmental Consequences

Direct and Indirect Effects

The current standards and guidelines in the 2008 Forest Plan were developed substantially through work that was done initially by the Anadromous Fisheries Habitat Assessment (AFHA) (USDA Forest Service 1995). Follow-up work in the Tongass after 1995 and other studies have contributed to modifications of these standards and guidelines both in the 1997 and 2008 Forest Plans. Monitoring in the Tongass has helped confirm that the actions taken under the standards and guidelines have protected fisheries resources in the Tongass. The currently considered actions will consider the information history of the implementation and evaluation of the Plans direction as well as how considered modification of the current plan considered under some alternatives may affect fish resources.

Fish Habitat

Roads

Roads pose the greatest risk to fish resources on the Tongass (Dunlap 1996), partly because they pose the largest risk of management-caused sediment input to streams (Reid and Dunne 1984; Furniss et al. 1991; Gomi et al. 2005; Hassan et al. 2005). Road construction, road drainage, level of road use, number of road stream crossings, watershed road density and related actions in forested areas may all influence the amount of sediment to streams (Gomi et al. 2005; Furniss et al. 1991; Swanson et al. 1987; Chamberlin et al. 1991; Reid and Dunne 1984).

As discussed in the *Water* section, road effects to aquatic systems and fish are likely to vary among the alternatives. Factors that vary among alternative that would increase risk or harm to fish include:

- Miles of new and reconstructed roads
- Roads on steep or unstable slopes
- Road density
- Roads in beach fringe
- Roads in riparian areas
- Number of streams crossed by roads
- Number of fish streams crossed by roads

Generally, the higher the number for each of the road parameters noted above, the greater the risk to fish resources. While standards and guidelines are in

place to help moderate these effects, some adverse effects, or increase in risk of adverse effects, would occur with these road parameters.

Other than number of road crossing of streams, which is discussed below, the effect of each alternative relative to these parameters is presented in the *Water* section and is summarized relative to fish resources in the Alternative Summary section below.

Fish Passage

Roads may also increase risk to fish movement due to improper construction affecting fish passage (Gibson et al. 2005) and blocked culverts. Stream-rearing fish, particularly cutthroat trout and Dolly Varden, which occupy the smaller headwater streams during some parts of their lives, are at the greatest risk. Juveniles of stream-rearing fish are often highly mobile during their freshwater stage, moving seasonally between stream reaches.

The number of road crossings of streams increases the risk of both adding sediment to streams and impeding fish passage (Class I and II streams). While BMPs for constructing culverts and bridges reduce the risks for sediment and turbidity, monitoring of some streams has found occasional increases in turbidity, at least in the short term, as described in the Forest Service Tongass Monitoring Reports (USDA Forest Service 2004a). Also, fish passage guidelines (Forest Service Handbook 2090.21 Aquatic Habitat Management Handbook [USDA Forest Service 2001]) for culvert design greatly reduces the risk of new culvert installation impeding fish passage on Class I and II streams, but some risks remain.

Reconstruction of existing road crossings also carries risk relating to increased sediment to streams but less than for new construction because in many cases much of the stream disturbance (e.g., new bank disturbance, tree removal) has already occurred. Sediment from reconstructed roads near stream crossings would be less than from new roads as some of the sources of sediment have already had initial erosion (e.g., cut and fill areas), having lost some of the more mobile sediment and becoming more armored and revegetated, which helps stabilize potential erosion areas (Baird et al. 2012). Additionally, the highest erosion rates from roads typically occurs in the first 2 years after construction. While reconstruction would disturb some of the area, it would be less than would occur from developing an entirely new road (e.g., limited new cut and fill, and retention of some bank vegetation). Additionally, some of the sites noted as needing reconstruction would require minimal changes because existing stream crossing structures are fully adequate to meet fish passage and new road uses. However, older reconstructed roads may require completely new structures. Because of this, crossings on roads that would be reconstructed over decommissioned roads were conservatively included in the new crossing category in this analysis. Some of the sites that would be reconstructed would also include replacing old non-fish-passable structures with new fish-passable structures, although this is not a project-level requirement. Thus, the number of reconstructed sites are not comparable in level of potential impact to fish streams as new crossings relative to potential sediment additions.

Some of the original valley bottom crossings of important and sensitive fish habitat areas (e.g., alluvial fans and floodplains) would also not be reconstructed due to cost and risk to fish, thus avoiding some of the potential areas of greater concern. At this planning stage, specific locations where roads would be reconstructed have not been determined.

An index of risks of fish passage impedance based on total new and reconstructed crossings is shown in Table 3.6-4. Currently, about 3,700 fish-

bearing stream crossings exist on the Tongass. Any of the alternatives would add substantially to this number, increasing risk. Based on the number of new and reconstructed crossings, Alternatives 2 and 3 would have the greatest risk, while Alternatives 1 and 4 would have the least risk. Alternative 5 would be intermediate based on the number of new and reconstructed crossings. The number of newly constructed crossings at Class I, II, and III streams would be the best indicator of potential sediment increases from crossing construction. The ranking of the alternatives based on the amount of sediment added, based on the number of new crossings only, would be the same as that noted for risk to fish passage impedance, with Alternatives 1 and 4 the least risk, and 2 and 3 the highest, Alternative 5 intermediate.

Table 3.6-4
Estimated Number of Existing[1] and Maximum New Stream Crossings for New Roads[2] and Reconstructed Roads[3] Stream Crossing by Alternative over the Length of the Project (approximately 100+ years)

Stream Class		Alternative									
		1		2		3		4		5	
	Existing[1]	New[2]	Recon[3]	New	Recon	New	Recon	New	Recon	New	Recon
I	1,312	384	259	466	355	438	331	367	262	414	300
II	2,357	691	465	838	639	787	595	660	471	743	539
III	2,433	720	484	873	666	820	620	688	491	775	562
Total	**6,102**	**1,795**	**1,208**	**2,177**	**1,660**	**2,045**	**1,546**	**1,714**	**1,225**	**1,931**	**1,402**

[1] Based on USDA Forest Service 2016 stream crossing data file (Jacobson, personal communication, 2016).
[2] Based on roads estimated to be needed to harvest all scheduled timber in the alternative. Includes new roads and new roads constructed over decommissioned road beds.
[3] Maximum number of stream crossing to be constructed over stored (maintenance level 1) roads, some subset will need replacement or repair

Timber Harvest

Timber harvest activities can increase risk to fish resources. Protection of riparian areas, including floodplains, areas of riparian vegetation, and certain wetlands associated with riparian systems, is of particular concern. As discussed earlier, riparian vegetation serves many important functions for stream fish habitat, including supplying LWD, food input, and stream shade to name a few. Also of concern is the amount of protection afforded steeper channels (often not fish-bearing) in the headwaters areas and protection of steep hillslope areas. These streams (e.g., Class III streams) also require LWD to properly function (Paustian et al. 2006), as well as contributing nutrients, food resources, and, in some situations, LWD to downstream fish streams. Protection of estuaries and beach fringe is also important when locating roads and timber harvest units. The 2008 Forest Plan standards and guidelines associated with riparian areas, wetlands, and beach and estuary fringe are expected to protect fish resources from significant impacts associated with timber harvest, but there is still some level of risk.

Windthrow risk will be evaluated when prescribing thinning and openings treatments in current timber harvest areas and in RMA areas of some of the alternatives to minimize accelerated windthrow. In order to protect the RMA, a RAW zone adjacent to the RMA buffer will be established in situations where multiple high risk factors are present. The risk is related to the level of harvest, the portion of streams in the harvest area, and quantity of potentially unstable slopes in the harvest area associated with each alternative. However, some alternatives would increase the risk to fish and their habitat because Forest Plan standards and guidelines for young-growth harvest riparian areas, wetlands, and

beach fringe would be less protective, especially during the first 15 to 25 years of the 100-year projected period under some alternatives.

Effects of timber harvest on water quality issues are addressed in the *Water* section, including the potential for increased landslides that would affect stream habitat quality. The risk of landslides in the future will be moderated by the requirement to evaluate slope stability for slopes over 72 percent prior to approval to harvest, which would continue to be required for young-growth harvest (see *Soils* section). Timber harvest activities on the Forest could potentially affect as many as 272,733 (Alternative 1) to 3367,952 total acres (Alternative 2) after full implementation of the Forest Plan (100+ years) (see *Water* section Table 3.4-4). Alternative 1 would harvest the least acreage, followed by Alternatives 4, 5, 3 and 2 (from least to greatest). The values are expected to reasonably approximate future Forest-wide harvest (see the *Timber* section). Additionally, sediment to streams from landslides is likely to be the greatest under Alternative 2, which has highest estimated increase of landslides at 13 landslides over 25 years when compared to the 2008 Forest Plan (Alternative 1). See the *Water* section for details.

Beach Fringe Harvest

Marine riparian forest areas serve much of the same function in the marine environment as they do on streams (Brennan et al. 2009; Lemieux et al. 2004). This includes reduction of overland sediment entry to local marine waters (see *Water* section), shading primarily shoreline beach areas, adding LWD to the marine system, providing organic input such as insects (a food source for fish) and leaf fall, and bank stability from the root system of large trees. Thus, the harvest of beach fringe in Alternatives 2 through 5 could have some impact on marine and anadromous nearshore marine fish resources. The type of harvest, timber removal methods, and total acres affected differ between alternatives and would influence the magnitude of potential effects to fish and their habitat.

There are some important differences that likely reduce the overall effects from loss of marine riparian forest relative to flowing systems. In most areas, entry of any increased sediment runoff to the marine system would be greatly diluted due to large volume of water in marine systems compared to streams, although some nearshore impacts could occur to benthic resources and, to a lesser extent, fish, which would be more able to avoid such higher turbidity areas. Input of organics may be less important to the marine system due to the relatively high production in these systems relative to streams. However, input of insects to marine systems has been found in some areas to be important food sources for early rearing juvenile salmonids (e.g., Chinook, chum, pink, and coho salmon) (Brennan et al. 2004, 2009; Bollens et al. 2010; Duffy 2003; Moulton 1997; Hillgruber et al. 2007; Fresh 2006; Salo 1991). Romanuk and Levings (2005) found that Pacific salmon (Chinook, chum, and pink) along the British Columbia coast obtained 6 to 40 percent of their carbon from supralittoral vegetation (which include insects), although in some studies insects appear to be very minor food source for juvenile salmonids in some marine waters (Godin 1981; Landingham et al. 1997; Salo 1991). The sources of insects in the marine systems include areas other than just the adjacent forest, such as stream drift and windblown swarms (Brennan et al. 2004). However, a study in Puget Sound found that reduced shoreline vegetation resulted in lower insect diversity and abundance entering the nearshore intertidal areas (Sobocinski et al. 2010). Thus, the importance of marine riparian forests could be highly variable for juvenile marine rearing fish including commercial and recreationally important salmonids.

While LWD in marine systems does not have as great a site-specific effect at forming important habitat as it does in streams, it serves many functions in the

marine system (Brennan and Culverwell 2004). LWD helps trap and stabilize sediment in salt marshes where juvenile salmonids may feed, local falling trees on banks affect longshore movement of sediment, and some may become imbedded while others move on. Where LWD accumulates, it may aid in the development of wrack (vegetation derived from both aquatic and upland sources), which helps to stabilize beaches and develop diverse habitats and associated organisms. LWD also supplies substrate for organisms to attach and grow, and may supply cover for small fish to help reduce predation (Brennan and Culverwell 2004). The tree root systems, especially in steep areas, help protect areas from slumping into the marine environment.

Shading from trees is unlikely to have much effect on local marine water temperature, although shading of beach areas (overhanging branches, and abundant trees) has been found to help control sand habitat temperatures and possibly reduce sand desiccation when the tide is out (Rice 2006). These conditions have been found to be important in some areas for development and survival of some organisms. It was found in Puget Sound that surf smelt, which are present in Alaska and spawn in the upper intertidal region, had greater survival in shaded intertidal areas that remained moist and had lower temperature than unshaded areas (Brennan and Culverwell 2004; Rice 2006; Rossell and Dinnel 2007).

The young-growth harvest methods including skid trails, beach traveling equipment, and marine yarding and transport of timber, may results in adverse effects on marine nearshore organisms (see *Water* section). In the short term, benthic organisms may be directly killed in small areas, and fish shellfish resources, possibly including juvenile rearing salmonids, juvenile Dungeness crab, and other primarily juvenile stages of other marine fish, may be displaced while activities are occurring in the nearshore beach areas. While effects would likely be short term, they would be most pronounced for the alternatives removing the greatest number of acres (Alternatives 2, 3, and 4; Table 3.4-4 in the *Water* section). Harvest methods effects to the marine system from Alternative 5 would likely be less than from the other alternatives (except Alternative 1) because the area would be small and the 200-foot buffer would limit further shoreline harvest vehicle access and therefore disturbance.

Overall, the total area of estuarine and shoreline areas that would be affected by any alternative would be small relative to the total shoreline area of the Tongass. Thus, fish resources that could potentially be affected would be slight for any action where harvest is allowed.

Alternative 1 retains current protections allowing no commercial harvest within 1,000 feet of estuarine or beach fringe fully protecting marine resources relative to potential nearshore effects (Table 3.4-4 in the *Water* section). The largest potential effect in the short term would be for Alternative 2, which would allow clearcut to the water edge for the first 15 years of harvesting as well as in non-development Land Use Designations (LUDs), except for Congressionally designated and administratively withdrawn areas, such as Wilderness, and islands less than 1,000 acres in size. Complete removal of the forested stands in the beach fringe would likely reduce all functions of marine and estuarine riparian area at least in the short term.

Alternatives 3 and 4 would allow commercial thinning (up to 33 percent of the basal area) but Alternative 3 would allow it to occur both within and outside of development LUDs and in roadless areas affecting more areas. Harvest in Inventoried Roadless Areas (IRAs) is inconsistent with the 2001 Roadless Rule. If an alternative were selected with harvest in IRAs, harvest would be deferred

until the Roadless Rule changes or the Tongass Roadless Rule Exemption is reinstated. Commercial thinning would allow much of the function of riparian forest to remain at a reduced level, as some loss of organic and LWD input would occur, some reduction of shading and less buffering upslope sediment input and reduced bank stability.

Alternative 5 would likely have little effect on the nearshore marine fish resources due to relatively low harvest area and the retention of the 200-foot no harvest buffer. Although the specific harvest opening areas (up to 10 acres maximum) would carry higher risk for soil disturbance effects downslope than comparable commercial thinning areas. Brennan et al. (2009) assessed what size marine riparian buffers were needed to adequately protect their functional contributions of Puget Sound in Washington State. They determined buffer widths that would provide greater than 80 percent effectiveness protection for the functions of fine sediment control, shade, LWD input, and organic input to the marine environment ranging from 79 to 190 feet (depending on the function) of marine riparian forests. Thus, while most riparian functions would be retained with a 200-foot buffer area, some reductions could occur with Alternative 5.

RMA Harvest Outside of TTRA Buffers

Restrictions on timber removal from Riparian Management Area (RMA) buffers are in place to protect both water quality and fish habitat. Details of existing riparian area conditions, how these relate to RMAs, and effects of alternatives on water quality and important watershed components that affect fish resources are described in the *Water* section.

RMA buffers reduce sediment input to streams and also with certain channel types (primarily floodplain and alluvial fan) and conditions supply LWD to streams which is an important habitat component to fish streams. Removal of trees from these areas may reduce future LWD inputs to streams, reduce successful regrowth of future LWD, and cause adverse sediment effects to streams (see *Water* section). The LWD supply, which is critical to floodplain habitat formation and maintenance, would thus be reduced if supply was restricted to the current Tongass Timber Reform Act (TTRA) area and harvest occurs in RMA buffers along some stream systems outside of TTRA buffers. For example, while commercial thinning would grow larger diameter trees faster, it is considered to reduce future LWD abundance in areas harvested (USDA Forest Service 2014d).

Overall harvest in RMAs would reduce large key LWD, probably decrease the stability and longevity of LWD accumulations, and thus diminish the beneficial functions of LWD in the stream ecosystem (Heimann 1988; Murphy and Koski 1989). Furthermore, abundance of juvenile salmonids in a stream often is directly related to the amount of LWD (Murphy et al. 1986; Bisson et al. 1987).

Additionally, harvest in RMA along Class III channels, such as high gradient contained channels, may add sediment to streams that could be transported to fish streams, impacting rearing and spawning habitat. RMA harvest along lakeshores could also contribute to sediment increases, potentially reducing lake fish production.

As discussed in the *Water* section, Alternatives 1, 3, and 4 would generally prevent harvest in RMAs. Alternatives 2 and 5 both have harvest along important channel types outside of TTRA buffers (see *Water* section and Table 3.4-9). As noted in the *Water* section, much of the projected harvest in RMA areas would be in areas not directly adjacent to streams or lake (see “Other” category harvest in Table 3.4-9). Alternative 2 would have a substantial area of harvest (Table 3.4-4 in the *Water* section) but would be limited to commercial thinning, which would reduce site-specific effects. However, commercial thinning

under this alternative would occur over a majority of all the available second-growth RMA areas. About 86 percent of past harvested RMA, outside of TTRA buffers, would be harvested by commercial thinning under Alternative 2. Alternative 5 would have a greatly limited RMA harvest area based on model assessment but this alternative would have less restrictive harvest methods (some open areas up to 10 acres maximum in first 15 years only, up to 1,100 RMA acres total), which could have more local, site-specific effects to fish streams than Alternative 2 methods. Overall estimates of RMA area to be affected under Alternative 5 are small, greatly limiting potential adverse effects to fish habitat. See the *Water* section for complete alternative comparison on effects related to water and watershed conditions that have direct and indirect effects to fish.

The Tongass 77 Watersheds and TNC/Audubon Conservation Priority Areas

As noted in the Affected Environment section, there are a number of watersheds and VCUs, including the TNC/Audubon conservation priority areas, that have been evaluated by public, private, and agency groups and considered of importance for fish habitat quality and production. The 2008 Forest Plan (Alternative 1) or Alternatives 2, 3, or 4 do not provide any special management practices for any suitable timber harvest in the Tongass 77 Watersheds or the TNC/Audubon Conservation Priority Areas. Alternative 5 would, however, exclude future old-growth timber harvest in these watersheds. Additionally, based on internal scientific review in collaboration with others, 16 of these VCUs are considered high value watersheds that should be monitored to determine the likely impact to fish and wildlife habitat from young-growth timber projects. Overall, Alternative 5 would afford additional protections, reducing risks associated with old-growth timber harvest actions, to some of the more important watersheds for fish resources in the Tongass.

Fish Habitat Enhancement

Fish enhancement projects, such as fishways and falls modifications, stream and lake stocking, and lake fertilization, would not be affected by any of the considered alternatives. Project enhancement funding and selection of projects is primarily independent of amount or location of timber harvest; therefore, all alternatives would have similar effects on enhancement activities.

Log Transfer Facilities

Timber (logs) are often transported from the harvest areas by barge or log rafts through log transfer facilities (LTFs). The details of the number of LTF sites and the Memorandum of Understanding concerning agreements on use of LTFs by the Forest Service are discussed in the *Transportation* section. As noted in that section, while there are over 100 LTF sites in the Tongass, only 55 LTFs have active permits. The Forest Service currently has state-granted rights to marine access up to a potential of 126 sites, 66 of which have been implemented.

The number of additional log storage and transfer sites that would be developed has not been determined at this time as locations where transport would occur cannot be determined until a Logging System and Transportation Analysis is completed for suitable lands or actual timber sales are proposed. However, considering that past log transport, which was much more intensive than proposed in any future alternative, was handled with the existing LTF sites; it is not anticipated that a substantial number of new LTF facilities would be developed under any alternative and that current sites would primarily be used.

LTF construction and operations in the past have been found to affect benthic resources and some fish-rearing habitat primarily through the accumulation of

bark from dumping, storage, and rafting of logs. Some shoreline disturbance can occur from the development of these sites, including modification or loss of habitat through the addition of rock or other structures on the shoreline. There is potential for runoff of sediment and oils from the landing area as well. But the major risk of these sites is the addition of bark to the marine system (Faris and Vaughan 1985). Historically, LTFs have affected approximately 2 acres of marine benthic habitat for the average site, mostly due to bark accumulation (Faris and Vaughan 1985). Bark and other wood fragments that sinks to the bottom, if abundant, can have varied adverse effects to marine areas by reducing organism diversity, burying benthic organisms, and reducing organism abundance (Sedell et al. 1991). If bark accumulations are high enough, specific benthic areas may become anoxic or locally toxic. This could result in adverse effects to organisms such as crabs, shrimp, and nearshore rearing marine and anadromous fish. The bark can remain for extended periods (decades) but, based on dive survey results for LTF sites of concern, the bottom area covered with bark (based on bottom area with continuous coverage) can be greatly reduced within a few years (e.g., 1 to 10) after operations cease (ADEC 2008). Additionally, after deposition has stopped, over time these areas can become biologically similar to areas unaffected by even large accumulations of bark and wood debris (Germano and Browning 2005). Log rafts also have the potential to cause adverse effects to habitat primarily from grounding of the rafts, which can damage intertidal habitats and organisms that are present.

ADEC regulates the permitting of LTF sites in Alaska. While many sites historically were found to violate the state standards for water quality (residue standards), all evaluated sites have improved. The past state standard for residue accumulation was for LTF sites to have less than 1.5 acres of continuous bark coverage. ADEC (2008) reported the results of evaluating 15 sites of concern and found that none of the sites exceeded this standard and did not warrant 303(d) listing. Current requirements for any permitted site are more stringent, requiring less than 1.0 acre of continuous bark coverage at an LTF site.

The Forest Service also has detailed requirements that future LTF sites must meet to be developed (Appendix G of the Forest Plan). Several factors in the guidelines would reduce potential adverse effects to marine fish and shellfish resources. Sites would need to be located where strong currents could disperse bark, be sited in relatively unproductive tidal and subtidal waters, not be sited adjacent to extensive tide flats, kelp or eelgrass beds, or harvest areas of marine organisms. Additionally, log rafts or bundles, should be stored in water over 40 feet deep to prevent grounding. These and other parameters in the guidelines will reduce adverse effects to fish and shellfish resources of any future LTF facilities developed or used.

However, some benthic organisms and rearing fish may be injured, killed, or displaced during the operations of these facilities. Some local habitat reduction in quality would also occur from the bark accumulation, although this would be limited due to the above guidelines and state requirements. Intermittently, some additional bottom disturbance would also occur from barge vessels at specific sites (e.g., anchors and propeller wash).

Generally, effects to marine aquatic resources would be proportional to the amount of timber harvest, as the harvest amount would typically indicate amount of logs transferred through LTFs. This would result in small areas of mostly shallow nearshore habitat covered with wood debris (primarily bark) (most less than 60 feet deep, although some deeper areas), affecting primarily benthic marine organisms in areas of tidal and subtidal habitat, as no more than 1.0 acre of continuous bark coverage would be allowed. Each active or intermittently

active sites also would be monitored for extent, distribution, density of accumulation, and thickness of bark layer. These results would be reported to the state to ensure compliance with state criteria. Other monitoring (e.g., oil sheen, site runoff) would occur, depending on site specific characteristics (see Appendix G of the Forest Plan). With the current state regulations, Forest Service guidelines, limited marine area affected, and required monitoring, the level of effects to marine fish and shellfish would be slight for any alternative. In addition, effects of specific LTF use would be evaluated in detail during any future proposed timber sale where LTFs would be used. At this planning-level evaluation, the effects from LTF operations on marine organisms would be greatest in descending order for Alternatives 2, 3, 5, 4, and 1 based primarily on the amount of projected total harvest acres (see Table 3.4-3 in the *Water* section).

Renewable Energy Development

Current and alternative Forest Plan requirements for energy development are provided in the *Renewable Energy* section and Appendix F of this EIS. All renewable energy development projects in Southeast Alaska have to meet detailed local, state, and, in most cases, federal laws, regulations, and requirements to be developed and operated. Additionally, the Tongass National Forest currently applies Transportation and Utility Systems standards and guidelines to this type of development (see *Renewable Energy and Transportation Systems Corridors* section and the current 2008 Forest Plan). These standards and guidelines apply to Alternative 1. The other Alternatives (2 through 5) would eliminate the Transportation and Utility Systems direction and replace it with the Renewable Energy plan components found in the Forest Plan Chapter 5. Under all alternatives, renewable energy projects could be developed on any NFS lands, and the proposed new direction under Alternatives 2 through 5 would eliminate “avoidance areas” which could increase the efficiency and likelihood of developing these projects. The type and number of renewable energy projects currently in or planned in the Tongass are described in the *Renewable Energy* section, with the majority being hydroelectric projects.

Potential effects to fish resources from the construction and operation of renewable energy projects are many. Hydroelectric projects can have a host of potential effects to fish resources. Construction can include the development of additional roads, some permanent and some temporary. As noted above, roads can increase sediment to fish streams affecting fish spawning and rearing conditions, increase basin water runoff adding to peak flow and bed scour. Other construction associated with these projects also could increase potential for landslides, as they often are located in steep areas. The issue of fish passage at road crossings is of further concern. Hydroelectric projects modify stream flow possibly in fish streams, which also could affect habitat quantity and suitability for fish. Rapidly changing rate of flow in streams can result in fish strandings. Natural lakes may be used or reservoirs formed to enhance and control flows. This again could affect habitat in a lake including potential dewatering of shoreline areas that could affect benthic food production and in some cases spawning areas of shoreline spawning fish (e.g., sockeye salmon and kokanee). The formation of a reservoir would result in loss of flowing stream habitat. Dam formation could also block movement of fish, resident or anadromous from accessing streams above the dam, as well as downstream passage of fish and juvenile salmon smolts. The presence of turbines could result in fish mortality for those fish that pass through turbines, and can be mitigated using downstream bypass screens. Other water quality conditions could be affected from flow modifications, or lake and reservoir use such as temperature, dissolved oxygen, and nutrients.

Associated transmission lines also have sets of impacts to fish resources. The construction on land involves clearing of forest, and often road construction. The clearing of forest over streams normally involves removing all trees from the TTRA and RMA buffers on streams crossed. This clearing would result in loss of some of the riparian function on short reaches of streams crossed. Since routes are linear, rarely is any one stream directly affected more than once, although some slight cumulative effects could occur in basins as multiple tributaries to some streams would be cleared. This would include loss of LWD input and reduction of direct organic input from large trees, although lower brush would remain contributing organic input. Loss of shade potentially affecting temperature would occur, although this would again be slight due to the small area and remaining low brush adding shade. The associated roads would have similar effects as those noted for timber management, although they may be rarely used after construction, reducing long-term sediment effects. Marine cables are also a potential transmission route of energy from projects. Their construction would displace and likely kill some benthic resources in small areas along the route and cause possibly greater disturbance and short-term loss of shallow water benthic resources where cables may be buried near entry and exit locations. There would be no long-term effects in the marine system from cables.

Of the 11 known currently proposed renewable energy projects (see Table 3.12b-3), 6 are hydroelectric sites. Nearly all would have some operational effect on anadromous fish resources but, through proper site selection, design, and mitigative actions, impacts to important anadromous fish resources would be greatly reduced or eliminated. All of these proposed sites have water intake, or a proposed dam, upstream of natural anadromous fish resources. The most common types of effect on anadromous fish resources by these projects are changes in downstream flow, downstream substrate supply, or stream temperature, or some combination of these. In most cases, anadromous segments of streams that are downstream of a project are small, with most less than a few hundred feet in length. The proper amount of flow that would need to be maintained in streams to protect fish resources. The amount of instream flow needed, as well as the effects of substrate transport on fish resources, would be determined by the agencies that manage fish resources before the projects could be permitted. In some cases, nearshore marine issues with project siting and construction or sediment movement could have potential effects on early marine rearing habitat for juvenile anadromous fish.

All of these potential impacts for currently proposed or future projects to fish resources would be addressed during the permitting and licensing of these projects. However, even with detailed regulations, some impacts from almost any project would remain that would be compounded with other basin impacts. In basins most heavily developed through other federal, state, and private actions, the development of these projects may be of concern. While under current direction (Alternative 1), renewable energy projects could be developed throughout the forest, the change in Forest Plan direction for renewable energy projects (Alternatives 2 through 5) would, in effect, make it simpler to site projects in what are currently considered “avoidance areas.” The result would be more consideration given to renewable energy site proposals and not necessarily an increase in the number of sites developed. Also, the current number of projects in place and planned are widely distributed across the Forest. This would likely reduce cumulative effects of these actions on any specific basin area. Overall, Alternatives 2 through 5 would likely have little additional adverse effects to fish resources relative to current conditions (Alternative 1).

Alternative Summary

Generally, the alternatives with more roads, greater removal of riparian areas especially including developing small open areas (up to 10-acre maximum) harvest in these areas, and excursions into beach and estuary fringe have the highest potential for adverse effects to fish and watershed resources in the Tongass. The effects to the water conditions, which ultimately affect aquatic habitat, are presented in the *Water* section and contribute to the overall evaluation of alternative effects to fish. Development of the 1997 Forest Plan included an expert panel of physical scientists and fish biologists to evaluate a range of alternatives (Dunlap 1996, 1997). Generally, their assessments are still relevant to the type of timber harvest-related actions that can affect fish resources in the Tongass. These experts stated that as the number of road miles and harvest increased, the likelihood of meeting riparian management objectives and maintaining anadromous and resident fish stocks in the Tongass would be reduced. Also, the greater the riparian protections, the greater the chance riparian objectives would be met in the future. They also stated that a 100-foot buffer on estuarine areas was likely inadequate for protection of salmonids. Of major concern was removal of timber from floodplains, riparian vegetation, and certain wetlands associated with riparian systems. Locating roads in estuarine areas was also of concern for fish resources. These factors were considered in the above metrics presented and summarized below by alternative.

It should be noted that all of the currently considered future alternatives would have considerably less harvest acres and road miles than were being evaluated in the 1997 Forest Plan. The 1997 Forest Plan considered effects of harvest on about 1 million acres of old-growth forest, whereas current alternatives consider up to 370,000 acres of harvest, with a maximum harvest in old-growth forest of about 63,000 acres. Although there has been substantial harvest since 1997, the amount of area potentially affected is still much less than that considered in 1997 under any alternative. Additionally, while there are differences among the alternatives, the overall risk to fish resources and watersheds is unlikely to be large.

Alternative 1: This alternative would have the lowest future harvest, second lowest new road construction, and lowest portion of reconstructed roads of any of the alternatives. This alternative would also have the second lowest number of new stream crossings and lowest potential number of reconstructed crossings of any alternative. All crossings increase risks to fish passage, and new crossings have a greater risk of sediment effects. Given the lower number of new and reconstructed stream crossings under this alternative, there would be an overall lower risk of sediment addition and passage issues than under most other alternatives. Also, riparian (e.g., RMA) and beach/estuary protection would be high because the alternative's Riparian and Beach/Estuary Standards and Guidelines are essentially the same as the 2008 Forest Plan standards and guidelines, while all other alternatives have some reduction in these.

Overall, this alternative has RMA and beach/estuary protections that are equal to or greater than other alternatives with low harvest, low amount of new roads construction and lower number of new stream crossing among the alternatives. Although differences among alternatives are low, considering the importance of the parameters and the relative magnitude of the differences from a fish and watershed status, Alternative 1 likely has the lowest risk level of the alternatives for these resources.

Alternative 2: Because of this alternative's emphasis on young-growth harvest including entry outside of the development LUDs and reduced restrictions on

beach fringe and RMAs harvest, it has the highest amount of new and reconstructed roads and total acres harvested. The result would be the greatest number of new and potential reconstructed stream crossings. It would have some of the highest amount of harvest and roads in beach/estuary fringe. Much of this road development and reconstruction and harvest would occur in the first 15-year period when even-age management in beach fringe would be allowed. This alternative would also have the highest harvest of RMAs of any alternative although as commercial thinning (e.g., less than 33 percent of stand basal area), which would minimize LWD supply loss (most pronounced in effects to floodplain and alluvial fan channels). This alternative's high RMA harvest acreage and substantial beach fringe amount and methods all add to the risk to aquatic habitat. Nearshore marine fish effects could occur from marine access harvest methods and log transport, which would be second highest of all alternatives in acres. While the differences among alternatives are not large, this alternative likely has the highest overall risk to fish and watershed conditions.

Alternative 3: Alternative 3 is similar to Alternative 2 in road miles, number of stream crossings, and acres harvested. It has the second highest new and reconstructed road miles, and similar ranking for new and reconstructed road stream crossings. It has a similar but somewhat less amount of harvest than Alternative 2. Unlike Alternative 2, riparian protection would remain high for the same reasons as for Alternative 1 with no harvest in RMAs. However, this alternative would have highest number of road miles and harvest in the beach/estuary fringe over the 100-year period. Since only commercial thinning (e.g., less than 33 percent of stand basal area) would be used in these habitats, potential adverse effects to fish resources would be moderated. Nearshore marine fish effects could occur from this alternative's marine access harvest methods and log transport, which would be the highest of the alternatives. Considering the relatively high amount of roads and stream crossing, good protections for RMA, and lower beach/estuary fringe protections, this alternative would rank low among the alternatives in maintaining fish and watershed resources.

Alternative 4: This alternative has the second lowest and lowest number of both new and reconstructed roads, and new and reconstructed road crossings, respectively. Additionally, it has the second lowest amount of harvest. Beach/estuary fringe protections are reduced from the 2008 Forest Plan, with commercial thinning (e.g., less than 33 percent of stand basal area) allowed but only in development LUDs, resulting in third highest harvest and reconstructed road miles in these habitats. Nearshore marine fish effects could occur from this alternative's marine access harvest methods and log transport, which are lower than most of the alternatives. Riparian areas retain current protections with no additional effects in RMAs ensuring stable LWD supply to all channel types. With a lower amount of new road miles and harvest, full protection of riparian areas, but some reduction in protection of beach/estuary fringes, this alternative would rank in the lower risk range of alternatives to fish resources.

Alternative 5 (Preferred): This alternative falls in about the middle of the alternatives for risks to fish resources and watershed conditions. Total harvest, new and reconstructed road miles, and new and reconstructed road stream crossings fall midway in rank among alternatives. Although RMA and beach/estuary fringe protections are reduced from current conditions, the total amount of these habitats that would be affected is small. Relative to other alternatives, there would be relatively few miles of constructed roads in the RMA habitat over a 100-year period, with most in the first 15 years. It would have the least road miles and harvest acres in the beach fringe of the four action alternatives that would allow harvest there. Also, less than 4,000 acres of

beach/estuary fringe would be affected, including optional maximum 10-acre open area cuts. No harvest could occur within 200 feet of the beach, greatly limiting effects to the nearshore marine habitat from the limited open area harvest management. Nearshore marine fish effects are unlikely to occur from harvest access methods as marine access harvest is unlikely. While open area harvest up to 10 acres maximum plus commercial thinning up to 35 percent of existing stands would be allowed in RMAs, these would only occur in development LUDs and the Old-growth Habitat LUD. These alternative characteristics, and other Forest Plan restrictions and levels of harvest, would result in few acres (less than 1,100) of young-growth timber being harvested in RMAs over the first 15 years, and none after. While some RMA and beach/fringe protections would be reduced from current plans, the overall effects of this change Forest-wide would be low. Additionally, there are 73 VCUs and TNC/Audubon Conservation Priority Areas considered important to fish resources that would be excluded from future old-growth timber harvest, eliminating risk to fish resources in these watersheds from old-growth timber harvest. The overall effects from this alternative's actions would be in the middle range of effects to fish resources among alternatives considered.

Special Status and Invasive Species Assessments

Threatened and Endangered Species

Consultation requirements for the Forest Plan Revision under Section 7 of the ESA, as amended, were completed with the USFWS and NMFS for the 1997 Forest Plan EIS. Both USFWS and NMFS reviewed the biological assessments for threatened and endangered species under their regulatory jurisdiction and concluded that the Tongass Forest Plan Revision was "not likely to adversely affect" threatened or endangered species occurring on the Tongass for the 1997 Plan. These findings were made subject to the programmatic scope of the Forest Plan Revision and following the associated Forest-wide standards and guidelines (see Chapter 4 of the 1997 Forest Plan).

Formal and informal consultation procedures (as directed by the ESA, as amended in 50 CFR 17.7, and Forest Service Manual 2670) are used with NMFS and USFWS on all projects that implement the 1997 Forest Plan and subsequent amendments. Forest-wide standards and guidelines (see Chapter 4 of the Forest Plan) for threatened, endangered, and sensitive species direct that all projects would comply with requirements of the ESA, as amended, and Forest Service policy (Forest Service Manual 2670).

The Selected Alternative (Alternative 6) of the 2008 Forest Plan Amendment FEIS was deemed through the consultation process to not likely adversely affect any of the threatened or endangered fish species occurring on the Tongass. The action alternatives being examined in this EIS would also likely fall in this category because the considered actions have the same or similar protective measures as Alternative 6 from the 2008 FEIS with a few potential exceptions, as discussed below. Additionally, future considered alternative plans have much lower harvest levels and therefore less use of LTF facilities and associated developments, further reducing potential adverse effects to listed fish.

As stated in the Affected Environment section, there are six Chinook salmon, one sockeye salmon, one coho salmon, one chum, five steelhead, and one green sturgeon evolutionarily significant units (ESUs)/DPSs that are federally ESA listed that may be present in waters potentially affected by project alternatives. Consultation with NMFS concerning potential project actions and their effects on these listed ESU/DPSs was initiated with the development of a BA (included in

the planning record) and will be finalized with the completion of the FEIS and Record of Decision.

No ESA-listed stocks of salmon or steelhead originate (spawn) in Alaska streams. Listed species and stocks originate in freshwater habitats in Washington, Idaho, and Oregon. Some of these listed species migrate into marine waters off the coast of Alaska. While distribution of these stocks is primarily in outer coastal waters, some are occasionally present in the inner waters of Southeast Alaska and they may feed on prey resources originating within marine and estuarine waters of the Tongass National Forest.

The southern DPS of the green sturgeon is rarely present in Southeast Alaska waters. Most are believed to stay south, but some could be present in the inside waters of Southeast Alaska, particularly during the fall and winter. They migrate south again in spring (Lindley et al. 2008). The adults live in nearshore waters typically less than 100 meters deep (Lindley et al. 2008). Based on their regional and seasonal distribution, they would be uncommon in nearshore areas where potential project actions may have some effect.

Beach and estuarine fringe harvest of Alternatives 2, 3, 4, and 5 have a greater chance of affecting nearshore habitat that may supply prey resources to listed salmon, steelhead, or green sturgeon than actions evaluated in the 2008 Forest Plan Amendment. Currently, there are about 17,000 miles of shoreline in the Tongass National Forest lands, and about 500 miles have past harvest. A subset of these areas, depending on the alternative, would be harvested over a 100+-year period. Nearshore marine bottom disturbance to intertidal and subtidal habitats could be caused by nearshore log yarding, vehicle travel on beaches, log rafting, and log loading and yarding vessel anchorage and associated activities. Effects on marine bottom disturbance could cause some short-term local reduction in some prey resources that could be utilized by rearing salmon, steelhead, or green sturgeon. Marine access to harvest these beach fringes would be limited for all of the alternatives, because much of the harvest would occur by road and helicopter, which would reduce the potential for nearshore disturbance. Runoff from the logging areas could also contribute sediment to the nearshore areas, which may smother benthic and epibenthic organisms, some of which are prey resources for juvenile salmonids and green sturgeon. These effects would be short term and local, primarily restricted to central landing areas along the beach, although some may occur near any skidder trails that may be accessed by the beach. Anchorage of barge log loading, log rafting, and possible A-frame yarding barges would have limited bottom disturbance either from grounding and/or anchor location. In most nearshore locations, the dynamic nature of beach and intertidal areas would be accustomed to moderate, natural disturbance and therefore somewhat resistant to additional disturbance that may be caused by shoreline harvest-related actions. As discussed in the Beach Fringe Harvest section above, there could be some reduction in terrestrial food sources with removal of trees from these area. These sources of food have been found to be of use by some salmonid rearing stages. These reductions, however, would be very small relative to other sources of food in the marine system. Overall, some indirect effects could occur to food sources for the listed species. For any of the listed fish species, however, the area of effects would be limited and use of any of these areas would be remote considering their limited distribution in Southeast Alaska marine nearshore waters.

Site-specific nearshore marine habitat-disturbing actions, or any other ground disturbing action, are not, however, directly authorized under the considered alternatives of the Forest Plan. Thus, the considered actions of the alternatives

will not have any direct adverse effects to any of the listed species addressed in this section from potential nearshore marine disturbance. Any proposed actions indirectly resulting from the considered alternatives will be evaluated on a case-specific basis as to their effects to listed species. This may include formal or informal consultation with NMFS at the time of project-specific evaluations.

Because of the listed fish species' very limited distribution relative to the project area and lack of direct project-authorized action effects to the marine environment, it is not anticipated that adverse effects would occur to any endangered or threatened salmon, steelhead, or green sturgeon ESU/DPS listed species from any of the alternatives. The details of potential effects to listed species are presented in the BA, which is included in the planning record.

Essential Fish Habitat Assessment

Section 305(b)(2) of the Magnuson-Stevens Act requires all federal agencies to consult with the Secretary on all actions or proposed actions authorized, funded, or undertaken by the agency that may adversely affect EFH. This consultation is completed for site-specific projects with ground-disturbing activity. The application of Forest-wide standards and guidelines and best management practices (BMPs) developed to meet soil protection, water quality standards, and fish habitat protection will help protect EFH on the Tongass National Forest and adjacent estuarine and marine waters. Adoption of the Forest Plan does not specifically result in any actions that could affect EFH, and any action that would be taken following adoption of the Plan that could affect EFH would have a formal EFH developed. No formal EFH will be developed for the considered actions in this EIS.

Sensitive Species

There are no aquatic sensitive species on the Tongass National Forest.

Invasive Aquatic Species

ADF&G lists four species of fish that are non-native to Alaska found in Alaskan waters (Fay 2002). Only two, the Eastern Brook trout and Atlantic salmon, have been found in the aquatic habitats of the Tongass National Forest. Additionally, northern pike, which has only been found in apparently native waters in the Yakutat area in the Tongass, is of greatest concern because of its potential to directly impact native salmon species. Other aquatic species, including the Chinese mitten crab and New Zealand mudsnail, both of which can inhabit freshwater, are a major concern for impacts they would cause if they invaded these aquatic habitats (Schrader and Hennon 2005; Fay 2002). Also, the green crab, while not in Alaskan marine waters, has been reported to be in British Columbia coastal waters (ADF&G 2015a). While no alternative would have substantial effects on invasion or establishment of non-native aquatic species, some actions could have indirect effects. One of the biggest concerns for invasive fish is active stocking of waters primarily with species often considered game fish in other areas. This would apply primarily to northern pike, which can inhabit lakes and rivers. In general then, alternatives that increase human access to fresh waters within the Forest would have the greatest risk of increasing invasive aquatic species in aquatic habitat of the Forest. The major form of increased access to aquatic habitats of the Forest would be through increased roads where people may travel with invasive species either intentionally, such as northern pike, or by accident, such as in the case of some aquatic species, like the New Zealand mudsnail. Based on this criterion, the relative risk would be proportional to road miles (Table 3.4-5), with Alternative 1 having the least and Alternative 5 the most risk. Additionally, increased use of marine vessels for log transport or shoreline harvest of beach fringe areas (primarily Alternatives 2, 3,

and 4) would increase risk of inadvertent entry of marine invasives like the green crab.

Conclusions – Direct and Indirect Effects

Much of this EIS evaluation has been based on the conclusions, derived from scientific literature, monitoring reports, and expert evaluations, that 2008 Forest Plan standards and guidelines, practices, and related BMPs are adequate to ensure minimal or no harm to fish resources, at least for most of the alternatives considered. However, there is a degree of scientific uncertainty associated with these conclusions. The current Plan has only been in place for 20 years, although many of the practices have been in place longer. The active monitoring that has been occurring does not suggest marked problems with water quality or fish resources as a result of these actions (USDA Forest Service 2004a, 2007, 2014a). While active monitoring has been occurring, the full effect of these types of actions has not had an extensive period of evaluation. Even though relevant information indicates protections would be adequate under most of the alternatives, there is some risk to fisheries resources in implementing any of the considered alternatives because all would result in increased road construction, reconstruction, stream crossings, and increased harvest. Also, some have less protection for important fish-related habitat than the 2008 Forest Plan.

Based on best available science, it can be concluded that there is a relatively low long-term risk to fish habitat from any alternative because of low levels of timber harvest and road construction and reconstruction, and the relatively high riparian protections offered by Forest Plan standards and guidelines for most alternatives. However, the allowance of harvest in previously protected beach/estuarine fringe and or RMA areas increase risk to resources where the harvest in these areas occur under Alternatives 2 through 5. Each of these four alternatives includes actions to reduce adverse effects to beach fringe and RMA conditions. For RMA areas, no harvest would be allowed in the TTRA buffers that supply most of the functions to most fish stream habitat in the Tongass National Forest. Also, none of alternatives would allow more than 33 to 35 percent of existing RMA stand to be removed, and, for Alternative 5, maximum open area harvest would be limited to 10 acres. Selection of these areas for harvest would only occur when other young-growth areas are not available, all of which would moderate but not eliminate adverse effects. Any designated commercial harvest in RMAs may reduce the objective of advancing the seral stages toward old-growth conditions in RMA habitat (USDA Forest Service 2015c). Beach fringe harvest effects would be moderated by allowing only commercial thinning (less than 33 percent of the stand) (Alternatives 3 and 4), restrictions on when harvest could occur (first 15 years only for Alternative 2), and a 200-foot beach buffer (Alternative 5).

Among alternatives with commercial harvest allowed in beach and estuary fringe or RMA, Alternative 2 would have the most risk because it has some of the highest harvest rates, includes even aged management in the beach fringe, and has a higher number of new and reconstructed road miles.

Cumulative Effects

General

The effects of the alternatives on fish resources may be influenced by other actions occurring in the project area. Appendix C provides a complete list of past, present and reasonably foreseeable actions considered for cumulative effects and indicates which of these interact with aquatic resources affected by the Forest Plan alternatives. The main factors affecting fish are related to land development actions that occur regionally. This primarily includes other timber harvest-related actions on non-NFS lands, especially associated roads. The total

lands within the Tongass National Forest boundary, which includes all NFS lands and other non-NFS lands, is about 17.8 million acres. Of this, only about 6 percent (1.1 million acres) are non-NFS lands. However, development actions on these non-NFS lands, which include most cities and towns in Southeast Alaska, are moderately intense.

Cumulative effects to fish resources include those actions that affect water and watershed resources, such as the development of roads. These cumulative effects are detailed in the *Water* section. Generally, overall average road density, which is an indicator of potential adverse sediment effects to streams, would increase markedly on non-NFS lands, but across the region (NFS and non-NFS combined) would only increase slightly in the future 100 years (Table 3.4-12) for all alternatives. The number of watersheds that would be considered to be either "fair" or "poor" (implying likely reduced fish production potential), based on road density greater than 1 mile per square mile (USDA Forest Service 2011a), would increase in the future (Table 3.4-13). However, few watersheds would change to these lower function categories and that number varies little among alternatives (range 19.6 to 20.0 percent of all watershed in these categories for all alternatives).

Effects on fish resources are less directly tied to the amount of timber harvest than to roads, but harvest may affect fish through effects to water quality, riparian condition, and where the harvest occurs, as discussed under Direct and Indirect Effects. The cumulative effects of timber harvest on water quality were discussed in the *Water* section for all lands (including non-NFS lands) within the Forest boundary and relate to potential effects to fish resources. Existing conditions include retention of 86 percent of the original productive old-growth forest inside the Forest boundary and 95 percent of the land area remaining undisturbed from direct timber harvest (Table 3.4-10 of the *Water* section). Overall, the cumulative effects to fish relating directly to quantity of timber harvest would be similar under all alternatives; about 82 percent of the original productive old growth on all lands within the Forest boundary would be retained for each alternative. Total cumulative effects to fish resources, based on relative amount of area disturbed, and would be slightly lower than existing conditions at 94 percent. However, some local regions may have fish resources affected where watershed harvest levels and road density are high. Additionally, with less protection for riparian areas on state and private land (e.g., no required buffers on non-fish-bearing streams and resident fish-bearing streams), a greater risk to fish resources would occur in watersheds that have a high portion of non-NFS harvest occurring. Again, effects of harvest activities on fish resources would ultimately be considered at the project-specific levels, ensuring minimal adverse cumulative effects.

Climate Change

Climate change is one factor that has some unquantifiable potential to affect fishery resources on the Tongass. Several models used in recent literature agree that temperatures and precipitation in Southeast Alaska and the Tongass National Forest will increase this century (Shanley et al. 2015; EcoAdapt 2014). One set of models specifically for Southeast Alaska projects annual air temperature increase of 0.5 to 3.5 degrees Celsius (°C) by 2050 and 2 to 6°C by 2100. Annual precipitation increases are projected to be 5 to 15 percent by 2050 and 15 to 35 percent by 2100 (summary from EcoAdapt 2014). These value estimates vary substantially between locations in Southeast Alaska. Higher temperature increases are expected in the winter months, with greatest precipitation increases expected in winter and fall (EcoAdapt 2014). With warmer temperatures, much of the precipitation that currently is snow will fall as

rain. The result will include greater melting of glaciers, higher peak flows in the winter and fall in most streams other than glacial-fed streams, and, even with increased precipitation, lower summer flows primarily in snowmelt- and rain-fed dominated basins, which would include the majority of major fish-producing systems in Southeast Alaska (Shanley and Albert 2014; Shanley et al. 2015).

The effects to fish resources in the Tongass National Forest from these changes would be both positive and negative and will vary by species, life stage, and location. Reduced stream flow in summer months and high water temperatures during this same period have been a common concern for salmonid populations in much of their native range.

One of the main factors affecting fish resources would be changes in stream temperature. Higher temperatures would result in faster egg development and emergence of fry. In the case of pink and chum salmon, which migrate directly to the marine environment after emergence, this may be a negative conditions as the historical planktonic food sources may not be as abundant in the marine system earlier in the late winter and early spring (Heard 1991; Salo 1991). Increased temperature could result in faster growth of rearing fish as long as food supply is adequate and temperatures do not become stressful. Unlike streams in the lower Pacific Northwest (e.g., Washington, Oregon), summer temperatures in most locations in the Tongass are well below upper levels of concern for rearing fish so some temperature increase would not be an issue in many areas. Although some areas, especially where nutrients are limited, production may not be enhanced with elevated temperatures. In the case of coho salmon, side channels may have lower flows and increased temperatures, which could reduce their usability. Coho salmon in Southeast Alaska typically rear for 2 years before smolting, likely because low production is related to low stream temperature. Should growth increase, some may smolt after one year's growth. This could be an advantage because they would not suffer an extra year of overwinter freshwater mortality, which can be high. This may be complicated if they are relatively small after one year's growth while entering the ocean, because the small size would be a disadvantage for marine survival. Elevated temperatures in lakes may also be of benefit for lake-rearing species because growth may increase in these systems, if available food supply is adequate, perhaps most noticeable in sockeye salmon, which generally need lake systems for rearing. Elevated lake temperatures may also benefit coho salmon and resident trout and char in those lake systems. Increased growth of coho and sockeye salmon has been observed in a lake system in Southeast Alaska during a period of higher water temperatures (Shanley et al. 2015). However, elevated temperature would likely increase rate of predation on juvenile fish by other fish species (e.g., cutthroat trout and Dolly Varden).

Life history of some species may be affected by temperature changes. Increasing water temperatures may affect whether *Oncorhynchus mykiss* (rainbow trout/steelhead) are anadromous or resident. While anadromous behavior is influenced by genetics, it is also influenced by environmental factors (Kendall et al. 2015; Pearse et al. 2009). Some studies have found that warmer waters increase the rate of anadromous smolt formation in *O. mykiss* stream populations (Sloat and Reeves 2014). Also in some similar natural stream systems studied by Kendall et al. (2009), those with higher temperatures, among other factors, tended to be dominated by anadromous and not resident forms *of O. mykiss*.

Elevated stream temperatures in the late summer may also be detrimental to returning spawning fish, primarily pink and chum salmon, that enter in late summer during low flows, and may hold in pools. These pools may have elevated temperatures and related low dissolved oxygen that could affect timing

of entry or survival for fish that do hold in these pools (Bryant 2009). The upstream migration of sockeye salmon also occurs in the late summer and may be adversely affected by warmer waters. Prior to spawning, however, these salmon usually hold in lakes, which would be buffered from the streams' potentially higher temperatures and lower oxygen conditions.

Increasing precipitation in the winter likely increases the risk of landslides and debris flows that may enter streams (Bryant 2009). Areas that historically received precipitation as snow may get more as rain as estimated for climate change. Saturated soil and intense rainfall increases the risk of slides (Bryant 2009), which could affect streams by adding sediment and scouring stream beds, while also adding wood. Heavy sedimentation and bed scour is detrimental to rearing and spawning habitat, while the addition of large woody debris may be beneficial because it aids in habitat formation and retention within streams.

Change in flow regime also would have positive and negative effects. Increased winter and fall flow may supply increased overwinter habitat including access to and formation of off-channel habitat areas for some species (e.g., coho salmon, Dolly Varden, cutthroat trout, and steelhead). However, if flows are high with elevated peaking in fall and winter, egg scour could occur, which would be detrimental for many fall spawning species (e.g., all salmon species) (Shanley and Albert 2014; Bryant 2009). Sloat et al. (in press) modeled the likely effects of future flow changes from climate change on spawning conditions in Southeast Alaska. They noted that median annual average flood flows would increase by 28 percent by 2080. The estimated effects on habitat varied by watershed and stream morphology–specific conditions. Many species of Pacific salmon have adapted to high flows by selecting coarser spawning substrate (depending on species size) and locations away from the channel center (May et al. 2009).

Low summer flows would be detrimental to over-summer rearing fish, which could include coho and Chinook salmon, steelhead, cutthroat trout, and Dolly Varden, by reducing rearing habitat area and possibly food supply. However, reductions in summer flow may need to be substantial to affect overall juvenile salmonid survival and growth (Harvey et al. 2006; Grantham et al. 2012). If summer mortality rates increase because of higher temperatures, later life-stage survival rates may increase to compensate for this increased seasonal mortality (i.e., density dependence). The diversity of the local fish stocks and their life stages will contribute to resiliency of regional species to moderate effects of both temperature and flow changes.

Climate change could also result in sea-level change. This sea-level rise could inundate estuarine rearing areas for fish. Stream mouth areas of some low-gradient small streams, which are used by some rearing fish including coho salmon, could also be inundated with salt water if sea-level rises were substantial. Pink and chum salmon in some areas spawn in intertidal regions, which could be affected with sea level rise. Current predictions are for a sea-level rise of 1.3 to 2.1 feet by 2081-2100 (Shanley et al. 2014). However, the Southeast Alaska land mass is rising in many areas; due to isostatic rebound from past glaciers, sea level in Southeast Alaska is decreasing by as much as about 3 cm/year (1.2 inches/year) (Larsen et al. 2005). Some areas, particularly in northern Southeast Alaska, may rise 1 to 4 feet over the next century (Kelly et al. 2007). This rate of land rebound increase would likely offset sea level rises over most of the Tongass shorelines. Thus, overall effects on estuarine areas, coastal stream mouths, and fish stocks would vary considerably and changes are difficult to predict and may even be difficult to detect.

In summary, there is general agreement that the climate is warming, precipitation will increase, and flows will increase in the fall and winter but decrease in summer in snow- and rain-dominated watersheds. However, there is uncertainty surrounding specific predictions and even more uncertainty regarding the effect of these changes on resources including fish.

Conclusions – Cumulative Effects

Overall, the cumulative effects of the Forest Plan alternatives, in conjunction with other actions described in Appendix C, primarily roads and timber harvests, would increase the regions of greatest risk for fish resources. While all alternatives would increase high road density areas, overall the number of watersheds with increased risks to fish remain relatively small. There is little difference among the alternatives on risk of road density increasing into undesirable conditions at the watershed level because the overall amount of new roads remains low on a forest level, with higher road density areas (e.g., greater than 1 mile/square mile) ranging from about 19.6 to 20.2 percent among the alternatives for all lands combined. Cumulative effects of actual timber harvest would follow a similar trend among the alternatives; however, the potential cumulative effects of harvest, road building, and other actions would be evaluated on a project-specific basis so that the potential for adverse cumulative effects to fish resources within a given watershed could be reduced or eliminated. The cumulative effects of climate change are not clear but some of the changes could be detrimental to fish resources.

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Plants

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Affected Environment

This section describes the affected environment for plants on the Tongass National Forest. It is divided into the following areas of focus: Plant Communities, Threatened and Endangered Species, Region 10 Sensitive Plants, Rare Plants, and Invasive Plants. The *Plant Communities* and *Vegetation Classification* subsections provide an overview of vegetation and describes the process and status of vegetation classification and vegetation mapping on the Tongass. The *Threatened, Endangered, Sensitive, and Rare Plants* and *Invasive Plants* subsections include an overview of current conditions. The detailed description and effects analysis to vegetation on a habitat/landscape scale are in the *Biodiversity* section of this chapter.

Plant Communities

The composition, age, and structure of the plant communities on the Tongass are the result of interactions between biological and physical environments, natural disturbances, and land use history. This subsection introduces the ecological context for the common forested and non-forested plant communities.

The coastal forest of Southeast Alaska is within the cool, temperate rainforest that extends along the Pacific coast from northern California to Cook Inlet in Alaska. The forest is dominated by conifers, primarily western hemlock *(Tsuga heterophylla)*, Sitka spruce *(Picea sitchensis)*, and western redcedar *(Thuja plicata)* (south of Frederick Sound). Mountain hemlock *(Tsuga mertensiana)* grows throughout the forest and is the dominant tree just below and at treeline. Pacific yew (*Taxus brevifolia*) and Pacific silver fir (*Abies amabilis*) grow at the extreme southern end of the Tongass. Lodgepole pine (*Pinus contorta* var. *latifolia* and *P.contorta* subsp. *contorta)* and yellow-cedar *(Callitropsis* [*Chamaecyparis*] *nootkatensis)* are scattered throughout the forest. Populations of subalpine fir (*Abies lasiocarpa*) grow from upper Lynn Canal south along the mainland to the Hyder area and west to Prince of Wales Island. Red alder *(Alnus rubra)* is common along streams, beach fringes, and on soils recently disturbed by management activities. Black cottonwood *(Populus balsamifera* subsp*. trichocarpa)* grows on the floodplains of major rivers and recently deglaciated areas.

Blueberry and huckleberry *(Vaccinium* spp.), rusty menziesia (*Menziesia ferruginea*), devil's club *(Oplopanax horridus)*, and salal *(Gaultheria shallon)* in the south, are common shrubs in forested communities. The forest floor supports a variety plants, including false lily-of-the-valley *(Maianthemum dilatatum)*, bunchberry *(Cornus canadensis)*, five-leaf bramble *(Rubus pedatus)*, and oak fern (*Gymnocarpium dryopteris)*. Because of the high amount of rainfall and high humidity, a wide variety of mosses and liverworts grow in great profusion on the ground, fallen logs, the trunks and branches of trees and

shrubs, as well as in forest openings. Hundreds of lichen species grow on tree trunks, branches, and on the ground, especially in old-growth forests, riparian areas, and maritime beach fringe forests.

Upper beaches, estuaries, lake margins, and muskeg edges support grass and sedge meadows. Thickets dominated by willow *(Salix* spp.) and Sitka alder (*Alnus viridis* subsp. *sinuata*) occur in recently deglaciated areas, river channels, avalanche chutes, sub-alpine communities and beach/forest ecotones. Muskeg (peatland) communities, which occur in poorly drained areas throughout the forest, are dominated by peat moss *(Spaghnum* spp.), sedges *(Carex* spp.), low shrubs and scattered shore pine *(Pinus contorta* subsp. *contorta)*. These non-forest vegetation types are also described in the *Wetlands* and *Biodiversity* sections of this chapter.

Above the treeline, a mosaic of plant communities blanket the subalpine meadows and alpine tundra. Subalpine meadows support an array of taller herbs and grasses. Plants of the more exposed alpine tundra are mat-forming, grow close to the ground and include plants from the heath and rose families, willows, clubmosses and lichens. Cushion-forming plants and non-vascular plants (lichens, mosses, and liverworts) occupy exposed rock outcrops, crevices, and talus slopes.

Vegetation Classification

Integrating vegetation information in analysis, planning, and decision making requires the development of vegetation classifications, which in turn are applied to vegetation maps, some of which are developed from remotely sensed imagery or ecological models. Classification of vegetation types is an established tool designed to group similar entities into named types or classes based on shared characteristics that facilitate our study, understanding, and communication of ecological information. Vegetation classifications are the basis for development of vegetation types at various spatial scales which have been widely used in forest planning, project planning, wildlife management, and silviculture in the National Forests. Vegetation classifications can be used to identify realistic objectives and management opportunities, determine capability and suitability, and evaluate forest health (USDA Forest Service 2011b). They can also be used to streamline monitoring design and facilitate extrapolation of monitoring interpretations; determine effects of disturbance or management actions; assess risks for the introduction of invasive species, fire, insects, and disease; and describe current habitats for plant and animal species based on current vegetation composition, structure, and function (USDA Forest Service 2011a).

On the Tongass National Forest, fine-scale vegetation communities known as plant associations have historically been used for analysis of silvicultural treatments. Work on describing forested plant communities on the Tongass began in the early 1980s. Three guides, one each for the former Ketchikan, Stikine, and the Chatham Areas, were developed to identify and describe forested plant associations (DeMeo et al. 1992; Pawuk and Kissinger 1989; Martin et al. 1995). Additionally, a fourth guide described plant communities of all lifeforms (herbaceous, shrub and forest types) in the Yakutat Foreland (Shephard 1995). Non-forested plant communities have also been described for the Stikine and Taku River ecological subsections, as part of the Key Coastal Wetland Initiative (Turner 2010). These guides provide a key for identifying the plant associations based on dominant and diagnostic species in the tree, shrub, and herb layers of the Forest. Forested plant association names consist of the dominant tree species that occurs in the overstory canopy, along with dominant or diagnostic species found in the shrub and/or herb strata (layers). Plant association descriptions include species cover and constancy (how often a species occurs in a particular association), productivity estimates, and

management considerations to guide the interpretation of site productivity on an area with a specific plant association.

In the Tongass plant association guides, forested plant associations are grouped into the following series (also known as alliances) based on the dominant tree species in the overstory canopy:

- Black Cottonwood Series
- Mixed-Conifer Series
- Mountain Hemlock Series
- Shore Pine (Lodgepole Pine) Series
- Sitka Spruce Series
- Sitka Spruce – Black Cottonwood Series
- Western Hemlock Series
- Western Hemlock-Western Red Cedar Series
- Western Hemlock-Yellow Cedar Series

Vegetation Mapping

Forest-wide overstory vegetation has been mapped using “CoverType”, a Geographic Information System–based data set that is a photo-interpreted delineation of the Forest by land type and timber cover type. CoverType delineates the Forest according to broad forest canopy cover types. CoverType also tracks vegetation changes through time (as modified by natural events or management activities) in addition to its natural condition. Information for forested stands includes forest cover type (dominant overstory tree species), size class (e.g., seedling, sapling, young growth, or old growth), productivity class, and volume class. Generalized non-forested conditions are also mapped (e.g., rock, ice and snowfields, alder, brush, muskeg-meadow, uplifted beach, alpine, sand dune, etc.).

Additionally, a model for classifying commercially productive forests of the Tongass has been developed that organizes forested stands into seven structural classes, using tree size (quadratic mean diameter) and tree density (trees per acre) categories (Caouette and DeGayner 2005). This map product, referred to as Size-Density, is described in the *Biodiversity* section of this chapter, and has been used to describe forest structural diversity and wildlife habitats.

Mapping vegetation communities at the plant-association level has not occurred on the Forest. Producing plant-association maps requires large amounts of field data and high-resolution imagery combined with modeling; therefore, plant-association maps are not now possible at the Forest scale. It is possible that in the future plant associations map products, which meet national standards for vegetation maps, may be developed on a project-specific basis. New and updated mid-level (alliance and/or dominance type) maps of vegetation types sufficient for Forest- or watershed-scale analysis may also be developed in the near future.

Threatened, Endangered, Sensitive, and Rare Plants

Threatened and Endangered Plants

There are no federally listed or proposed threatened or endangered plants under the Endangered Species Act known to occur on the Tongass National Forest. The only federally listed or proposed plant in Alaska is the Aleutian hollyfern (*Polystichum aleuticum)*, which is listed as endangered. It is only known to occur on Adak Island and is not expected to occur on the Tongass National Forest. A petition to list yellow-cedar (*Callitropsis nootkatensis*) was filed with the U.S. Fish and Wildlife Service (USFWS) on June 24, 2014. The 90-day finding of this petition, published on April 10, 2015 (80 Federal Register 19263), determined that the petition to list yellow-cedar presented "substantial scientific or commercial information indicating that the petitioned action [to list the species under the Endangered Species Act] may be warranted". A 12-month status review will be conducted by the USFWS to determine whether this petitioned action is in fact warranted. Yellow-cedar is broadly distributed across the Forest, although it is absent or rare over large portions of the Forest that appear to be suitable habitat (Hennon et al. in review).

Alaska Region Sensitive Plants

Sensitive plants are those plants identified by the Regional Forester for which population viability is a concern on National Forest System (NFS) lands within the region. A viability concern is identified by either a significant existing or predicted downward trend in population numbers or density, or a significant existing or predicted downward trend in habitat capability that would reduce a species' existing distribution. The objective of the Forest Service Sensitive Species Program (Forest Service Manual 2600 [USDA Forest Service 1991]) is to ensure that species numbers and population distributions are adequate so that no federal listing will be required and no extirpation will occur on NFS lands. Revisions to the Regional Forester's Sensitive Plant Species list are periodically completed based on new information derived from recent publications, field work, and laboratory analysis. The Alaska Region Sensitive Species list was updated in 2009 (Goldstein et al. 2009). Eighteen plants are designated as sensitive; 14 of these are known to occur on the Tongass National Forest, with an additional two that are not known but are suspected to occur. The 16 sensitive plants known or suspected to occur in the Tongass National Forest are listed in Table 3.7-1. This table includes a general range and habitat description for each species.

Sensitive plant surveys are conducted as part of project planning to identify populations or habitats of sensitive species within planning areas. Our understanding of sensitive and rare plant distribution across the Tongass is limited because most botanical surveys are focused on specific project areas.

Rare Plants

The Alaska Natural Heritage Program (ANHP) maintains a list of plants that are rare in Alaska. The ANHP Rare Vascular Plant List was most recently updated in 2012. This list contains 126 plants documented to occur on the Tongass National Forest. The 2008 Tongass Land and Resource Management Plan (Forest Plan) defines rare plants as:

> "…those with potential conservation concerns on the Tongass National Forest. They may be common elsewhere; however, the edge of their range is known or suspected to be on the Tongass National Forest, or disjunct populations of the plant species occur on the Tongass National Forest."

Table 3.7-1
2009 Alaska Region Sensitive Plants Known or Suspected to Occur on the Tongass National Forest[1]

Common Name (Scientific Name)	Range and Habitat[2]
Eschscholtz's little nightmare (Aphragmus eschscholtzianus)	This plant grows in southern Alaska and adjacent Canada in a band extending from the Aleutians through the southwest Yukon. There are also disjunct populations on the Seward Peninsula and in the Brooks Range. It is suspected to occur in mountainous areas on the northern mainland of the Tongass. It grows in moist mossy areas, seeps, heaths, and scree slopes in subalpine and alpine areas. Because the plant is so small, it is easily overlooked. This plant is suspected on, but has not been documented on the Tongass.
Spatulate moonwort (Botrychium spathulatum)	This plant is distributed from the upper Great Lakes east to southeastern Quebec, as well as in the mountains of northern Montana and Idaho to the Wrangell-St. Elias Range in Alaska. In southeastern Alaska, populations are known from Kruzof Island (on lands managed by the state of Alaska, which is surrounded by the Tongass) and a small population on Chicagof Island on the Tongass (USDA Forest Service 2015e). Habitat includes coastal forests, stabilized coastal dunes, upper beach meadows, well-drained open areas, alpine habitats, and riparian forests.
Moosewort fern, no common name (Botrychium tunux)	Moosewort fern grows on upper beach meadows, coastal dunes, stream terraces, river bars and subalpine and alpine slopes. There are nine known occurrences of this species on the Tongass; seven on the Yakutat Ranger District, one on the Wrangell Ranger District and one in the Admiralty National Monument.
Moonwort fern, no common name (Botrychium yaaxudakeit)	Wrangell St. Elias Range to Glacier bay, southwest across Canada to Alberta, with disjunct alpine populations in Montana, Oregon and California. Across its range, this fern grows on upper beach meadows, beach dunes, coastal outwash plains, abandoned fields and roadsides. There are 11 known occurrences in Alaska (ANHP 2015), including five occurrences in beach meadows on the Yakutat Ranger District.
Macoun's thistle (Cirsium edule var. macounii)	This plant ranges from southern Southeast Alaska, disjunct to southern British Columbia, to the North Cascades and Olympics of Washington and northern Oregon. It grows in moist to dry open meadows, open forests in the upper montane to lower alpine zone, on scree slopes and talus slopes, and along glacial streams and lakeshores. There are 2 known occurrences of Macoun's thistle on the Tongass, both on the Ketchikan-Misty Fiords Ranger District.
Mountain lady's slipper (Cypripedium montanum)	This orchid ranges from California north to British Columbia and east to the Rockies of Alberta, Idaho, and Montana. In Alaska it is known from Glacier Bay, the Haines area and Etolin Island. Habitat includes upper beach meadows, areas along the beach-forest ecotone, open forests, muskegs, and wet meadows. It is often found on calcareous substrates. There is one known population on the Tongass; on the Wrangell Ranger District.
Large yellow lady's slipper (Cypripedium parviflorum var. pubescens)	This plant's range is discontinuous and extends across boreal North America and south to Montana. On the Tongass, this orchid grows in peatlands on calcareous substrates (USDA Forest Service 2015e). There are two known occurrences of large yellow lady's slipper on the Tongass, both on northern Prince of Wales Island.
Calder's lovage (Ligusticum calderi)	This plant is endemic to coastal British Columbia and Southeast Alaska and is known from Vancouver Island north through the southern part of the Tongass (Dall and Prince of Wales Islands). Habitat includes alpine and subalpine meadows, boggy slopes, open mixed conifer forests, and rocky areas. There are 24 known occurrences on the Tongass; 23 on the Craig Ranger District and one on the Thorne Bay Ranger District.
Lichen, no common name (Lobaria amplissima)	In North America, this lichen is known primarily from Alaska, although one occurrence has been documented from California.There are 30 known occurrences on the Tongass. This lichen grows on trunks and main branches of Sitka spruce, Pacific crab apple (Malus fusca), and western hemlock in old-growth beach fringe forest (Dillman 2004 as cited in Goldstein et al. 2009).

Table 3.7-1 (continued)
2009 Alaska Region Sensitive Plants Known or Suspected to Occur on the Tongass National Forest[1]

Common Name (Scientific Name)	Range and Habitat[2]
Pale poppy (Papaver alboroseum)	Pale poppy is distributed from Kamchatka and northern Kurile Islands; across the Aleutians to south central Alaska and the east side of the Juneau Icefields in north central British Columbia. This plant grows in open, well-drained areas, in rocky tundra of ridges and mountain summits, ash and cinder slopes, and in sand and gravel of glacial outwash and river floodplains (FNA 2014). Occasional disturbance can create or maintain habitat; infrequent (versus continuous) disturbances (e.g., stabilized road sides, railroad trackbeds) by humans can create habitat (Goldstein et al. 2009). Although suspected to occur on the Tongass, there are no known occurrences on the Tongass. This plant is no longer listed on the ANHP rare plant list.
Alaska rein orchid (*Piperia unalascensis*)	The range extends disjunctly from Unalaska east to southeastern Alaska, south into northern California, along the Sierra Nevadas into Mexico, and south along the Rocky Mountains into Utah. There are also disjunct populations in Colorado, New Mexico, Montana, South Dakota and Newfoundland. This plant is known from 18 occurrences on the Tongass. Habitat includes dry open sites, under tall shrubs in riparian areas, mesic meadows, drier areas in coniferous and mixed evergreen forests, and bogs and heath habitat from low to subalpine elevations. On the Tongass, this plant generally grows in low-productivity forests at lower elevations in poorly drained soils (Dillman 2011a).
Lesser round-leaved orchid (*Platanthera orbiculata*)	This plant is widely distributed across North America from southeastern Alaska disjunctly across boreal and north temperate North America to Tennessee and South Carolina. Throughout its range it occurs in a variety of habitats including temperate, boreal, deciduous, and wetland forests (Dillman 2008). In Alaska, it grows in low elevation forested wetlands, medium to high volume old-growth hemlock forests with high bryophyte cover and a red cedar component, forest edges or near gaps in shady forests, and near muskegs, open water, or boggy areas (Dillman 2008). There are 291 known occurrences, comprising 61 distinct populations known on the Tongass (USDA Forest Service 2015e).
Kruckeberg's swordfern (*Polystichum kruckebergii*)	This fern's range includes disjunct populations in Southeast Alaska, the Cascades and Coast Range of British Columbia, mountains of northern California, and the Rockies (centered on Idaho). There are nine known occurrences comprising three distinct populations in Southeast Alaska; one within a development LUD (Timber Production) on the Ketchikan-Misty Fiords Ranger District, one within a non-development (Wilderness) LUD on the Sitka Ranger District, and one on non-National Forest lands. Habitat includes ultramafic rock outcrops.
Unalaska mist-maid (*Romanzoffia unalaschcensis*)	This plant ranges from the Aleutian Islands through Prince William Sound, disjunct to the Tongass. It grows on ledges and crevices in rock outcrops and in gravelly areas along stream banks, often along coasts. There are two known occurrences on the Tongass; both on the Thorne Bay Ranger District.
Henderson's checkermallow (*Sidalcea hendersonii*)	Endemic to the Pacific Northwest from Oregon to British Columbia with a disjunct population in Alaska. This plant's habitat includes wet meadows, estuaries, and tidal flats (Douglas et al. 1999). On the Tongass, the one known population grows at the upper edge of an upper beach meadow near the edge of a hemlock and spruce forest (USDA Forest Service 2015e). This population was located on the Juneau Ranger District; however, during surveys of the site conducted in 2013, the occurrence was not located (USDA Forest Service 2015e).
Dune tansy (*Tanacetum bipinnatum* subsp. *huronense*)	This species is distributed disjunctly across boreal and arctic North America and disjunctly south along the Pacific coast to California. Habitat for this species includes upper beaches, sand dunes, and well drained and calcareous soils. There is one known occurrence of this species on the Tongass, on a sandy beach of Kruzof Island on the Sitka Ranger District.

[1] Sensitive Plant list updated February 2009.
[2] Range, habitat, and occurrence information, unless otherwise noted, based on: Goldstein et al. 2009; Nawrocki et al. 2013; USDA Forest Service 2012; and USDA Forest Service 2014e

Under the 2008 Forest Plan rare plants have similar protection in the Forest-wide standards and guidelines as sensitive plants. The ANHP Rare Vascular Plant List, with global and state rankings, is used as guidance for determining which rare plants may be evaluated in the project-level analysis. This list with state and global rankings is available online at: http://aknhp.uaa.alaska.edu/botany/rare-plants-species-lists/rare-vascular-hulten/#content. Generally, plants with a state ranking of S1 (critically imperiled in state) or S2 (imperiled in state) are given consideration during project analysis. Plants with a state ranking of S3-5 are sometimes given consideration if they are known to be rare in a specific location on the Forest.

Invasive Plants

Invasive plants can adversely affect an area either when invasive plants become established or when an existing invasive plants spread to occupy a larger area. Invasive plants can negatively affect habitat by competing with native plants for resources such as water and light, establishing and changing the community composition, eliminating or reducing native plants, or by changing the vegetation structure. The changes in community composition or vegetation structure can reduce native plant populations as well as negatively affect habitat for wildlife and fish. Highly invasive plants often have aggressive reproductive methods and can successfully compete for resources (Schrader and Hennon 2005).

In the past, Alaska's remoteness, cold climates, and relatively low level of human disturbance have provided some protection from infestations of invasive plants (Carlson and Shephard 2007). Compared to the other states, Alaska has a low amount of invasive plant infestations, but the amount of invasive plant infestations within the state are increasing (Carlson and Shephard 2007; Nawrocki et al. 2011; Schrader and Hennon 2005). Not all non-native plants are invasive. Executive Order 13112 (1999) defines an "invasive species" as a species that is 1) non-native (or alien) to the habitat under consideration, and 2) whose purposeful or accidental introduction causes or is likely to cause economic or environmental harm or harm to human health. This Executive Order directs all federal agencies to address invasive species concerns and refrain from actions likely to increase invasive species problems. A considerable body of law and policy provide direction for managing invasive plants.

Policy and guidance for managing invasive plants are provided by the Forest Service Manuals and Handbooks. The Invasive Species Management Policy (Forest Service Manual [FSM] 2900) lists and details the law, regulations, and executive orders relating to managing invasive species. It also lays out objectives, policy, details responsibilities and lists definitions for managing invasive species. In concert with Forest Service policy, the *National Strategic Framework for Invasive Species Management* (USDA Forest Service 2013e) provides broad strategic direction for Forest Service's programs and guides and prioritizes invasive species management. The Alaska Region Invasive Plant Strategy (USDA Forest Service 2005) (under revision) and the Tongass National Forest Invasive Plant Management Plan (Lerum and Krosse 2005) provide Regional and Forest guidance. All alternatives would follow Forest-wide standards and guidelines regarding invasive species. FSM 2900 and these standards and guidelines include direction to review proposed projects to determine the risk of introduction or spread of invasive plants and implement appropriate mitigation measures. They also include direction to control existing invasions and rehabilitate habitats impacted by invasive species.

Although the term invasive plants is used in this document, invasive plants can also be referred to as non-native, exotic, noxious, weeds, alien, or invasive alien; depending on the context of the term's use.

Occurrences of invasive plants throughout Alaska are tracked by the Alaska Exotic Plants Information Clearinghouse (AKEPIC). The AKEPIC is a

cooperative project between the Forest Service, State and Private Forestry, the National Park Service, U.S. Geological Survey, University of Alaska, and other federal, state, and local agencies. The AKEPIC database maintains a georeferenced inventory of Alaska's invasive plants (AKEPIC 2015). Additionally, all invasive plant surveys, invasive plant finds, and treatments are entered into the Forest Service's Natural Resource Information System (NRIS) georeferenced invasive species database (USDA Forest Service 2016a).

The invasiveness of non-native plants has been ranked to better assess what species could be most problematic in Alaskan ecosystems. Of the 124 (Table 3.7-2) species of invasive plants on the Tongass, 94 have been given an invasiveness ranking (some plants have not yet been ranked). The invasiveness ranking is based on analysis of the following four parameters for each species:

- Ecological impact: impact on processes, community structure and composition, and other trophic levels.
- Biological characteristics and dispersal ability: mode of reproduction, methods of dispersal, potential to be spread by human activities, competitive abilities, and habitat.
- Ecological amplitude and distribution: United States and global distribution, and level of impact in other locations.
- Feasibility of control: seed bank viability, other methods of reproduction, and effort known to be required for control.

Invasiveness rankings range from 1 to 100 (100 representing the highest invasiveness rating) (Carlson et al. 2008). The invasiveness rankings of non-native plants in Alaska are available online through the ANHP at: http://aknhp.uaa.alaska.edu/botany/akepic/non-native-plant-species-list/#content

During the past decade, surveys have been conducted for invasive plants along most forest highway roads, as well as many trails, trailheads, and other sites of recent human activity in Southeast Alaska. Recently, systematic surveys of all invasive plants have been initiated in areas of heavier use that are more susceptible to invasive plant invasion. The areas of greatest invasive plant diversity and extent of invasion have been found around towns and the most heavily traveled areas. The areas with the lowest number of species were further from population centers or paved roads (Arhangelsky 2005). Schrader and Hennon (2005) cited references suggesting that the greatest invasive plant diversity and density are in areas of human activity, such as roads, recreational areas, industrial, commercial, and industrial development.

Surveys conducted between 2005 and 2010 documented species occurrences but did not accurately map invasive plant infestations. After 2010, this information was used to generate an invasive plant map which resulted in on overall under-representation of acres infested. Therefore, the current Forest Service database (NRIS-INVP) and associated map provides an estimate of the extent of infestation, as well as the locations of species observed. Table 3.7-2 lists the number of invasive plant species known on the Tongass.

Table 3.7-2
Number of Invasive Plant Species on the Tongass National Forest by District

Ranger District	Number of Invasive Plant Species
Admiralty National Monument	17
Craig Ranger District	51
Hoonah Ranger District	40
Juneau Ranger District	52
Ketchikan-Misty Fiords Ranger District	53
Petersburg Ranger District	54
Sitka Ranger District	47
Thorne Bay Ranger District	80
Wrangell Ranger District	45
Yakutat Ranger District	19
Total	**124**

Source: USDA Forest Service 2016a

Table 3.7-3 is a list of all invasive plants known on the Tongass National Forest and their invasiveness ranking.

Table 3.7-3
Invasive Plants on the Tongass: Number of Occurrences and Invasiveness Ranking

Common Name	Scientific Name	Number of Occurences[1]	Invasiveness Ranking[2]
alfalfa	*Medicago sativa*	1	59
alsike clover	*Trifolium hybridum*	609	57
annual bluegrass	*Poa annua*	956	46
annual canarygrass	*Phalaris canariensis*	1	not ranked
big chickweed; common mouse-ear chickweed	*Cerastium fontanum* subsp. *vulgare; Cerastium fontanum*	1,560	36
big trefoil	*Lotus pedunculatus*	1	not on list[3]
bigleaf lupine	*Lupinus polyphyllus* ssp. *polyphyllus*	101	71
birdeye pearlwort	*Sagina procumbens*	29	39
bird's foot trefoil	*Lotus corniculatus*	16	65
Bishop's goutweed	*Aegopodium podagraria*	2	57
bitter dock	*Rumex obtusifolius*	9	48
black bindweed	*Polygonum* (*Fallopia*) *convolvulus*	3	50
black medic, hop clover	*Medicago lupulina*	64	48
bladder campion	*Silene latifolia*	1	42
Bohemian knotweed	*Polygonum* (*Fallopia*) *bohemicum*	3	87
brittlestem hempnettle	*Galeopsis tetrahit*	20	50
bull thistle	*Cirsium vulgare*	45	61
burr medic	*Medicago minima*	2	not ranked
butter and eggs	*Linaria vulgaris*	2	69
Canada bluegrass	*Poa compressa*	73	39
Canada thistle	*Cirsium arvense*	23	76
Canadian horseweed	*Conyza canadensis*	1	not ranked
colonial bentgrass	*Agrostis capillaris* (*A. tenuis*)	59	not ranked
common brassbuttons	*Cotula coronopifolia*	2	42
common chickweed	*Stellaria media*	50	42
common comfrey	*Symphytum officinale*	1	48
common dandelion	*Taraxacum officinale*	1,727	58
common dogmustard	*Erucastrum gallicum*	2	not ranked

Table 3.7-3 (continued)
Invasive Plants on the Tongass: Number of Occurrences and Invasiveness Ranking

Common Name	Scientific Name	Number of Occurrences[1]	Invasiveness Ranking[2]
common eyebright	*Euphrasia nemorosa*	17	42
common groundsel; old man-in-the-spring	*Senecio vulgaris*	9	36
common gypsyweed	*Veronica officinalis*	1	not ranked
common hawkweed	*Hieracium lachenalii*	3	57
common nipplewort	*Lapsana communis*	25	33
common plantain	*Plantago major* var. *major*	2,663	44
common sheep sorrel	*Rumex acetosella*	93	51
common St. Johnswort	*Hypericum perforatum*	27	52
common tansy	*Tanacetum vulgare*	24	60
common velvetgrass	*Holcus lanatus*	128	56
common wheat	*Triticum aestivum*	1	not ranked
common yarrow	*Achillea millefolium* var. *millefolium*	99	not on list[3]
creeping bentgrass	*Agrostis stolonifera*	50	not ranked
creeping buttercup	*Ranunculus repens*	738	54
crested wheatgrass	*Agropyron cristatum*	1	not ranked
curly dock	*Rumex crispus*	16	48
curlytop knotweed	*Polygonum lapathifolium* (*Persicaria lapathifolia*)	1	47
disc mayweed; pineappleweed	*Matricaria discoidea*	104	32
dooryard dock; garden dock	*Rumex longifolius*	4	48
European mountain ash	*Sorbus aucuparia*	5	59
fall dandelion	*Leontodon autumnalis*	3	51
field mustard	*Brassica rapa* *Brassica rapa* var. *rapa*	45	50
field sowthistle	*Sonchus arvensis*	24	73
fowl bluegrass	*Poa palustris*	720	not on list[3]
foxtail barley	*Hordeum jubatum*	9	63
garden strawberry	*Fragaria ananassa*	9	not on list[3]
garlic mustard	*Alliaria petiolata*	2	70
Gerrman chamomile	*Matricaria recutita*	1	not on list[3]
germander speedwell	*Veronica chamaedrys*	2	not ranked
green bristlegrass	*Setaria viridis*	1	not ranked
hairy cat's ear	*Hypochoeris radicata*	142	44
horseradish	*Armoracia rusticana*	1	not ranked
Italian ryegrass	*Lolium perenne* ssp. *multiflorum*	21	41
Japanese knotweed	*Polygonum cuspidatum* (*Fallopia japonica*)	14	87
Kentucky bluegrass	*Poa pratensis*	670	52
lady's mantle	*Alchemilla mollis*	1	56
lambsquarters	*Chenopodium album*	1	37
lesser burdock	*Arctium minus*	1	49
lesser hawkbit	*Leontodon taraxacoides* ssp. *taraxacoides* (*L. hirtus*)	1	not ranked
marsh cudweed	*Gnaphalium palustre*	11	not ranked
max chrysanthemum	*Leucanthemum maximum*	5	not ranked
mayweed, stinking chamomile	*Anthemis cotula*	2	41
meadow fescue	*Schedonorus pratensis* (*Lolium pratense*)	9	not ranked
meadow foxtail	*Alopecurus pratensis*	18	52
meadow hawkweed	*Hieracium caespitosum*	10	79
narrowleaf hawksbeard	*Crepis tectorum*	27	56
narrowleaf hawkweed	*Hieracium umbellatum*	9	51
orange hawkweed	*Hieracium aurantiacum*	355	79

Table 3.7-3 (continued)
Invasive Plants on the Tongass: Number of Occurrences and Invasiveness Ranking

Common Name	Scientific Name	Number of Occurrences[1]	Invasiveness Ranking[2]
orchardgrass	*Dactylis glomerata*	593	53
oxeye daisy	*Leucanthemum vulgare*	663	61
paleyellow iris	*Iris pseudacorus*	1	66
perennial cornflower	*Centaurea montana*	3	46
perennial rye grass	*Lolium perenne* ssp. *perenne*	141	52
prickly lettuce	*Lactuca serriola*	5	not ranked
prostrate knotweed	*Polygonum aviculare*	1	45
purple foxglove, foxglove	*Digitalis purpurea*	65	51
quackgrass	*Elymus repens*	1	59
Queen Anne's lace	*Daucus carota*	1	not ranked
rampion bellflower	*Campanula rapunculooides*	1	64
red clover	*Trifolium pratense*	147	53
red fescue	*Festuca rubra*	2	not on list[3]
red sandspurry	*Spergularia rubra*	1	34
redtop	*Agrostis gigantea*	338	not ranked
reed canarygrass	*Phalaris arundinacea*	4,138	83
Robert geranium	*Geranium robertianum*	3	67
rough bluegrass	*Poa trivialis*	43	52
rugose rose	*Rosa rugosa*	1	72
scentless mayweed	*Tripleurospermum perforatum* (*T. inodorum*)	9	48
scotch broom	*Cytisis scoparius*	2	69
shepherd's purse	*Capsella bursa-pastoris*	5	40
Siberian wildrye	*Elymus sibiricus*	1	53
slender hairgrass	*Deschampsia elongata*	300	35
smooth brome	*Bromus inermis* ssp. *inermis*	5	62
sneezeweed	*Achillea ptarmica*	2	46
spearmint	*Mentha spicata*	2	43
spiny sowthistle	*Sonchus asper*	14	46
splitlip hempnettle	*Galeopsis bifida*	4	50
spotted knapweed	*Centaurea stoebe* ssp. *micranthos* (*C. biebersteinii*)	6	86
sticky chickweed	*Cerastium glomeratum*	1	36
suckling clover	*Trifolium dubium*	3	50
sweet vernalgrass	*Anthoxanthum odoratum*	13	not ranked
tall buttercup	*Ranunculus acris*	14	54
tall fescue	*Schedonorus phoenix* (*S. arundinaceus; Festuca arundinacea*)	620	63
tall oatgrass	*Arrhenatherum elatius*	3	not ranked
tansy ragwort, stinky willie	*Senecio jacobea*	13	63
thyme-leaf speedwell	*Veronica serpyllifolia* ssp. *serpyllifolia*	205	36
timothy	*Phleum pratense*	1,769	54
true forget-me-not	*Myosotis scorpioides*	41	54
wall hawkweed	*Hieracium murorum*	35	not ranked
wall lettuce	*Mycelis muralis*	45	31
water foxtail	*Alopecurus geniculatus*	2	49
western dock	*Rumex aquaticus* var. *fenestratus*	4	not on list[3]

Table 3.7-3 (continued)
Invasive Plants on the Tongass: Number of Occurrences and Invasiveness Ranking

Common Name	Scientific Name	Number of Occurrences[1]	Invasiveness Ranking[2]
white clover	*Trifolium repens*	2,612	59
wormseed mustard, wormseed wallflower	*Erysimum cheiranthoides*	3	not on list[3]
yellow salsify, goatsbeard	*Tragopogon dubius*	1	50
yellow sweet clover	*Melilotus officinalis*	18	69

[1] USDA Forest Service 2016: http://data.fs.usda.gov/geodata/edw/datasets.php?dsetParent=InvasiveSpecies
[2] AKEPIC 2016: http://aknhp.uaa.alaska.edu/botany/akepic/non-native-plant-species-list/#content
[3] Plant not listed on the AKEPIC non-native species list

Environmental Consequences

The alternatives described in Chapter 2 differ in the locations, type, and extent of timber harvest. Effects from the proposed alternatives would mainly apply to productive old-growth (POG) and young-growth forests. Although there would be effects on unproductive forest, non-forest or other vegetation types, these effects would be limited since these vegetation types would not be the focus of any proposed action. Renewable energy projects and road construction activities (construction, reconstruction and maintenance), however, would impact unproductive forest, non-forest, and other vegetation types. Impacts to POG and young growth are described in the *Biodiversity* section, and thus will not be further discussed, except as relevant to this section.

This section compares effects of the five alternatives on sensitive, rare, and invasive plants. There would be no effects to threatened or endangered plants because none are known on the Tongass.

Direct and Indirect Effects

Sensitive and Rare Plants

Effects Common to All Alternatives

Direct effects of the proposed alternatives on sensitive or rare plants during timber harvest would include physical damage by cutting, trampling, or crushing them with vehicles, other machinery, foot traffic, or felled trees. Severe impacts may cause mortality, or inhibit the vigor and reproductive capability of the plants.

Construction of new roads and construction of renewable energy projects and associated utility lines would also involve temporary and permanent removal of vegetation within the path of the road or construction footprint. Additionally, if a hydroelectric power project involves creation of a reservoir, inundation would result in the removal of vegetation within the inundation zone. These activities could affect rare and sensitive plants that inhabit the specific habitat found within the location of a new road, renewable energy project facility or utility line corridor. Roads and utility lines can be constructed in many types of habitat, depending on the need for access for forestry activities or energy transmission.

Road reconstruction maintains the original investment and makes the road suitable and safe for the intended use and typically involves the rehabilitation of the original roadbed. It can include cleaning ditches, replacing drainage structures, re-installing bridges, and grading and shaping. The roadbed had been created and used (compacted) in the past and, in general, no longer supports sensitive or rare plants; however, newly exposed bedrock in unique geological areas could create new habitat for some rare and sensitive plants. Road maintenance can include reconditioning the original road template, grading

the road surface, cleaning roadside ditches, and removing vegetation that may encroach upon the road or block vision. Because the maintenance activities remain in the existing road prism, these activities would be unlikely to have an effect on sensitive or rare plants or their habitat.

Indirect effects to sensitive or rare plants from timber harvest, road construction, and construction of renewable energy projects and associated utility lines involves alteration of habitat, such as changes in sunlight and moisture availability, herbivore or pollinator behavior, soil structure and fertility, vegetation structure, fragmentation of habitat, and competition from other native plants as well as invasive plants. Some indirect effects, such as changes in sunlight or moisture, can be beneficial or harmful depending on the effect and the species' life history. For example, if a plant has habitat requirements of partial sun, then increasing the size of a forest opening may benefit that species; however, that same opening may be harmful to a plant that requires shade. Activities likely to cause indirect effects to sensitive and rare plants include removal or reduction of tree canopy, road construction, changes in hydrology associated with road construction, reservoir creation or flow diversion, increased competition from invasive plants, increased off-road vehicle use, increased access, and increased use and associated trampling by recreationists.

Under all alternatives, a biological evaluation (BE) was conducted for sensitive plants for the planning area (Krosse 2016). A BE is also conducted as part of the site-specific environmental analysis for individual project proposals. This type of sensitive plant review is required to include sufficient detail to determine how any proposed action may affect each sensitive species. The intensity and scope of inventories selected to provide information for effects analysis is required to be commensurate with the potential risk of a proposed project to sensitive plant species. The review is used to evaluate project-level impacts to sensitive plants in order to ensure that proposed project activities do not contribute to population or habitat declines that could lead to federal listing or loss of viability in the plan area (the Tongass National Forest). In addition, existing Forest-wide standards and guidelines would be applied to avoid or minimize impacts to those sensitive plants and their habitat.

The Forest-wide standards and guidelines include a provision for reviewing the implementation and effectiveness of conservation actions for sensitive plants. This review provides information to improve conservation efforts and reduce the likelihood of negative effects to sensitive plant species due to management actions.

As a part of National Environmental Policy Act (NEPA) analysis, an effects analysis may also be conducted for rare plants; however, a formal BE is not required. All alternatives would continue to follow the current Forest-wide standards and guidelines for rare plants.

Effects Specific to Each Alternative

Impacts to sensitive and rare plant species from timber harvest, road construction, and renewable energy development, as well as species specific impacts to the 16 sensitive plant species known or suspected to occur on the Tongass under each alternative are discussed in the sections below.

Approximately 126 plants listed on the ANHP Rare Vascular Plant List have been documented on the Tongass; because of the large number of rare plants, species specific impacts to rare plants are not discussed in this document, but if, during project planning, they are known or suspected within the project area, they would be evaluated.

Timber Harvest and Road Construction
In general, alternatives with fewer acres of timber harvest and miles of road construction would have less risk of direct and indirect adverse effects to sensitive and rare plants. Alternatives with more acres proposed for harvest and miles of road construction would have more risk of adverse effects. Other activities related to timber harvest, such as log transfer facility (LTF) construction, would increase with elevated timber harvests.

Table 3.7-4 displays the maximum acres of timber harvest and miles of road construction that would occur under each alternative after 100 years. Based on the proposed maximum acres of timber harvest and miles of road construction for each alternative (Table 3.7-4), Alternatives 2 and 3 would have a higher risk of direct and indirect effects to sensitive and rare plants due to harvest and road work than the other alternatives. Alternative 1 would result in the least amount of timber harvest (maximum harvest of 272,733 acres over 100 years), but would result in the greatest acreage of old-growth timber harvest (Table 3.7-4). Alternatives 4 and 5 propose fewer acres of harvest than Alternatives 2 and 3; however, Alternatives 4 and 5 would harvest more acres of old growth than either Alternatives 2 or 3.

Alternative 2 would result in the greatest amount of total road construction (new and reconstructed roads) and the greatest amount of new road construction, followed by Alternatives 3, 5, 1, and 4 (Table 3.7-4). As stated above, new road construction has a greater risk of adverse effects to sensitive and rare plants than road reconstruction. Increased harvest of POG and new road construction could increase the risk of adverse effects to sensitive and rare plant species as compared to harvest of young-growth and road reconstruction activities. A species distribution is limited to areas that can meet the species-specific physical and biological needs. Due to the limited scope of surveys conducted within the Tongass, exact distributions of plants and their habitat are unknown. Although it is not possible to predict the exact distribution of each species, knowing the preferred habitats for sensitive and rare plants can aid in assessing the potential risk for each species from timber harvest, road construction, and other activities under the proposed alternatives. Therefore, in addition to the number of acres of timber harvest and miles of road construction, the locations of these activities may increase or decrease the potential risk of adverse effects to sensitive and rare plant species.

Table 3.7-4
Maximum Acres of Harvest and Maximum Miles of Road Construction by Alternative

	Alternative				
	1	2	3	4	5
Maximum Acres Likely to be Harvested after 100 years					
Productive Old Growth	62,851	32,609	35,568	42,597	42,479
Young Growth	209,882	335,344	313,216	234,885	284,144
Total Acres	272,733	367,953	348,784	277,482	326,623
Maximum Miles of Road Likely to be Constructed after 100					
New Road Construction	944	1,056	1,020	871	994
Road Reconstruction Decom. Roadbeds and Road Reconstruction	1,315	1,790	1,696	1,344	1,585
Total Road Work (includes reconstruction)	2,259	2,846	2,716	2,216	2,579

Source: Tongass National Forest GIS database

Table 3.7-5 below (and Table 3.9-13 in the *Biodiversity* section) displays the acres of projected young-growth and old-growth timber harvest in beach buffer, Riparian Management Areas (RMAs), old-growth reserves (OGRs), other non-development land use designations (LUDs), and 2001 Roadless Areas under each alternative. Harvest of young growth and old growth would not occur in any of these areas under Alternative 1. This represents the current condition from the 2008 Forest Plan Amendment. Old-growth harvest would not occur in beach buffers, RMAs, OGRs, or other non-development LUDs under any of the other alternatives and would only occur in 2001 Roadless Areas under Alternatives 2 and 3 (Table 3.7-5). Projected harvest of young-growth would be greatest in RMAs, OGRs, and other non-development LUDs under Alternative 2. Projected harvest of young growth would be greatest in beach buffers and 2001 Roadless Areas and second greatest in OGRs and other non-development LUDs under Alternative 3. Under Alternative 4, young-growth harvest is only projected to occur in beach buffers. Under Alternative 5, young-growth harvest would occur in beach buffers, RMAs, and OGRs. Alternative 1 would have the lowest risk of potential direct and indirect effects to sensitive and rare plant species found in beach buffers, RMAs, OGRs, other non-development LUDs, and 2001 Roadless Areas compared to the other alternatives. Alternative 2, followed by Alternative 3, would have the highest risk of potential direct and indirect effects to sensitive and rare plant species found in these habitats compared the other alternatives.

Table 3.7-5
Projected Harvest of Young Growth[1] and Old Growth in Beach Buffers, RMAs, Old-Growth Reserves, other Non-Development LUDs, and 2001 Roadless Areas by Alternative

Conservation Strategy Component	Estimated Acres of Harvest over 100 Years									
	Alt 1		Alt 2[1]		Alt 3[2]		Alt 4[3]		Alt 5[4]	
	YG	OG	YG	OG	YG	OG	YG	OG	YG	OG
Harvest in Beach Buffer	0	0	21,871	0	30,769	0	11,114	0	3,903	0
Harvest in RMA	0	0	26,030	0	0	0	0	0	1,089	0
Harvest In OGRs	0	0	31,640	0	26,186	0	0	0	1,811	0
Harvest in other Non-Development LUD	0	0	11,641	0	10,593	0	0	0	0	0
Maximum Harvest in 2001 Roadless Areas	0	0	9,104	2,171	11,809	17,037	0	0	0	0

[1] Alt 2 Prescriptions: Young Growth - Clearcutting is permitted in Beach Buffer for first 15 years; thereafter, only Commercial Thinning is permitted. Only Commercial Thinning is permitted in RMAs. Clearcutting is permitted in OGRs, Non-Development LUDs, and Roadless Areas, unless otherwise restricted. Old Growth - Clearcutting is permitted in Roadless Areas.
[2] Alt 3 Prescriptions: Young Growth - Only Commercial Thinning is permitted in Beach Buffers. Clearcutting is permitted in OGRs, Non-Development LUDs, and Roadless Areas, unless otherwise restricted. Old Growth - Clearcutting is permitted in Roadless Areas.
[3] Alt 4 Prescriptions: Young Growth - Only Commercial Thinning is permitted in Beach Buffers.
[4] Alt 5 Prescriptions: Young Growth - Group Selection and Commercial Thinning are permitted in Beach Buffers, OGRs, and RMAs for first 15 years; thereafter, No Harvest is permitted.

Renewable Energy Site Development

Development of renewable energy sites would occur under all alternatives; however, Alternatives 2, 3, 4, and 5 would include new management direction (i.e., plan components) in the Forest Plant that improves flexibility in renewable energy development. Alternative 1 would not facilitate the development of renewable energy sites to the extent that Alternatives 2, 3, 4, and 5 would. Therefore, these alternatives could result in greater impacts to sensitive and rare plant species than Alternative 1 from development of renewable energy sites. Under all alternatives; however, renewable energy site development would be subject to site-specific environmental analysis under NEPA.

Species Specific Impacts to Sensitive Plants

Potential effects to the 16 sensitive plant species known or suspected to occur on the Tongass National Forest under each of the alternatives are discussed below. In addition to assessing potential impacts to sensitive species based on locations and acres of timber harvest and miles of road construction, potential impacts to known occurrences of sensitive plant species can be estimated by looking at the proportion of occurrences of each sensitive plant species in areas suitable for young-growth and old-growth harvest, and the percent of harvest expected in each of these suitable areas under each alternative. Table 3.7-6 below displays the proportion of known occurrences of the three sensitive species expected to be in old-growth or young-growth harvest units after 100 years.

Eschscholtz's little nightmare (Aphragmus eschscholtzianus):

This species grows within moist mossy areas, seeps, heaths, and scree slopes in subalpine and alpine locations, areas where timber harvest and renewable energy development would likely not occur. Additionally, very little access to timber (i.e., road construction) through its preferred habitat (alpine or subalpine areas) would likely occur under any of the alternatives. Although suspected to occur on the Tongass, no populations of Eschscholtz's little nightmare have been documented; therefore, no known populations of this species would be impacted by timber harvest, road construction, or renewable energy development under any of the alternatives. If previously undocumented populations of this species are located during project surveys, Forest-wide standards and guidelines under all alternatives would consider protection to minimize impacts to this species on the Tongass. Because this species is not currently documented on the Tongass, because it may receive protection from existing Forest-wide standards and guidelines, and because there is a very low chance of impacting populations or habitat for Eschscholtz's little nightmare, there is a very low risk that any alternative would impact this species.

Spatulate moonwort (Botrychium spathulatum):

Across its range, habitat for this species includes coastal forests, riparian forests, stabilized coastal dunes, maritime and upper beach meadows, well-drained open areas, limestone, alpine habitats and areas historically disturbed by humans such as roadsides. On the Tongass, this species is currently only known from one population located on a calcareous, subalpine ridge (USDA Forest Service 2015e) which would likely not be impacted by timber harvest, road construction, or renewable energy and utility line projects under any of the alternatives. Additionally, no known occurrences of spatulate moonwort are expected in old-growth or young-growth harvest units under any of the alternatives. However, due to the small stature of this species and the difficulty of correct identification, spatulate moonwort has likely been overlooked or misidentified; therefore, it is likely that additional populations of this species exist on the Tongass (USDA Forest Service 2015e).

Table 3.7-6
Proportion of Known Occurrences of Sensitive Plant Species with the Potential to be in Old-Growth or Young-Growth Harvest Units after 100 Years

	Alternative									
	1		2		3		4		5	
Species	Known Occurrences Estimated to be in OG Harvest Units	Known Occurrences Estimated to be in YG Harvest Units	Known Occurrences Estimated to be in OG Harvest Units	Known Occurrences Estimated to be in YG Harvest Units	Known Occurrences Estimated to be in OG Harvest Units	Known Occurrences Estimated to be in YG Harvest Units	Known Occurrences Estimated to be in OG Harvest Units	Known Occurrences Estimated to be in YG Harvest Units	Known Occurrences Estimated to be in OG Harvest Units	Known Occurrences Estimated to be in YG Harvest Units
Lichen, no common name (*Lobaria amplissima*)	0	0	0	0.9	0	0.9	0	0.9	0	0
Alaska rein-orchid (*Piperia unalascensis*)	0.6	0	0.3	0	0.1	0	0.3	0	0.4	0
Lesser round-leaved orchid (*Plantathera orbiculata*)	16.1	16.7	8.4	23.2	5.9	23.2	9.3	14.2	8.7	20.1

Under Alternative 1, timber harvest would not occur in the beach buffer and RMAs, two of the preferred habitats where this species may occur. Under Alternatives 2 and 5, young-growth timber harvest would be allowed in the beach buffer and in RMAs suitable for timber production and, under Alternatives 3 and 4, timber harvest would be allowed in the beach fringe (Table 3.7-5). Alternatives 2 through 5, therefore, would result in increased risk of potential adverse effects to undocumented occurrences of spatulate moonwort compared to Alternative 1. Alternatives 2 and 3 would have the greatest projected timber harvest in RMAs and beach buffers; therefore, they would have a greater risk of potential effects to undocumented occurrences of spatulate moonwort from timber harvest than all the other alternatives. Additionally, Alternatives 2 and 3 would result in more miles of road construction and reconstruction than the other alternatives (Table 3.7-4); thus, these two alternatives would pose a greater risk of potential effects to spatulate moonwort from road construction and reconstruction than the other alternatives.

Forest-wide standards and guidelines under all alternatives would consider protection to minimize adverse impacts to this species if populations are located during pre-project surveys. Because spatulate moonwort may receive protection from existing Forest-wide standards and guidelines and because there is a very low chance of impacting the one known occurrence of this species, there is a low risk that any alternative would impact this species.

Moosewort fern (Botrychium tunux):
Across its range, habitat for moosewort fern includes upper beaches, beach meadows, coastal dunes, riparian forests, stream terraces, and river bars. Habitat on the Tongass also includes subalpine and alpine rocky slopes (USDA Forest Service 2015e). Due to the small stature of this species, it has likely been overlooked and there are potentially additional populations on the Tongass National Forest (USDA Forest Service 2015e). On the Tongass, eight of the nine known occurrences of moosewort fern are found within non-development LUDs, including seven occurrences on beach meadows (within non-development LUDs) in the Yakutat area. One known occurrence of this species is located within a non-forested area Timber Production LUD on the Wrangell Ranger District. However, no known occurrences of moosewort fern are expected in old-growth or young-growth harvest units under any of the alternatives.

Under Alternative 1, timber harvest would not occur in non-development LUDs, or in beach buffer and RMAs, which are the preferred habitat for this species. While access to timber through beaches may be needed under Alternative 1 if new LTFs are required, it would be infrequent. Under Alternatives 2 and 5, young-growth timber harvest would occur in the beach buffer and RMAs and under Alternatives 3 and 4 timber harvest would occur in the beach buffer (Table 3.7-5). Therefore, Alternatives 2 through 5 would result in increased risk of potential adverse effects to undocumented populations of moosewort fern and its habitat from timber harvest compared to Alternative 1. Alternatives 2 and 3 would have the greatest projected timber harvest in RMAs and beach buffers and; therefore, they would have a greater risk of potential adverse effects to moosewort fern from timber harvest than the other alternatives. Additionally, Alternatives 2 and 3 would result in more miles of road construction and reconstruction than the other alternatives (Table 3.7-4); thus, these two alternatives would have a greater risk of potential adverse effects to moosewort fern from road construction and reconstruction than the other alternatives.

Alternatives 2 through 5 would also facilitate the development of renewable energy projects and would allow their development in the beach buffer and RMAs. Therefore, Alternatives 2 through 5 would result in increased risk of potential adverse effects to moosewort fern and its habitat from renewable energy development compared to Alternative 1.

Forest-wide standards and guidelines under all alternatives would consider protection to minimize adverse impacts to this species if populations are located during pre-project surveys. Because moosewort fern may receive protection from existing Forest-wide standards and guidelines and because no known occurrences of moosewort fern are expected in old-growth or young-growth harvest units under any of the alternatives, there is a low chance of impacting known occurrences of this species.

Moonwort fern (Botrychium yaaxudakeit)
Habitat for this species includes upper beach meadows, beach dunes, coastal outwash plains, and abandoned fields and roadsides. The five occurrences of moonwort fern on the Yakutat Ranger District are located in a non-development LUD (Semi-Remote Recreation). No known occurrences of moonwort fern are expected in old-growth or young-growth harvest units under any of the alternatives.

Under the Alternative 1, timber harvest would not occur in non-development LUDs or the beach buffer and RMAs which are the preferred habitat for this species. While access to timber through beaches may be needed under Alternative 1 if new LTFs are required, it would be infrequent. Therefore, under Alternative 1, there is essentially no risk of impact to this species from timber harvest and road construction. Under Alternatives 2 through 5, young-growth timber harvest would be allowed in the beach buffer which could potentially result in impacts to undocumented occurrences of moonwort fern. Alternatives 2 and 3 would have the greatest projected timber harvest in RMAs and beach buffers (Table 3.7-5). Additionally, Alternatives 2 and 3 would result in more miles of road construction and reconstruction than the other alternatives (Table 3.7-4); thus, these two alternatives would result in a greater risk of potential adverse effects to moonwort fern from timber harvest and road construction and reconstruction than the other alternatives.

Alternatives 2 through 5 would also facilitate the development of renewable energy projects and would allow their development in the beach buffer. Therefore, Alternatives 2 through 5 would result in increased risk of potential adverse effects to moonwort fern and its habitat from renewable energy development compared to Alternative 1.

If populations of this species are located during project surveys, Forest-wide standards and guidelines under all alternatives would consider protection to minimize adverse impacts to this species. Because no known occurrences of moonwort fern would be impacted under any of the alternatives and because this species may receive protection from existing Forest-wide standards and guidelines, there is a low risk that any alternative would impact this species.

Macoun's thistle (Cirsium edule var. macounii):
Two occurrences of Macoun's thistle are known on the Tongass, both on the Ketchikan-Misty Fiords Ranger District. One occurs in a non-development LUD (Nonwilderness National Monument) and one occurs in a Development LUD (Timber Production). The likelihood of adverse effects to this species from timber harvest and associated road construction under all alternatives is low because habitat for this plant includes open meadows, open forests in the upper montane to lower alpine zone, scree slopes, and along glacial streams and lakeshores where harvest typically would not occur. However, access to timber through these types of habitat may be needed. Alternatives 2 and 3 would result in more miles of road construction and reconstruction than the other alternatives (Table 3.7-4); thus, these two alternatives would have a greater risk of potential adverse effects to Macoun's thistle from road construction and reconstruction than the other alternatives.

Alternatives 2 through 5 would facilitate the development of renewable energy projects; therefore, Alternatives 2 through 5 may result in a slightly increased risk of

potential adverse effects to Macoun's thistle and its habitat compared to Alternative 1. Because this species is not likely to be impacted by timber harvest and because protection from the Forest-wide standards and guidelines would consider protection to minimize adverse impacts to this species from road construction and reconstruction and renewable energy projects under all alternatives, there is a low risk that any alternative would impact this species.

Mountain lady's slipper (Cypripedium montanum):
Within its range, this species is known from a variety of habitats including upper beach meadows, areas along the beach-forest ecotone, open forests, muskegs, and wet meadows. On the Tongass, this species is currently only known from one location on Etolin Island on the Wrangell Ranger District. This population is adjacent to an existing road, which is to be reconstructed (USDA Forest Service 2015e).

Under Alternative 1, timber harvest would not occur in the beach buffer. While access to timber through beaches may be needed under Alternative 1 if new LTFs are required, this would be infrequent. Under Alternatives 2 through 5, young-growth timber harvest would be allowed in the beach buffer (Table 3.7-5). Projected harvest in the beach buffer would be greatest under Alternatives 2 and 3, followed by Alternatives 4 and 5. Therefore, Alternatives 2 and 3 would have a greater risk of potential adverse effects to mountain lady's slipper than the other alternatives. Additionally, Alternatives 2 and 3 would result in more miles of road construction and reconstruction than the other alternatives (Table 3.7-4); thus, these two alternatives would result in a greater risk of potential adverse effects to mountain lady's slipper from road construction and reconstruction than the other alternatives. Alternatives 2 through 5 would facilitate the development of renewable energy projects and would allow their development in the beach buffer. Therefore, Alternatives 2 through 5 would result in increased risk of potential adverse effects to mountain lady's slipper and its habitat from renewable energy development compared to Alternative 1.

Forest-wide standards and guidelines under all alternatives would consider protection to minimize adverse impacts to this species if it is located during pre-project surveys. However, because only one occurrence of this species is known in the plan area, coupled with the potential for some level of impacts to this occurrence from future timber harvest and road construction, an increased level of risk to this species exists under all alternatives.

Large yellow lady's slipper (Cypripedium parviflorum var. pubescens):
Across its range this species is known from scree slopes, rock outcrops, and river bluffs and is often associated with open spruce forest and aspen woodlands. On the Tongass, this orchid is known from peatlands on calcareous substrates. There are two known occurrences of large yellow lady's slipper on the Tongass, both within a Timber Production LUD on northern Prince of Wales Island. Although the habitats where this species is suspected to occur are not generally vulnerable to timber harvest, the known occurrences of this species are located near existing roads (USDA Forest Service 2015e).

Based on the limited number and small size of the occurrences on the Tongass and existing threats to known occurrences from proposed road construction, additional impacts to this species from road construction or renewable energy and utility line projects under all alternatives could impact the ability of this species to persist over time. Alternatives 2 and 3 would result in more miles of road construction and reconstruction than the other alternatives (Table 3.7-4); thus, these two alternatives would result in a greater risk of potential adverse effects to large yellow lady's slipper from road construction and reconstruction than the other alternatives. Alternatives 2 through 5 would also facilitate the development of renewable energy

projects; therefore, Alternatives 2 through 5 would result in increased risk of potential adverse effects to large yellow lady's slipper and its habitat from renewable energy development compared to Alternative 1.

Forest-wide standards and guidelines under all alternatives would consider protection to minimize adverse impacts to known occurrences of this species and new occurrences of this species located during pre-project surveys. However, due to the low numbers of known occurrences of this species in the plan area, coupled with the potential for some level of impacts to these occurrences from future road construction, an increased level of risk to this species exists under all alternatives.

Calder's lovage (Ligusticum calderi):
Habitat for this plant includes alpine and subalpine meadows, boggy slopes, open mixed conifer forest, and rocky areas. Twenty-four occurrences of this species have been documented on the Tongass, 11 within development LUDs and 13 within non-development LUDs. However, no known occurrences of Calder's lovage are expected in old-growth or young-growth harvest units under any of the alternatives.

Although the habitats where this species is suspected to occur are not generally vulnerable to timber harvest, they may be impacted by road construction activities. Alternatives 2 and 3 would result in more miles of road construction and reconstruction than the other alternatives (Table 3.7-4); thus, these two alternatives would result in a greater risk of potential adverse effects to Calder's lovage from road construction and reconstruction than the other alternatives. Alternatives 2 through 5 would also facilitate development of renewable energy projects and would allow their development in the beach buffer and RMAs. Therefore, Alternatives 2 through 5 would result in increased risk of potential adverse effects to Calder's lovage and its habitat from renewable energy development compared to Alternative 1.

Forest-wide standards and guidelines under all alternatives would consider protection to minimize adverse impacts to the known occurrences of this species and new occurrences of this species located during pre-project surveys. Because habitat for this species is generally not vulnerable to timber harvest and because of the relatively low projected impacts from future road construction to the 24 known occurrences of this species on the Tongass, a low level of risk to this species exists under all alternatives.

Lichen, no common name (Lobaria amplissima):
In Southeast Alaska, this lichen is only known as an epiphyte on tree trunks and branches of the forest/beach ecotone (Dillman 2011b). Forested habitat where this species is found tends to be well drained, with old growth Sitka spruce and/or western hemlock trees. Known sites of this species are also exposed to the open ocean or other large bodies of marine water (e.g., ocean entrances to bays and inlets) (Dillman 2011b).

There are 30 documented occurrences of *Lobaria amplissima* on the Tongass, 5 of which are located in development LUDs and 25 of which are located within non-development LUDs. Under Alternatives 2, 3, and 5, timber harvest would occur in OGRs, and under Alternatives 2 and 3 harvest would occur in other non-development LUDs, which would increase the risk of potential adverse effects to *Lobaria amplissima* in these areas as compared to Alternatives 1 and 4. No known occurrences of this species are expected within old-growth or young-growth harvest units under Alternative 1 or Alternative 5 (Table 3.7-6). Approximately 0.9 of the known occurrences are expected to be within young-growth harvest units under Alternatives 3, 4, and 5 (Table 3.7-6).

Under Alternative 1, young-growth timber harvest would not occur in the beach buffer. While access to timber through beaches may be needed under Alternative 1

if new LTFs are required, it would be infrequent. Under Alternatives 2 through 5, young-growth timber harvest would occur in the beach buffer (Table 3.7-5). Alternative 3 would have the greatest projected harvest in the beach buffer, followed by Alternatives 2, 4, and 5. Additionally, Alternatives 2 and 3 would result in more miles of road construction and reconstruction than the other alternatives (Table 3.7-4); thus, these two alternatives would result in a greater risk of potential adverse effects to *Lobaria amplissima* from timber harvest and road construction and reconstruction than the other alternatives. Alternatives 2 through 5 would also facilitate the development of renewable energy projects and would allow their development in the beach buffer. Therefore, Alternatives 2 through 5 would result in increased risk of potential adverse effects to *Lobaria amplissima* and its habitat from renewable energy development compared to Alternative 1.

Forest-wide standards and guidelines under all alternatives would consider protection to minimize adverse impacts to known occurrences of this species and new occurrences of this species located during pre-project surveys. Because only about one of the 30 known occurrences is expected to be within young-growth harvest units, there would be a relatively low level of risk to this species under all alternatives.

Pale poppy (Papaver alboroseum):
Although suspected to occur on the Tongass, no populations of pale poppy have been documented; therefore, no known populations of this species would be impacted under any of the alternatives. This plant occurs in open, well-drained areas, recently deglaciated areas, rock outcrops, rocky tundra of ridges and mountain summits, sand and gravel of glacial outwash and river floodplains; areas where timber harvest would not typically occur. While road construction for access to timber through this type of habitat may be needed, it is not likely. Alternatives 2 through 5 would facilitate the development of renewable energy projects, which could impact habitat for this species. Therefore Alternatives 2 through 5 would have a slightly increased risk of potential adverse effects to pale poppy and its habitat from renewable energy development compared to Alternative 1.

If previously undocumented occurrences of this species are located during project surveys, Forest-wide standards and guidelines under all alternatives would consider protection to minimize impacts to this species. Because pale poppy is not currently documented on the Tongass, because it may receive protection from the Forest-wide standards and guidelines, and because of the very low chance of impacting potential habitat, there is a very low risk that any alternative would adversely impact this species.

Alaska rein orchid (Piperia unalascensis):
Habitat for Alaska rein orchid includes dry open sites, under tall shrubs in riparian zones, mesic meadows, drier areas in coniferous and mixed evergreen forests, and bogs and heath habitat from low to subalpine elevations. On the Tongass, this species often grows at the ecotone between forested and muskeg habitats and is generally found in low productivity forests at lower elevations in poorly drained soils (Dillman 2011a). However, some of the forest stands where the species is found are managed for timber production (USDA Forest Service 2015e). A few occurrences are located in the rights-of-way of forest roads; it is not known if they are remnants that have survived the disturbance, or if they have colonized the areas due to modification of habitat (USDA Forest Service 2015e).

There are 18 known occurrences of Alaska rein orchid on the Tongass, 8 of which occur in development LUDs and 10 of which occur in non-development LUDs. Under Alternatives 2, 3, and 5, timber harvest would occur in OGRs, and under Alternatives 2 and 3 harvest would occur in other non-development LUDs, which

would increase the risk of potential adverse effects to Alaska rein orchid in these areas as compared to Alternatives 1 and 4. Approximately 0.6 of the known occurrences of Alaska rein orchid are expected to be within old-growth harvest units under Alternative 1, 0.3 occurrences under Alternatives 2 and 4, 0.1 occurrences under Alternative 3, and 0.4 occurrences under Alternative 5 (Table 3.7-6).

Under Alternative 1, young-growth timber harvest would not occur in RMAs, habitat preferred by Alaska rein orchid. Under Alternatives 2 and 5, approximately 36,092 and 882 acres of young-growth timber harvest would occur in RMAs, respectively (Table 3.7-5). Timber harvest in RMAs would not occur under Alternatives 3 and 4. Therefore, Alternatives 2 and 5 would result in greater potential risk to Alaska rein orchid from young-growth timber harvest in RMAs than the other alternatives. Alternatives 2 and 3 would result in more miles of road construction and reconstruction than the other alternatives (Table 3.7-4); thus, these two alternatives would result in a greater risk of potential adverse effects to Alaska rein orchid from and road construction and reconstruction than the other alternatives.

Development of renewable energy projects would be facilitated under Alternatives 2 through 5 and these alternatives would allow their development in RMAs; resulting in an increased risk of potential adverse effects to Alaska rein orchid and its habitat under these alternatives compared to Alternative 1. Considering all factors, Alternative 2 would have the greatest potential risk of adverse effects to Alake rein orchid.

Forest-wide standards and guidelines under all alternatives would consider protection to minimize adverse impacts to known occurrences of this species and new occurrences of this species located during pre-project surveys. Because only a portion of one of the 18 known occurrences of this species is expected to be within old-growth harvest units, there would be a relatively low level of risk to this species under all alternatives.

Lesser round-leaved orchid (Platanthera orbiculata):
Habitat for lesser round-leaved orchid on the Tongass includes mesic areas of coniferous forests, forested wetlands, old-growth hemlock forests with high bryophyte cover and a red cedar component, and along the edges of forest near muskegs, open water, or boggy areas. There are 291 known occurrences of this species currently located at least partially on NFS land. Of these occurrences, 205 are located within development LUDs. These occurrences have recently been condensed into 61 distinct populations by the Alaska Natural Heritage Program (Fulkerson 2015 in progress). Of the total area occupied by the 61 known populations, 44 percent is located within non-development LUDs and 56 percent is located within development LUDs (USDA Forest Service 2015e). A recent pilot monitoring study of population trends for lesser round-leaved orchid on Prince of Wales Island suggested a potential 57 percent decrease in population density of observed plants over the two-year monitoring period (USDA Forest Service 2015e), indicating a possible concern about the long-term persistence of this species on this portion of the Tongass. However, the sample size of the pilot study was small resulting in high variation among sample plots and the monitoring was focused on known locations in only a portion of the Forest. Therefore, inferences regarding downward trends may only apply to populations on the portion of Prince of Wales Island where monitoring has occurred and should not be used to make accurate inferences to this species' viability across the Tongass. Additionally, factors related to a potential downward trend are uncertain and may include a number of variables, such as this species' inherent periodic dormancy, requirement for specific mycorrhizal symbiont, and herbivory, in addition to management actions such as timber harvest and road construction. Additional details on the pilot monitoring and

the status of lesser round-leaved orchid can be found in the Plants BE (Krosse 2016).

The proportion of known occurrences expected to be within old-growth harvest units under each alternative includes 16.1 occurrences under Alternative 1, 8.4 occurrences under Alternative 2, 5.9 occurrences under Alternative 3, 9.3 occurrences under Alternative 4, and 8.7 occurrences under Alternative 5 (Table 3.7-6). The number of occurrences expected to be within young-growth harvest units under each alternative includes 16.7 occurrences under Alternative 1, 23.2 occurrences under Alternatives 2 and 3, 14.2 occurrences under Alternative 4, and 20.1 occurrences under Alternative 5 (Table 3.7-6). Therefore, Alternative 2 has the potential to impact a greater proportion of the known occurrences of lesser round-leaved orchid than the other alternatives.

Under Alternatives 1 and 4, young-growth harvest would be restricted in non-development LUDs (Table 3.7-5). Additionally, fewer acres of timber and fewer miles of road are expected to be harvested and constructed under Alternatives 1 and 4 than under the other alternatives (Table 3.7-4). Alternatives 2, 3, and 5 would allow young-growth timber harvest in old-growth reserves and Alternatives 2 and 3 would also allow young-growth timber harvest in other non-development LUDs (Table 3.7-5). Additionally, acres of timber harvest and miles of road construction would be greatest under Alternative 2, followed by Alternative 3; therefore, Alternatives 2 and 3 would result in greater risk of potential adverse effects to lesser round-leaved orchid from timber harvest and road construction than the other alternatives.

Alternatives 2 through 5 would facilitate the development of renewable energy projects to a greater extent than Alternative 1. Therefore, Alternatives 2 through 5 would have a greater risk of potential adverse effects to lesser round-leaved orchid and its habitat from renewable energy development compared to Alternative 1.

Forest-wide standards and guidelines under all alternatives would consider protection to minimize adverse impacts to known occurrences of this species and new occurrences of this species located during project surveys. Because, at the most, out of the 291 distinct occurrences on the Tongass approximately 16 known occurrences are expected to be within old-growth harvest units, and another 23 known occurrences are expected to be within young-growth harvest units, there would be a relatively low level of risk to this species under all alternatives. Additional details on the assessment of impacts to lesser round-leaved orchid is provided in the Plants BE (Krosse 2016).

Kruckeberg's swordfern (Polystichum kruckebergii):
There are nine known occurrences of Kruckeberg's swordfern comprising three distinct populations in Southeast Alaska, one within a development LUD (Timber Production) on the Ketchikan-Misty Fiords Ranger District, one within a non-development (Wilderness) LUD on the Sitka Ranger District, and one on non-NFS land. On the Tongass, habitat for this species includes talus slopes and ultramafic rock outcrops, areas where timber harvest, road construction, and renewable energy development would not likely occur. While access to timber through this species' habitat may occur, it is not likely. No known occurrences of Kruckeberg's swordfern are expected in old-growth or young-growth harvest units under any of the alternatives.

Forest-wide standards and guidelines under all alternatives would consider protection to minimize adverse impacts to known occurrences of this species and new occurrences of this species located during project surveys. Because Kruckeberg's swordfern may receive protection from existing Forest-wide standards and guidelines and because there is a very low chance of impacting occurrences or

habitat for this species, there is a low risk of adverse impacts to this species under all alternatives.

Unalaska mist-maid (Romanzoffia unalaschcensis):
The plant grows on ledges and crevices within rock outcrops, in gravelly areas along stream banks, often along the coast; areas where timber harvest would likely not occur. Neither of the known occurrences of this species are expected in old-growth or young-growth harvest units under any of the alternatives. Habitat for this species; however, could potentially be impacted by road construction and renewable energy projects.

Both of the two known occurrences of Unalaska mist-maid on the Tongass occur within non-development (Special Interest Area) LUDs on the Thorne Bay Ranger District. Under Alternatives 1, 4, and 5, young-growth timber harvest would not occur in non-development LUDs (Table 3.7-5) whereas, under Alternatives 2 and 3, young-growth timber harvest would be allowed in non-development LUDs.

Timber harvest would not occur in RMAs (preferred habitat for this species) under Alternatives 1, 3, and 4; whereas, Alternatives 2 and 5 would allow approximately 36,092 and 882 acres of young-growth harvest in RMAs, respectively (Table 3.7-5). Alternatives 2 would also result in more miles of road construction and reconstruction than the other alternatives (Table 3.7-4). Alternative 2, therefore, would result in a greater risk of adverse impacts to this species compared to the other alternatives

Forest-wide standards and guidelines under all alternatives would consider protection to minimize adverse impacts to known occurrences of this species and new occurrences of this species located during project surveys. Because Unalaska mist-maid may receive protection from existing Forest-wide standards and guidelines and because there is a low chance that any of the known occurrences will be associated with old-growth or young-growth timber harvest or other proposed activities in the future, there is a low risk that any alternative would adversely affect this species.

Henderson's checkermallow (Sidalcea hendersonii):
Potential habitat for this species includes wet meadows, estuaries, and tidal flats in the lowland zone (Douglas et al. 1999). There is one known occurrence of Henderson's checkermallow on the Tongass; within a non-development (Semi-remote Recreation) LUD on the Juneau Ranger District. This occurrence, which is located in an upper beach meadow at the edge of hemlock and spruce forest on Howard Bay, could not be relocated during surveys in 2012 (USDA Forest Service 2015e). This occurrence is not expected to be located in old-growth or young-growth harvest units under any of the alternatives.

Under Alternative 1, timber harvest would be restricted in the beach buffer, which is the preferred habitat for this species. While access to timber through beaches may be needed under Alternative 1 if new LTFs are required, this would be infrequent. Therefore, under Alternative 1, there is essentially no risk of adverse impacts to Henderson's checkermallow. Under Alternatives 2 through 5, young-growth timber harvest would occur in the beach buffer which could potentially result in impacts to undocumented occurrences of Henderson's checkermallow or its habitat. Projected timber harvest in beach buffers would be highest under Alternatives 2 and 3; therefore, these two alternatives would result in a greater risk of potential adverse impacts to undocumented occurrences of this species and its habitat than the other alternatives (Table 3.7-5). Additionally, Alternatives 2 and 3 would result in more miles of road construction and reconstruction than the other alternatives (Table 3.7-4); thus, these two alternatives would result in a greater risk of potential adverse

effects to Henderson's checkermallow from and road construction and reconstruction than the other alternatives.

Alternatives 2 through 5 would facilitate the development of renewable energy projects and would allow development of renewable energy projects in the beach buffer. Therefore, Alternatives 2 through 5 would have a greater risk of potential adverse effects to Henderson's checkermallow and its habitat from renewable energy development compared to Alternative 1.

Forest-wide standards and guidelines under all alternatives would consider protection to minimize adverse impacts to the known occurrence and new occurrences of this species located during project surveys. Because Henderson's checkermallow may receive protection from existing Forest-wide standards and guidelines and because no known occurrences of this species would be impacted under any of the alternatives, there is a low risk that any alternative would adversely impact this species.

Dune tansy (Tanacetum bipinnatum ssp. huronense):
There is only one known occurrence of this species on the Tongass, located within a Development LUD (Modified Landscape) on the Sitka Ranger District. This population has been declining due to habitat loss from beach erosion (USDA Forest Service 2015e). Habitat for dune tansy includes upper beaches and sand dunes on well-drained and calcareous soils, areas where timber harvest activities would not likely occur; and the one known occurrence of dune tansy is not expected in old-growth or young-growth harvest units under any of the alternatives. Access to timber harvest units through beaches or sand dunes may be needed for new LTFs; however, this need would be infrequent. If dune tansy is located during project surveys, Forest-wide standards and guidelines under all alternatives would consider protection to minimize adverse impacts to this species. Because of the possible protection from the Forest-wide standards and guidelines, and the very low chance of impacting the one known occurrence or unknown occurrences of this species or its habitat, there is a low risk that any alternative would adversely affect this species.

Invasive Plants

Effects Common to All Alternatives
Ground disturbance associated with timber harvest, road construction, renewable energy development, and other management activities on the Forest provides an opportunity for invasive plant introduction or expansion. Introduction and spread of invasive plants are potential direct effects of timber harvest, road construction, or renewable energy project development and operation, because these activities disturb soil and/or remove existing vegetation, providing openings for invasive plants to establish or spread. Additionally, movement of equipment and personnel can also provide opportunities for transport of invasive plant seeds or propagules into new areas. Indirect effects can include the establishment or spread of invasive plants through the use of roads after harvest for recreation or during road maintenance. Similarly, construction and maintenance of energy and utility line projects and associated road construction, maintenance, and use increases the risk of invasive species spread and colonization. The impacts of invasive plant spread and colonization can often spread beyond the area of disturbance.

Effects Specific to Each Alternative
All of the alternatives include timber harvest and road construction activities, which could directly and indirectly increase the number and spread of invasive plants. Increased disturbance increases the risk of establishment or spread of invasive plants. The effects would vary between alternatives depending on the level of

disturbance due to timber harvest, new roads construction and development of renewable energy projects.

Because of the difficulty in estimating the amount of disturbance that will be caused by each alternative, a relative estimate of total acres of timber harvest and miles of road construction is used to compare each alternative's potential for establishment and spread of invasive plants. However, it should be noted that the acres of timber harvest in either old-growth or young-growth harvest units is many times greater than the soil disturbance that would a result from these activities. Contrary to timber harvest, road construction is a direct source of soil disturbance; therefore, total miles of road construction may be interpreted as a relatively accurate account of the level of soil disturbance created as a result of this activity.

The acres of harvest and miles of road included in each alternative are shown in Table 3.7-4. Alternatives 2 and 3 would have a higher risk of introduction and spread of invasive plants due to the greater maximum acres of timber harvest and miles of road construction that would occur under these alternatives as compared to the other alternatives. Alternative 1 would result in the lowest risk of introduction and spread of invasive plants from timber harvest and road construction and Alternatives 4 and 5 would be intermediate; their risk would likely fall in the mid-range when compared to the other alternatives.

The proposed Renewable Energy plan components, under Alternatives 2, 3, 4, and 5, would facilitate development of renewable energy projects, which would result in an increased risk of introduction and spread of invasive plants compared to Alternative 1. However, procedures to prevent and control the spread of invasive would be included in each of the projects (described in more detail below under *Cumulative Effects*).

Cumulative Effects

Sensitive and Rare Plants

When considering effects to sensitive and rare plants, it is important to look at the cumulative effects of past, present, and reasonably foreseeable future activities on all land ownerships within the geographic area. Each land ownership has differences in vegetation patterns primarily as a result of differences in management activities. The significance of any direct or indirect effect in contributing to the cumulative effects on sensitive and rare plants from management activities depend on the amount and type of disturbance in the cumulative effects analysis area and how that disturbance may affect known locations of sensitive and rare plants. Appendix C provides a full list of all the projects considered in the cumulative effects analysis.

Assessing cumulative effects to sensitive and rare plants will be done for individual projects as part of the NEPA process for the relevant analysis area. For this analysis past plus expected harvest and road construction for forestry and other uses and development of renewable energy projects and associated utility lines on all land ownerships within the Forest boundary can be used to compare the risk that each alternative would add to cumulative effects on both sensitive and rare plants.

Timber harvesting on state, municipal, and private land is governed by the Alaska Forest Resources and Practices Act (AS 41.17). Alaska Forest Resources and Practices Regulations (ADNR 2013) do not address threatened, endangered, or rare plants; however, they do recommend minimizing road construction and limiting disturbance in marshes and muskegs, which would provide some protection for some of the sensitive and rare plants.

There are no federally listed or proposed threatened or endangered plants that are known to occur or are likely to occur on the Tongass National Forest; therefore,

there would be no contribution to cumulative effects to threatened or endangered plants under any of the alternatives.

To compare the potential cumulative effects of harvest under the five alternatives on sensitive or rare plants, harvest on lands of all ownerships in Southeast Alaska was analyzed. Therefore, all lands in Southeast Alaska constitute the cumulative effects analysis area for sensitive and rare plants.

There are approximately 21.6 million acres of land in Southeast Alaska. Non-NFS lands comprise about 4.8 million acres or 22 percent of the 21.6 million acres in Southeast Alaska; Glacier Bay National Park consists of about 2.5 million acres. Approximately 30 percent of the lands in Southeast Alaska were originally POG. Approximately 14 percent of the POG on all ownerships had been harvested by 2015. Thus, approximately 86 percent of the original POG on all ownerships was remaining in 2015 (Table 3.7-7). Looking at all ownerships of land in the Forest, the POG forest remaining in 100 years under full implementation of the Forest Plan would be the same for all alternatives at 83 percent (Table 3.7-7). Therefore, the risk of cumulative effects to sensitive or rare plants due to harvest would be similar for all alternatives. Table 3.9-16 in the *Biodiversity* section shows a similar relative risk among the alternatives for cumulative effects by Biogeographic Province.

Table 3.7-7
Cumulative Percent of Original POG Remaining on All Ownerships in 2015 and Estimated Minimum Percent Remaining after 100+ Years[1] for All Lands within the Tongass Forest Boundary[2]

Remaining POG on All Ownerships in 2015 as a Percent of all Original POG	Remaining POG after 100+ Years as a Percent of Original POG[3]				
	Alternative				
	1	2	3	4	5
86%	83%	83%	83%	83%	83%

[1] Assumes full implementation of Forest Plan for project timber sale quantity levels plus future non-NFS harvest.
[2] Annette Island is included because it is surrounded by areas within the Forest boundary.
[3] Note that ¾ of the POG reduction is on private and state lands.
Source: Tongass National Forest GIS database.

Existing road density is greater on the non-NFS lands within the Tongass National Forest boundaries than on the NFS lands due to concentrated harvest and more populated areas. It averages 0.20 mile per square mile on NFS lands and 2.32 miles per square mile for the non-NFS lands. The average for lands of all ownerships is 0.34 mile per square mile; however, those are averages over a very large area and there is great variability. The range of road density by subwatershed shows large variability across the Tongass as seen in Table 3.4-5 in the *Water* section (percentage of subwatersheds by road density category for the Tongass). All subwatersheds have road densities of less than 4 miles per square mile under existing conditions.

Table 3.7-8 shows the average future road density for each alternative. It includes existing roads and forestry as well as other roads proposed for construction on NFS lands and reasonably foreseeable on non-NFS lands. All the alternatives would have similar maximum road densities. Therefore, all alternatives have similar risks that management actions would add to cumulative effects to sensitive or rare plants.

Table 3.7-8
Existing and Estimated Future Maximum Road Density (miles per square mile) for NFS Lands and for All Ownerships within the Forest Boundary by Alternative after 100+ Years[1]

		Alternative				
Land Ownership	**Existing**	**1**	**2**	**3**	**4**	**5**
National Forest Land	0.20	0.23	0.24	0.23	0.23	0.23
All Ownerships	0.34	0.45	0.45	0.45	0.45	0.45

[1] Assumes 100+ years of Forest Plan implementation plus future non-NFS harvest.
Source: Tongass National Forest GIS database

There are other activities that have occurred in the past and are reasonably foreseeable to occur in the future that have the potential to add to cumulative effects to rare and sensitive plants in regional and local areas. They include mineral extraction, energy and utility line projects, hydroelectric projects, transportation developments, and urban and recreational site development. Existing mining is at Greens Creek on Admiralty Island, Kensington Gold Mine north of Juneau, as well as other existing locations. Potential future mining sites include the Bokan Mountain and Niblack sites on the southern end of Prince Wales Island. There are also several regional transportation projects and regional energy and utility line projects planned for construction, including the Kake to Petersburg Transmission Line Intertie Project, regional transportation development defined in the Southeast Alaska Transportation Plan and Forest Service Alaska Region Long Range Transportation Plan, road paving on Prince of Wales Island, and construction of the Angoon Airport. Urban and recreational site development includes the growth in the cruise ship and guiding industries, development of fishing lodges, other lodges, recreational cabins, and expansion of cities. Existing and foreseeable renewable energy projects within the Tongass National Forest boundary include the potential geothermal development at Bell Island, potential hydroelectric development at Angoon, Sweetheart Lake, and Soule River, and expansion of the Swan Lake hydroelectric project.

Each of the activities described above could include clearing vegetation and disturbing habitat for construction and maintenance; therefore, they have the potential to affect sensitive and rare plants and their habitat. These impacts would be considered in project analysis.

Changes in Alaska's climate (discussed in the *Climate and Air* section of this chapter) could affect the hydrology and other habitat conditions where sensitive and rare plants occur. While the models do not fully agree on the climate change predictions for Southeast Alaska, they generally predict warmer weather with increased rainfall, and a decrease of snowfall. Recent research by Shanley et al. (2015) predicted an increase in mean annual temperature of approximately 3 to 10 degrees Fahrenheit, a 3 to 18 percent increase in mean annual precipitation, and a 22 to 58 percent decrease in snowfall by the 2080s (Shanley et al. 2014). These changes would likely result in lower soil moisture due to increased evaporation during warmer summer months. Also, a precipitation shift from snow to rain could lead to more water running off the landscape rather than being stored as snow and feeding streams and wetlands in the late spring and summer, thus increasing evaporation and reducing water storage. These factors could lead to drier streams, meadows, and wetlands.

Changes in temperature and hydrologic conditions would likely favor some plants and stress others. There has been little research into the effects of changes in environmental conditions for each of the sensitive and rare species; consequently,

there is uncertainty as to the effect of changes in the climate on sensitive and rare plant species known or suspected to occur on the Tongass.

Invasive Plants

Invasive plants on any land ownership in Southeast Alaska can affect establishment or spread of invasive plants on NFS lands and vice versa. Also, activities on land of any ownership can result in establishment or spread of invasive plants that affect other lands. As mentioned in the direct and indirect effects, activities can have wider effects on invasive plant spread than the specific area of land disturbance due to the interconnectedness of land.

As discussed above, differences in vegetation patterns primarily as a result of differences in harvest intensity are expected to vary between public and private land ownerships. The cumulative effects of invasive plants from management activities of all land ownerships across the Tongass National Forest would depend on factors such as the following:

- Amount of harvest and road building;
- Location and size of renewable energy projects and associated facilities);
- Existence and extent of invasive plants at the time of project implementation;
- Overall habitat alteration due to invasive plants expected as a result of past, present, and foreseeable projects; and
- Anticipated response of invasive plants to the proposed actions and any management considerations or mitigation and monitoring that will be applied to each project.

Past, present, and future harvest and road construction for harvest and other purposes on both private and public lands can be used to compare the risk of cumulative effects of the five alternatives on invasive plant introduction or spread. Table 3.7-8 shows the existing road density and maximum future road density for each alternative for all land ownerships and for NFS lands. The maximum future road density for all alternatives is similar, with Alternative 2 having just slightly less maximum road density after 100 years than the other alternatives.

As discussed under cumulative effects for sensitive and rare plants, there are fewer restrictions on timber activities on non-NFS lands than on NFS lands. Timber activities on non-NFS lands that can contribute to the introduction or spread of invasive plants are not specifically regulated by the State of Alaska. To compare the risk of effects of harvest under the five alternatives on invasive plants, POG remaining on land of all ownerships was analyzed. Looking at all ownerships of land in the Forest, the POG (unharvested) forest remaining in 100 years under full implementation of the Forest Plan would be greatest for Alternative 4 and 5 (83 percent). Alternatives 1, 2, and 3 would have slightly less POG forest remaining (82 percent) in 100 years under full implementation (Table 3.7-7). Therefore, the risk of cumulative effects on the introduction and spread of invasive plants would be slightly higher for Alternatives 1, 2, and 3 than Alternatives 4 and 5.

There are other activities that have occurred and are reasonably foreseeable to occur in the future that have the potential to add to cumulative effects of invasive plants. They include mineral activities, renewable energy and utility line projects, hydroelectric projects, transportation developments, and urban and recreational site development (see above for list of past, present and reasonably foreseeable projects). Each of these activities can include clearing vegetation, construction, transportation for construction and ongoing activities, and maintenance. Therefore,

they have the potential to introduce or spread invasive plants in an area and would need to be considered in the project analysis.

Changes in Southeast Alaska's climate (discussed in the *Climate and Air* section of this chapter) could also create the conditions that encourage the spread of invasive plants by altering opportunities for invasive plants to colonize new areas, where could be compounded by climate change. Changing climate may also result in range extensions for some species that are native at more southerly latitudes, and they may become established or become more widespread on the Tongass, as a result. Changes in growing conditions would likely favor some plant species and stress others. There is uncertainty in the effect of changes in the climate to the invasive plants on the Tongass.

With any of the action alternatives, applying mitigation measures in the form of Forest-wide standards and guidelines as well as ongoing invasive plant control and management programs will contribute to lessening the cumulative effects of invasive plants across Southeast Alaska.

Currently, the Forest uses mitigation measures for invasive plant prevention during implementation of management actions. Examples of these types of mitigation measures include vehicle and equipment cleaning in certain locations; use of weed-free forage and gravel; minimizing the removal of overstory trees and shrubs to decrease sunlight and soil disturbance; revegetation practices using non-invasive seed and plant materials; and timing considerations for road maintenance schedules to avoid potential spread of invasive plants during seed emergence. These mitigation measures are considered through a risk assessment for all proposed activities from timber sale and transportation planning and maintenance programs, to renewable energy development, and recreation and wilderness management.

Invasive plant control and management include multiple strategies depending on the invasiveness of the species, its location, and its aerial extent. Strategies such as eradication, containment, and control will be applied to existing and new infestations of invasive plants throughout the Forest for those areas where their presence threatens the ecological integrity or desired condition of the sites they occupy. A strategy of tolerance will equally be applied for other infestations which do not threaten the ecological integrity of habitats. A variety of control measures may be implemented for the eradication or control of infestations using a variety of treatment options, including manual, mechanical and chemical control (e.g., herbicides). All treatments will be evaluated through proper environmental analysis.

As stated above, FSM 2900 and Forest-wide standards and guidelines regarding invasive plant species include direction to review proposed projects to determine the risk of introduction or spread of invasive plants and implement appropriate project-specific mitigation measures. They also include direction to control existing invasions and rehabilitate habitats impacted by invasive species. Specific policies and directions for invasive plant management outlined in FSM 2900 include:

- Initiate, coordinate, and sustain actions to prevent, control, and eliminate priority infestations of invasive species using an integrated pest management approach[1];

[1] Integrated pest management is an ecologically based holistic strategy that focuses on the long-term prevention of pests or their damage by managing the ecosystem. Integrated pest management techniques are defined within four broad categories: 1) biological, 2) cultural, 3) mechanical/physical, and 4) chemical.

- Determine factors that favor establishment and spread of invasive species on NFS lands and design management practices to reduce or mitigate the risk of introduction or spread of invasive species;
- Determine the risk of introduction, establishment, or spread of invasive species associated with any proposed action and provide for alternatives or mitigation measures to reduce or eliminate that risk;
- Ensure that management activities are designed to minimize or eliminate the possibility or spread of invasive species on NFS lands or adjacent areas and ensure that invasive species are not used in any management activities on NFS lands such as site restoration or revegetation work or watershed rehabilitation projects.
- Establish and implement standards and requirements for vehicle and equipment cleaning to prevent spread of invasive species on NFS lands and adjacent lands and make every effort to ensure that all materials used on NFS lands are free of invasive species and/or noxious weeds;
- Monitor all management activities for the potential spread or establishment of invasive species.
- Develop and utilize site-based and species-based risk assessments to prioritize management of invasive species infestations;

Additional directives associated with integrated pest management are provided in FSM 2070 (Native Plant Material Policy) and FSM 2150 (Pesticide Use Management and Coordination Policy). FSM 2070 promotes the use of native plant materials and restricts the use of non-native species for revegetation, rehabilitation, and restoration. FSM 2150 provides direction regarding the use of pesticides and herbicides, including direction to: prepare a site-specific or project-specific analysis prior to pesticide use which includes an assessment of chemicals to be used and evaluation of potential effects to target and non-target species. In addition, a Pesticide-Use Proposal must be completed and reviewed prior to any pesticide application activity planned on NFS lands. FSM 2150 policy also includes directives to conduct all pesticide-use activities in full compliance with applicable U.S. Environmental Protection Agency pesticide label restrictions and applicable federal and state laws and regulations, including regulations that apply to personnel training and licensing.

Forest Health

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Affected Environment

Current Situation

Insects, diseases, related decay processes, and windthrow are an integral and natural part of forest ecosystems. Many of these appear to play key roles in gap-level disturbance (see discussion of old-growth forests in the *Biodiversity* section of this chapter) and in providing wildlife habitat. The majority of the forests on the Tongass are old-growth forests. Losses to the timber resource caused by heart rot in live trees are considerable in old-growth forests. Approximately one-third of the volume of the old-growth hemlock-spruce forests in Southeast Alaska is decayed by heart rot fungi (USDA Forest Service and ADNR 2014).

In addition to heart rot, some of the more common destructive insects, diseases, and conditions within Southeast Alaska are listed below.

Black-Headed Budworm, *Acleris gloverana* (Walsingham), is one of the more destructive forest insects in coastal Southeast Alaska. In 1993, a peak year for budworm, approximately 258,000 acres of spruce-hemlock forests were affected. This was the largest outbreak in decades. In the 1950s, almost one-third of the net timber volume was lost on many hemlock sites due to budworm defoliation (USDA Forest Service and ADNR 2000). In 2006, Black-headed budworm populations were at endemic levels, with less than 1,000 acres of mapped defoliation in the previous 3 years (USDA Forest Service and ADNR 2007). The 2014 aerial survey indicates little impact of this insect in Southeast Alaska (USDA Forest Service and ADNR 2015). Larval feeding strips hemlock foliage and can cause growth reduction, top-kill, and, at times, tree mortality (USDA Forest Service and ADNR 2000). Juday et al. (1998) rated many potential impacts on the coastal forests of Southeast Alaska due to climate change. They concluded that there was a high risk of increased damage from black-headed budworm outbreaks.

Hemlock Sawfly, *Neodiprion tsugae* (Middleton), is a serious defoliator of western hemlock throughout Southeast Alaska. Outbreaks tend to be of longer duration in southern Southeast Alaska where widespread damage is usually confined to the area south of Frederick Sound, especially along Clarence Strait. Larvae feed on mature (older) needles rather than current year (new) foliage. Most sawfly outbreaks do not cause tree mortality, but the tops are killed in some trees and tree growth may be reduced. Heavy defoliation by hemlock sawflies is known to reduce radial growth and cause top kill. In 2014, 3,940 acres of hemlock sawfly defoliation were detected (USDA Forest Service and ADNR 2015). At two locations, Etolin and Revillagigedo Islands, damage was detected in 2012, 2013, and 2014. Consecutive infestations are notable because they may cause mortality in hemlock stands.

Spruce Beetle, *Dendroctonus rufipennis* (Kirby), is the most destructive forest insect Alaska-wide, although outbreaks in Southeast Alaska are typically smaller and of shorter duration than those in south/central and interior Alaska. Most

outbreaks originate in blowdown or in cull logs left in harvest units and spread to adjacent standing timber. Mortality in unmanaged Sitka spruce stands varies and can be as high as 75 percent. Weather conditions appear to play a role in the expansion or contraction of beetle populations, and warm winters increase the probability of a spruce beetle infestation in southeast Alaska (Bentz et al. 2010). Spruce beetle activity has been noted across the Tongass National Forest and adjacent lands from Yakutat Forelands to Dall Island (USDA Forest Service and ADNR 2000). Spruce beetle activity in 2014 was concentrated on Kupreanof Island, and northwest of Haines. These two areas account for approximately 1,680 acres of mapped spruce beetle outbreak, though other small patches of activity were mapped throughout Southeast Alaska (USDA Forest Service and ADNR 2015).

Spruce Needle Aphid, *Elatobium abietinum* (Walker), is an introduced species that feeds on the needles of Sitka spruce, often causing reduced growth and increasing susceptibility to other mortality agents such as spruce beetle. As with other insect pests, populations have cycles, generally increasing following mild winters. More than 25,000 acres of spruce forest were defoliated in the winter of 1991 to 1992 (USDA Forest Service and ADNR 2000). An outbreak that began in 1998 lasted several years with the worst defoliation occurring in 2003 when more than 30,000 acres were affected. Defoliation by spruce aphids affected approximately 9,120 acres in 2006, mostly in small pockets within the beach fringe from Lynn Canal in the north to Dall Island in the south (USDA Forest Service and ADNR 2007). A large outbreak occurred in 2010, with 40,680 acres affected (USDA Forest Service and ADNR 2011). The most recent aerial survey indicates limited spruce aphid activity, with 425 acres of damage detected near Haines (USDA Forest Service and ADNR 2015).

Hemlock Dwarf Mistletoe, *Arceuthobium tsugense* (Rosendhal, G. N. Jones), is a parasitic flowering plant that infects western hemlock throughout Southeast Alaska as far north as Haines. Infestation levels vary—dwarf mistletoe is absent in some stands, while almost every hemlock is infected in other stands. The upper elevational limit for Hemlock dwarf mistletoe is approximately 500 feet (Shaw and Hennon 1991). Basal area growth in western hemlock trees heavily infected with dwarf mistletoe can be reduced by 36 percent or more (Shaw et al. 2008). In addition to reduced stem growth, infestations cause increased growth and retention of lower branches and distortion and weakening of wood strength at and near swellings. The spread of dwarf-mistletoe in young hemlock stands can result from leaving standing infected hemlock in harvest units (Laurent 1974). Dwarf mistletoe responds to light with increased seed production. Rates of spread to adjacent and lower canopy trees may increase in partial cuts where infected hemlocks remain. Trummer et al. (1998) developed a model for dwarf mistletoe infections in uneven-aged forests of Southeast Alaska that suggests infection rates are significantly correlated with levels of dwarf mistletoe infection in the residual trees. Deal (2001) reports partial cutting resulted in maintaining mistletoe levels at generally undamaging levels, with a trend towards less mistletoe in stands with higher harvest levels. A study of partial cut stands in British Columbia found that most young trees infected with mistletoe were advanced regeneration established before logging (Muir 2006). Barrett et al. (2012) note that dwarf mistletoe is limited in several ways by cold temperatures, and habitat may increase over time under warming conditions. Climate models predict substantial increase in dwarf mistletoe habitat (374% to 757%) in the next century (USDA Forest Service and ADNR 2015).

Alaska Yellow-Cedar. Decline and mortality of yellow-cedar continues to be one of the most widespread and important forest problems in Southeast Alaska. Aerial surveys have mapped over 585,000 acres of decline in a wide band from

western Chichagof and Baranof Islands to the Ketchikan area (USDA Forest Service and ADNR 2015). In 2014, approximately 20,000 acres of dying (i.e., active decline) yellow-cedar trees were mapped (USDA Forest Service and ADNR 2015). This decline is associated with wet, poorly drained sites, and recent research has demonstrated that no organism is the primary cause of the decline (Hennon and Shaw 1997). Schaberg et al. (2011) assert that yellow-cedars have roots that are both less cold tolerant and more concentrated near the soil surface than co-occurring species, making them especially susceptible to cold injury. Hennon and Shaw suggest that reduced snow pack in low-elevation areas associated with a warming trend that started in the 1800s has exposed fine surface roots to freezing, which in turn kills trees. As the climate continues to warm, cedar decline is likely to continue to spread, especially in the south and east. Conversely, yellow-cedar appears to be spreading northward as climate warms, into areas that retain snow longer into the spring.

Hemlock Fluting. Hemlocks with fluting have deeply incised grooves and ridges extending vertically along their trunks, a condition that reduces the value of hemlock logs because they yield less sawlog volume and some of the milled wood contains bark. Fluting is a common problem in Southeast Alaska, especially on mid- to high-quality sites at low elevations, on gradual slopes, and with western exposure (Julin et al. 1993). It is rarely found away from the coast. The cause of fluting is not completely understood, but it may be associated with increased wind firmness, especially on shallow soils, due to growth increases triggered by silvicultural treatments or natural disturbance (USDA Forest Service and ADNR 2014). Julin et al. (1993) found that the larger buttresses were generally aligned with the direction of the tree lean. They also concluded that western hemlock trees in Southeast Alaska may be genetically predisposed to form fluted trunks. Silvicultural treatments that favor other species and reduce branch size and retention period would greatly reduce fluting (Julin et al. 1993). However, because fluting primarily occurs in the beach buffer, the effect on timber resources is limited.

Decays. Stem decays cause substantial loss in all tree species in unmanaged stands. Tree death and stem breakage resulting from decay contribute to the structural diversity in stands and may be a major factor in small-scale disturbance in Southeast Alaska (Hennon and McClellan 2003). Many decay fungi enter through tree wounds. The accidental wounding of trees during partial cuts and commercial thinnings can increase the impact from decay organisms in managed stands (USDA Forest Service 1997a, Appendix G). However, Christensen et al. (2002) found very low levels of disease-caused defects in both thinned and unthinned 90-year-old hemlock-Sitka spruce stands on the Tongass compared to old-growth forests. Juday et al. (1998) rated many potential impacts on the coastal forests of Southeast Alaska due to climate change. They concluded that there is a risk that new fungal tree diseases will appear in Southeast Alaska as the climate warms.

Animal Damage. Significant animal damage to trees is apparent at various locations across the Tongass National Forest. Porcupine feeding on hemlock and spruce is common on Mitkof Island and many mainland areas. Young trees in managed and unmanaged stands are often top-killed or killed outright as porcupine feeding girdles the main bole. Bark beetles have been found infesting damaged trees. This damage becomes significant when groups of trees are killed or deformed. As trees grow larger (age 40 to 50 years), porcupine damage shifts from top kill to basal wounds, which serve as entry points for decay fungi. Brown bears cause basal wounds on Alaska yellow-cedar each spring on Baranof and Chichagof Islands. Bears rip off the bark in the spring to lick the sweet cambium.

The majority of yellow-cedar in some stands have basal wounds from bear feeding (USDA Forest Service and ADNR 2015).

Fire. Fire has played a minor role in the forests of Southeast Alaska because of the abundant year-round precipitation. The average fire size on the Forest from 2006 to 2014 was 5.2 acres (Alaska Interagency Coordination Center 2015). More active fire seasons do occur, 2005 for example, when 322 acres burned. Recent General Circulation Model data indicate the area will see increased temperatures in coming decades. However, increased rainfall is predicted as well. These conditions will likely offset, and the impact of fire on resources on the Tongass National Forest is likely to remain low.

Windthrow. Windthrow is the dominant disturbance agent in Southeast Alaska. Two forms occur: small-scale events (gap disturbance) and large-scale events (catastrophic disturbance). Most of the Forest is subject to small-scale windthrow events. Individual trees or small groups of trees blow over during storm events, opening gaps in the canopy that allow young trees to grow to fill the openings. This results in complex, mixed-aged stands. Disease and decay agents also play a role in this process. Nowacki and Kramer (1998) state that diseased trees are more at risk to windthrow and stem-snap, while Hennon and McClellan (2003) report that many of the uprooted or broken-stemmed trees had died before falling. Small-scale events occur on a regular basis and result in openings from 6 to 13 percent on the canopy (Nowacki and Krammer 1998). Areas not protected by topographic barriers from the severe effects of infrequent, major storms are subject to large-scale windthrow events that cause catastrophic damage. Entire stands have been blown down in the past, resulting in the regeneration of more even-aged stands with more uniform canopies (Nowacki and Krammer 1998). Both forms of windthrow are a part of the natural forest generation, growth, and development. Juday et al. (1998) rated many potential impacts on the coastal forests of Southeast Alaska due to climate change. They concluded that there was a high risk of increased large-scale blowdown across Southeast Alaska as well as increased windthrow around harvest units.

Monitoring and Pest Management

Forest pest activity on the Tongass National Forest is typically detected during on-the-ground activities, or during annual aerial surveys conducted by the region's Forest Pest Management group. The timing of surveys coincides with foliage and pest development. Pest activity noted during surveys is documented and reported to the appropriate land manager. In cooperation with land managers, Forest Pest Management people conduct on-site investigations to verify the pest, evaluate the pest and its host(s), and formulate future management alternatives. Often, pest and host monitoring is required to fully understand potential impacts prior to development of management alternatives.

Populations of historically significant defoliating insects are monitored through a sampling system that occurs in conjunction with the annual aerial survey. Defoliating larvae are collected, identified, and counted at designated sites. Gypsy moth pheromone traps have been placed throughout Southeast Alaska to provide an early warning that these insects are present. Data from larvae counts and pheromone traps, in conjunction with the collection of host and weather information, enhance forest pest managers' ability to predict defoliator damage.

The impact of hemlock dwarf-mistletoe and methods of reducing damage from the disease in managed stands have been established by several research studies. In addition, Forest Pest Management has surveyed numerous even-aged stands from 10 to 100 years old to determine the incidence and impact of hemlock dwarf-mistletoe in managed stands.

Research studies have yielded information on the pathology and epidemiology of decline of yellow-cedar (cited above). In addition, information on the distribution of decline and acreage affected has been determined by mapping during aerial surveys. Porcupine damage in managed stands is currently being assessed. As more young-growth stands reach commercial thinning age, forest pest research is beginning to focus on pest activity within these stands.

The Forest develops site-specific prescriptions, based on monitoring information, scientific information, and pest management projections, to prevent or limit insect and disease damage. The objective is to limit infestations of natural insects, disease-causing organisms, and parasites to normal background levels, and to prevent or reduce infestations of non-native organisms to the extent feasible. Similarly, the Forest objective is to limit windthrow to levels that would occur naturally through silvicultural prescriptions prepared for each timber sale.

Environmental Consequences

Direct and Indirect Effects

In general, alternatives that favor high amounts of old-growth harvest would likely reduce timber lost to insect and disease. Alternatives that favor a shift toward decreased old-growth harvest and increased harvest of young stands would tend to perpetuate current disease levels in old-growth forests, but ecological processes and wildlife habitat for old-growth associated species would be maximized. Higher amounts of timber harvest would generally yield young stands with lower levels of insect and disease activity. However, two-aged and uneven-aged management could maintain or even increase levels of hemlock dwarf mistletoe. Two-aged and uneven-aged management may also result in higher levels of stem and root disease caused by injuring residual trees during harvest operations; however, the degree of increase, if any, is uncertain. Two-aged treatments that clump leave trees are less likely to cause damage to residual trees. Similarly, thinning young, even-aged stands may also lead to stem and root disease due to wounding of leave trees during thinning, although a retrospective study did not find that thinning had increased defect levels in thinned stands on the Tongass compared to unmanaged stands (Deal et al. 2002), and Christensen et al. (2002) did not find higher levels of decay in two 90-year-old stands that had been commercially thinned 25 years earlier compared to unthinned stands.

Alternative 1 has over 20,000 more acres of old growth likely to be harvested over the next 100 years than Alternatives 4 and 5, and approximately 27,000 to 30,000 more acres likely for old-growth harvest than Alternatives 2 and 3. Therefore, over time, Alternative 1 and, to a lesser extent, Alternatives 4 and 5 are likely to result in more acres with a lower risk of insect activity and somewhat less forest with high levels of heart rot and other disease organisms than the other alternatives. Conversely, Alternatives 2 and 3 would retain more acres of old-growth forest, which would likely result in somewhat higher levels of insect and disease across the Tongass. There is some concern that two-aged and uneven-aged harvest could lead to higher levels of windthrow, dwarf mistletoe, and stem decay compared to even-aged harvest methods. Deal et al. (2002) report that the number of uprooted trees was somewhat higher in partially harvested stands, but overall tree mortality rates were similar. Bole wounds were common on trees in partially harvested stands, but “natural tree injuries from falling trees and animal feeding were far more abundant at several sites” (USDA Forest Service and ADNR 2002). Alternatives with more two-aged and uneven-aged management may favor shade-tolerant species (western hemlock, mountain hemlock, and yellow-cedar), while even-aged may result in stands with a higher proportion of Sitka spruce. However, retrospective studies indicate that Sitka spruce can be maintained in mixed hemlock-Sitka spruce stands over a

wide range of cutting intensities if enough Sitka spruce trees are present in the stand after harvest (Deal et al. 2002).

In general, endemic levels of insect and disease activity in mature and overmature forests would be allowed to run their course under all alternatives. Harvesting flexibility would be maintained to take advantage of timber salvage opportunities, particularly for dead and dying yellow-cedar stands. Insect and disease suppression may be justified in high-quality, mature to overmature stands that cannot be salvaged immediately, or that lie near recreation areas and communities where scenic values are high.

Animal damage, such as that from porcupines, is expected to continue and would likely be increasingly evident in precommercially thinned stands where porcupines are present. Winter feeding by porcupines is known to damage and sometimes kill young trees. The Forest has been alternating precommercial thinning prescriptions to reduce porcupine damage by favoring cedar and deferring thinning in some areas. Bear also damage young trees by removing bark to reach the sweet cambium tissue below the bark. Alternatives that result in creating more young stands, most notably Alternative 1, would lead to more acres of forest that would be vulnerable to animal damage.

Damage from wind would continue to occur; some increase is likely to occur along the edges of harvest units and along stream buffers and other legacy trees. Alternatives with more old-growth harvest and the associated road building (most notably Alternative 1) would tend to increase the risk of harvest- and road-related windthrow compared to those with less harvest and road building (Alternatives 2 and 3). If the current climate trend continues and more gale-force wind storms occur, blowdown may increase for all alternatives in proportion to the amount of harvest.

There may be a short-term increase in fire risk during harvest operations if activities are conducted during dry periods. Alternatives with higher levels of timber harvest may have a small increase in fire risk compared to alternatives with less harvest. Warmer winters are likely to increase insect damage because more insects will survive the winter. This could result in more dead and dying biomass that would contribute to the available fuels, but if the predicted increases in temperatures are paired with increases in precipitation there may be no significant increase in fire risk (refer to the *Climate and Air* sections of this chapter).

Cumulative Effects

The greatest potential forest insect and disease problems are likely to be in mature and overmature stands where disease levels are high. Tree vigor tends to decrease with maturity, causing an increase in susceptibility to insects and diseases. Heart rot levels are directly proportional to both tree and stand ages. The spruce beetle has the potential to significantly alter the desired condition of stands in certain locations near the mainland where the insect has periodically become active. The spruce aphid was introduced approximately 80 years ago and appears to be causing more damage to spruce as the climate warms (Schrader and Hennon 2005). The recent assessment of invasive pathogens in Alaska and its national forests states that Alaskan forests are particularly vulnerable to invasive pathogens because of the relatively small number of native tree species and the narrow genetic base (Schrader and Hennon 2005). The Schrader and Hennon report concluded that the European scolytid bark beetle poses the greatest threat to the spruce forests throughout Alaska if introduced.

Stem and root decay, and the incidence of hemlock dwarf-mistletoe, have historically increased with intensified land management activities, particularly under harvesting systems other than clearcutting (Trummer et al. 1998). If the

current warming trend continues, cedar decline and damage from insects are likely to increase, both from species currently present in Southeast Alaska and from those entering the area from other parts of North America or elsewhere. Invasive plants may also adversely affect forest health. Refer to the *Plant* section of this chapter for a discussion of invasive plant species.

Shorter rotations and even-aged silvicultural prescriptions implemented on non-National Forest System (NFS) lands are likely to contribute to decreasing mistletoe, insect, and disease levels in the forests of Southeast Alaska, especially the loss due to heart rot. Alternatives with more even-aged management, especially Alternative 1, would add to these changes. Conversely, increased use of commercial thinning in the may damage leave trees, increasing decay rates. Also, the younger stands established after harvest on all lands are likely to add to the loss of growth and tree mortality caused by animal damage in the region. Harvest-related windthrow may increase on NFS lands and adjacent areas that are harvested using even-aged silvicultural systems whether on NFS or non-NFS lands.

Maintaining biotic and structural diversity provides an opportunity for limiting some insect and disease problems. Some insects and diseases are host-specific, depend upon plants that are under stress, or flourish under homogeneous conditions. In other cases, and particularly for heart rot, favoring younger-aged stands through even-aged management may be the most effective way of limiting insect and disease problems. Maintaining healthy young-growth stands through stand density control (thinning) may reduce insect damage (Neilson 2007).

The careful use of alternatives to even-aged harvest methods can be a tool for maintaining natural but not excessive levels of diseases, such as heart rot and dwarf mistletoe, which have important ecological consequences. Integrated Pest Management provides the opportunity to evaluate these and more traditional clearcut practices. Through prescription processes, stands with unacceptable insect and disease-related losses, as well as those of high risk for future losses, would be identified for treatment. Detection methods such as aerial surveys, currently in use, would continue to be used for the early identification of epidemics.

The current warming trend increases the risk of increased insect and disease outbreaks, and catastrophic blowdown events. Juday et al. (1998) rated many potential impacts on the coastal forests of Southeast Alaska due to climate change. They concluded that there was a high risk of increased large-scale blowdown across Southeast Alaska and increased windthrow around harvest units; although, they also state that as of the date of their report, the increased frequency of storms in the last few decades has not corresponded to an increase in large-scale blowdown in Southeast Alaska. Also, the 2014 Forest Health report noted very little blowdown in aerial and ground surveys (USDA Forest Service and ADNR 2015); however, this does not rule out the risk of increased windthrow in the future as additional warming occurs.

Warmer, drier weather may result in increased levels of insect and disease levels. For example, Juday et al. (1998) concluded that there was a high risk of increased damage from black-headed budworm outbreaks, and there is a risk that new fungal tree diseases will appear in Southeast Alaska as the climate warms.

Appendix C of this EIS provides a full list of all the projects considered in the cumulative effects analysis.

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Biodiversity

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Affected Environment

Biological diversity, or biodiversity, may be defined as "the variety of and variability within and among living organisms and the ecological complexes of which they are part; this includes diversity within species, between species, and of ecosystems" (United Nations Environment Programme 1991). Biodiversity encompasses the variety of genetic stocks, plant and animal species and subspecies, ecosystems, and the ecological processes through which individual organisms interact with one another and their environments. Under the National Forest Management Act (NFMA), the Forest must provide for diversity of plant and animal communities based on the suitability and capability of specific land areas.

This section provides an overview of the Tongass Conservation Strategy, describes the ecosystems on the Tongass National Forest, and provides a summary of past timber harvest. Landscape connectivity and fragmentation and invasive species are also discussed. Additional information on the background of the Conservation Strategy and its components is provided in Appendix D.

Ecosystem Classification

Southeast Alaska is divided into 23 biogeographic provinces, or ecosystem-based landscape delineations characterized by 1) similarities in terrestrial wildlife species composition, 2) similarities in distributional patterns for many of these species, 3) geologic and water barriers stemming from past events, such as glaciation, and 4) generally similar climatic conditions and physiographic characteristics (USDA Forest Service 2003a). Biogeographic provinces in Southeast Alaska are described in Table 3.9-1 and show in Figure 3.9-1. Twenty-one biogeographic provinces coincide with the Tongass National Forest. Biogeographic provinces provide an appropriate scale for the analysis of impacts to biodiversity because they are ecosystem-based and vary in the level of resource development that has taken place and is allowed within them (see the Suitable Land maps in the Map Packet accompanying this EIS for the distribution of suitable POG and young-growth harvest across the Planning Area). .

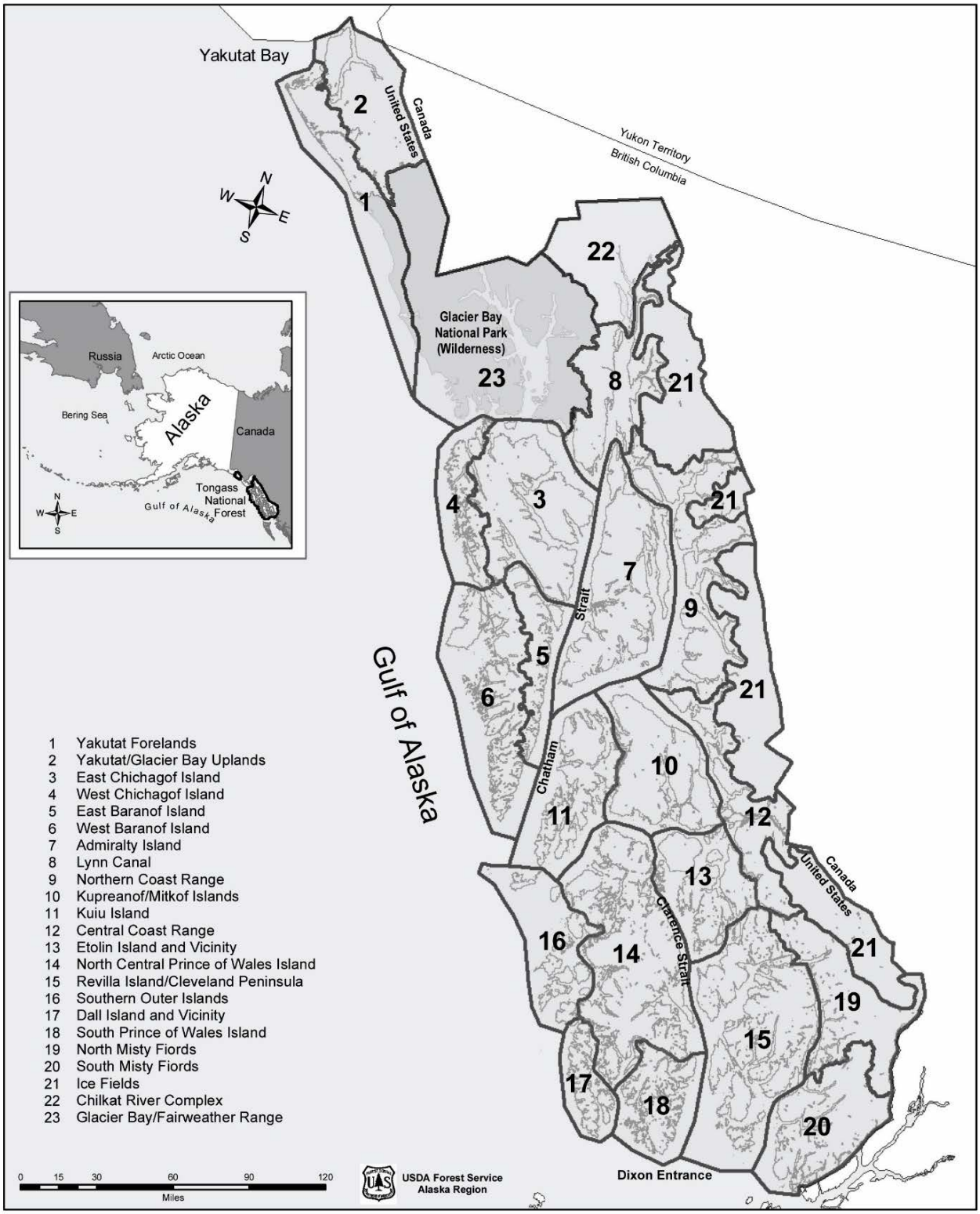
Table 3.9-1
Biogeographic Provinces in Southeast Alaska and the Tongass National Forest

No.	Province	Description
1.	Yakutat Forelands	A very young, nearly flat landscape with extensive flooding and active isostatic rebound (uplifting of the ground after glaciers recede). Most surfaces vary from 200 to 1,500 years old. Dune formation and succession are ongoing processes due to glacial rebound and wave action. Plant community patterns reflect a diverse mosaic of naturally occurring older and young forests, shrublands, bogs, and meadows. Sitka spruce, alder, and cottonwood are abundant on well drained, recently deglaciated, and active fluvial surfaces. Most of the province is inside the Tongass Forest boundary, but the southern lobe that extends into Glacier Bay National Park is not.
2.	Yakutat/ Glacier Bay Upland	The climate varies from very wet hyper-maritime along the coast to very wet maritime inland. Mountains abruptly rising more than 10,000 feet from sea level, extensive active glaciers, and fiords dominate this landscape. Sitka spruce, alder, and cottonwood are abundant at lower elevations; alpine and lichen over rock plant communities dominate the land from 2,000 to over 10,000 feet elevation.
3.	East Chichagof Island	This province is drier and colder than the outer coast of Chichagof Island; the winter snow pack is generally greater. Chichagof Island is deeply dissected into three peninsulas, which may be functioning biologically more like separate islands. Vegetation in this province represents a modal condition similar to the Admiralty Island Province.
4.	West Chichagof Island	This province is dominated by a very wet hyper-maritime climate and exposure to outer coastal storms. Hundreds of small islands dot the coast. Topography is gentle when compared to the mountains of Baranof Island and the coastline is highly irregular. The Sitka spruce/Pacific reedgrass plant association is abundant along the outermost coastal fringe; otherwise, vegetation is similar to the other northern islands.
5.	East Baranof Island	This province is colder than West Baranof or East Chichagof Island. Mountain glaciers occur along the divide between east and west Baranof. Topography is rugged and steep to saltwater, with little flat land. Plant associations on East Baranof are similar to much of the mainland due to the steep topography and cold environment. Spruce, devil's club, salmonberry forest associations are common on avalanche and steep erosional slopes; alpine and rock/lichen plant communities are abundant.
6.	West Baranof Island	This province is similar to the West Chichagof Island Province with the exception of southern Baranof, where precipitation exceeds 250 inches per year. Topographically, Baranof Island is the most rugged of all the islands in Southeast Alaska. The southern half of this province is highly dissected by steep-sided fiords; the outer coast is dotted with hundreds of small islands. All forest plant associations except those in the Western red-cedar series and those found around large mainland rivers occur in this province. Kruzof Island has some unique vegetation communities, which have not been classified.
7.	Admiralty Island	This province is represented by relatively gentle topography and moderate rainfall. Winter conditions are moderated by the surrounding marine environment. Winds from Chatham and Icy Straits, Lynn Canal, and off the mainland are often severe. All forest plant associations but those in the Western red-cedar series, those found around large mainland rivers, and those occurring only on outer coastal areas occur in this province. Forest productivity is high. Fresh and saltwater marshes in the numerous bays and inlets, and alpine and bog communities, are abundant.
8.	Lynn Canal	Rain shadows and the dominating influence of the continental climate make this the driest and seasonally warmest province in Southeast Alaska. Precipitation is generally less than 60 inches per year. The topography is rugged and glaciated. The southern portion of the Chilkat Peninsula is more similar to the East Chichagof Island Province. Western and mountain hemlock and Sitka spruce plant associations are common. Alpine tundra and extensive rock/lichen communities dominate much of the land from 2,000 to over 8,000 feet elevation.
9.	Northern Coast Range	This province has little maritime influence. Topography is rugged and glaciated. The Taku and Whiting Rivers extend into Canada. All forest plant associations except those in the Western red-cedar series and those occurring only on outer coastal areas occur in this province.
10.	Kupreanof/ Mitkof Islands	The climate is cooler and the winter snow pack greater than on the islands to the south. The eastern edge of this province is strongly influenced by wind-born loess (silt) coming from the Stikine River and the mainland. All forest plant associations except those in the Western red-cedar series and those occurring only on outer coastal areas occur in this province. This province contains the highest percentage of muskeg wetlands within the Tongass.
11.	Kuiu Island	Kuiu Island is deeply dissected, creating several prominent peninsulas. The topography is gentle compared to neighboring Baranof Island or the mainland. The climate is cooler and winter snow pack greater than on islands to the south, yet milder than the mainland or islands nearer the mainland. The western portion of Kuiu Island is subject to severe windstorms from both the ocean and Chatham Strait. Most forested plant associations occur here, but those found in outer coastal environments dominate.

Table 3.9-1 (continued)
Biogeographic Provinces in Southeast Alaska and the Tongass National Forest

No.	Province	Description
12.	Central Coast Range	This province is warmer than the Northern Coast Range Province. The topography is similar, but overall less precipitous. The Stikine River system is located in the center of this province and has a major continental influence, providing a migration corridor for plant and animal species. Plant associations found along saltwater are similar to those occurring elsewhere in northern Southeast Alaska except for those near the mouth of the Stikine River. Here, unique plant associations subject to high loess-carrying winds can be found.
13.	Etolin Island and Vicinity	Similar to the Kupreanof/Mitkof Islands Province, this province is also subject to continental influence from the mainland and the Stikine River. Glacial flour (very finely ground particles of rock, silt, or clay created by a glacier when its rock-filled ice scrapes over bedrock and which flow out from beneath a glacier in the meltwater) is present in the marine environment in the northern part of this province nearly year-round. All forest plant associations except those occurring only on outer coast areas are present.
14.	North Central Prince of Wales Island	Topography is relatively gentle, limestone is common, and precipitation is relatively low due to interception by lands to the south and southwest. All forest plant associations except those found around the mainland river systems occur in this province. Overall forest productivity is high. Karst topography and numerous caves are present.
15.	Revilla Island/ Cleveland Peninsula	Climate is variable with warm and wet conditions predominating on land nearest the outer coast; much colder conditions occur near the mainland. Revilla, Gravina, and Annette Islands are influenced by human activities and populations, whereas the Cleveland Peninsula and Duke Island are generally in a natural condition. Revilla Island has many exceptional estuaries. Muskeg ponds are common on Duke Island, attracting many wintering and migratory birds.
16.	Southern Outer Islands	These islands are isolated and are subject to strong oceanic influences. Temperatures are moderate year-round. The topography is low-lying and gentle. These islands are relatively rich in endemic vertebrate species, including dusky shrew, long-tailed vole, and ermine. Major coastal seabird colonies are present.
17.	Dall Island and Vicinity	These islands are subject to strong oceanic influences. Temperatures are moderate year-around. The topography is rugged and dissected, with abundant limestone outcrops. Dall Island appears to be a glacial refugia but inventories of plants and animals are limited. Major coastal seabird colonies are present on Dall Island.
18.	South Prince of Wales Island	The climate is warm and wet, and deep snow is rare or highly transient. The topography is steep and rugged and the coastline is highly dissected. The vegetation in this province is strongly influenced by southeasterly storms; mixed conifer and western hemlock-red-cedar plant associations dominate.
19.	North Misty Fiords	Compared to South Misty Fiords, this province has considerable topographic relief and characterized as having a colder, mainland-type climate with many glaciers. Vegetation occurs in long, narrow strips along the valleys and lower slopes of fiords. Much of the vegetation is muskeg, with cottonwoods in some of the river bottoms and subalpine fir along the Canadian border.
20.	South Misty Fiords	South Misty Fiords is typical of the other mainland provinces and is the warmest. Topographic relief is lower in comparison with North Misty. Forest plant associations are more diverse than the other coastal provinces, and the vegetation is less fragmented by rock and ice than in North Misty Fiords. The southwestern portion of this province is rolling, nearly continuous muskeg with conifer forests in the bottoms and flats. This province is the northern limit of Pacific silver fir, yew, and honeysuckle.
21.	Ice Fields	Permanent ice fields, active glaciers (some advancing and some receding), and nunataks (mountain peaks between glaciers) dominate this province.
22.	Chilkat River Complex	The Chilkat River Complex lies at the northern end of the Inside Passage and is outside the Tongass Forest boundary. It consists of tall ridge systems, large glacial rivers, and includes glaciers and snowfields. Many of the rivers and drainage basins extend across the international boundary into Canada. Because of the overlap of coastal and interior floras and faunas, the province contains Alaska's highest vascular plant species richness and the highest mammalian diversity in Southeast Alaska (Carstensen et al. 2007).
23.	Glacier Bay/ Fairweather Range	This is the largest province in Southeast Alaska (2.5 million acres) and is located outside the Tongass Forest boundary. The vast majority is high mountains and glaciers and the majority is non-vegetated. The highest peaks are in the Fairweather Range along the western edge of the province, with Mt. Fairweather at over 15,000 feet. A large flat, foreland, the Gustavus Foreland, occurs in the area around Gustavus and to the north in the Bartlett River valley. Lowlands are also fairly extensive along the Dundee River and other smaller drainages on the southwest side of Glacier Bay. Glacier Bay National Park protects virtually the entire province (97 percent), except for about 75,000 acres in the vicinity of Gustavus.

Figure 3.9-1
Map of Biogeographic Provinces of Southeast Alaska



Cover Types

The vegetation of Southeast Alaska and the Tongass National Forest is dominated by temperate coastal rain forests at lower elevations (less than about 2,000 feet). Interspersed within the forest are muskegs, other wetlands, and other non-forest types. At higher elevations, alpine vegetation, rock, glaciers, and snowfields dominate. Table 3.9-2 summarizes the breakdown of cover types by biogeographic province. Each of these cover types is described in detail below.

Approximately 60 percent of the Tongass National Forest consists of forest land (including harvested acres). Of this, approximately 5.5 million acres are considered "productive forest land," defined as land capable of producing at least 20 cubic feet of wood fiber per acre per year or having greater than 8,000 board feet per acre of standing volume (see the *Timber* section for additional discussion). The remaining acres (about 4.4 million acres) are considered unproductive because they do not meet these criteria. Historically, old-growth timber harvest and management of young-growth (e.g., thinning) has occurred only within the productive forest land base.

Productive forest land is then divided into productive old growth (POG) and young growth, comprising 30 percent (about 5 million acres) and 3 percent (about half million acres) of the Tongass National Forest, respectively. Young growth includes that resulting from past timber harvest, as well as natural young growth (e.g., created by wind, fire, or glacial retreat).

The remaining 40 percent of the Tongass National Forest (about 6.6 million acres) is classified as non-forest land and includes shrub and herbaceous habitats (e.g., muskeg, alpine, estuaries), sparsely vegetated and non-vegetated areas (e.g., snow, rock, ice), and aquatic habitats (e.g., streams, ponds, and lakes).

Table 3.9-2
Major Cover Types on the Tongass National Forest by Biogeographic Province (NFS Lands Only)

		Productive Forest (acres)			Unproductive Forest (acres)			Non-Forest (acres)		
	Biogeographic Province	POG[3]	Young-growth[1,3]	Total Productive Forest	Forested Muskeg[3]	Other Unproductive Forest[3]	Total Unproductive Forest	Land[2,3]	Water[3]	Total Non-Forest
1	Yakutat Forelands	95,063	40,262	135,325	101,827	25,703	127,530	34,339	7,255	41,595
2	Yakutat Uplands	44,014	13,242	57,256	5,241	14,807	20,048	818,834	20,009	838,843
3	East Chichagof Island	399,206	47,331	446,537	108,710	203,798	312,507	276,080	6,800	282,880
4	West Chichagof Island	72,643	329	72,972	45,204	82,691	127,895	72,722	8,430	81,152
5	East Baranof Island	88,668	14,283	102,951	12,198	90,057	102,255	177,699	6,323	184,022
6	West Baranof Island	214,457	17,716	232,173	70,549	193,754	264,303	242,254	19,678	261,931
7	Admiralty Island	595,432	14,103	609,535	85,110	190,234	275,345	148,513	13,267	161,780
8	Lynn Canal	157,988	8,320	166,309	20,617	100,240	120,857	349,501	2,803	352,305
9	North Coast Range	322,684	5,930	328,614	19,697	159,444	179,141	478,694	15,363	494,057
10	Kupreanof/Mitkof Island	307,752	39,036	346,788	176,592	212,256	388,848	15,478	3,822	19,300
11	Kuiu Island	291,839	30,934	322,773	44,128	88,402	132,530	19,494	2,571	22,065
12	Central Coast Range	246,153	9,269	255,422	27,199	152,597	179,796	268,001	10,612	278,612
13	Etolin Island	221,055	41,419	262,474	71,848	130,102	201,950	22,106	4,836	26,941
14	North Central Prince of Wales	486,160	170,306	656,466	152,189	270,927	423,116	45,859	21,953	67,812
15	Revilla Island/Cleveland Peninsula	504,827	49,119	553,946	175,045	311,591	486,636	91,126	36,079	127,205
16	Southern Outer Islands	112,035	18,114	130,149	27,148	44,386	71,535	4,926	909	5,835
17	Dall Island and Vicinity	66,951	1,299	68,249	6,467	26,553	33,020	9,773	2,962	12,735
18	South Prince of Wales	151,074	4,275	155,349	45,287	105,889	151,176	27,438	10,902	38,340
19	North Misty Fiords	198,210	6,549	204,759	21,227	264,636	285,863	461,818	14,394	476,212
20	South Misty Fiords	309,132	2,405	311,537	80,097	292,249	372,346	204,948	14,714	219,663
21	Ice Fields	116,893	10,006	126,899	8,628	171,804	180,432	2,606,398	15,588	2,621,986
Forest-wide		**5,002,255**	**544,250**	**5,546,504**	**1,305,009**	**3,132,122**	**4,437,131**	**6,376,478**	**239,272**	**6,615,750**

[1] Includes 83,000 acres of natural young growth, 422,000 acres of even-aged harvested stands, and about 40,000 acres of partial harvested stands.
[2] Non-forest land classes primarily include alder brush, brush, alpine, ice and snow fields, muskeg meadow, recurrent slide, and rock.
[3] Totals may not sum or match exactly to other tables in this section due to rounding.

Productive Old-Growth Forest

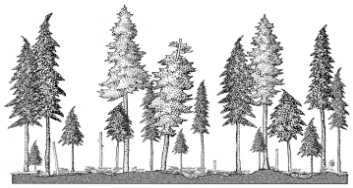
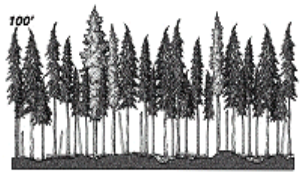
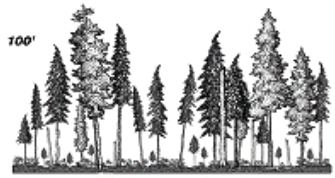
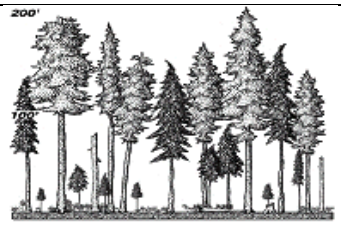
Old-growth forests support biodiversity due to their structural and ecological complexity. Franklin (1993) estimated that invertebrate biota, creatures essential to ecosystem function through such processes as nitrogen fixation and decomposition, may represent more than 90 percent of the species diversity of old-growth forests in the Pacific Northwest. In Southeast Alaska, old-growth forests are greater than 150 years old, and are characterized by multiple canopy layers; an interspersion of trees of multiple age classes; the presence of snags, decadent trees, and fallen trees; presence of forbs; and variation in the amounts and distribution of live trees (USDA-FS R10-TP-28). These features create intricate habitat niches that support many plant and animal species (Spies 2004). In Southeast Alaska, old-growth forests have been the focus of past timber harvest making them the most susceptible ecosystem to changes caused by forest management activities. For these reasons, old-growth forest is described in detail below.

Old-Growth Forest Classification

The Size-Density Model (SDM), which uses a combination of tree sizes and tree densities to classify forest structure (Caouette and DeGayner 2005), is used by the Tongass to map POG and assess impacts to old-growth habitat. This classification system builds on the timber volume-based classification system (volume strata) for POG used developed prior to the 2008 Land and Resource Management Plan (Forest Plan) (low-, medium-, and high-volume strata), which used hydric soils and steep slopes as measures of productivity and growth. While timber volume may be a good indicator of the overall productivity of a forested stand, volume fails to recognize key differences in forest structures. Forest structure is important because it reflects the complex spatial and temporal interactions between plant growth (e.g., dispersal and competition), environmental gradients (e.g., geology, soils, slope, aspect, elevation, and climate), and disturbance (e.g., wind and logging) (Caouette and DeGayner 2005). To move beyond the limitations of timber volume, the SDM was developed as a mean to produce a classification system based on forest structure. By modeling forest structure patterns using two measurable forest attributes: tree sizes and densities, the SDM is more applicable in assessing biodiversity, estimating timber values, and describing wildlife habitat than using timber volume alone (Caouette and DeGayner 2005). Seven POG types have been defined, which were used to develop a hierarchical mapping model for predicting tree sizes and densities on the Tongass National Forest. Figure 3.9-2 presents a description of each of the categories and illustrates the most probable forest type based on land form and forest condition.

POG forest can be further described in terms of two categories which have the highest importance from a biodiversity standpoint. High-volume POG is defined as the grouping of the three tree size and density classes that represent the highest volume strata—SD5S, SD5N, and SD67 types. Large-tree POG is defined as the SD67 class, representing the most productive of the POG types, and typically containing the highest density of large trees. The 2008 Forest Plan Final Environmental Impact Statement (FEIS) provides more information on the development and use of the SDM (USDA Forest Service 2008b).

Figure 3.9-2
Tree Size and Density Model used to Describe Forested Conditions across the Tongass National Forest

SD Class	*Land and Forest Condition* Most Probable Forest Type	*Tree Sizes and Densities* Most Probable Forest Type 1	*Illustration* Most Probable Forest Type
4H	Low productive older forests associated with wet, poorly drained land types (e.g., muskegs, fens, rolling hills, broken mountain slopes, plateaus, glacial outwash zones). Canopy closure is variable. Trees are small, old, and defective. Stand volume is low.	Low densities **(SDI < 280)** of small-diameter trees **(QMD < 17 inches)**. Tree size distribution and spacing is variable and patchy. Tree diameters greater than 40 inches are generally not present.	
4N	Low to moderately productive older upland forests. Canopy characteristics are variable and patchy, with moderate canopy closure and relatively coarse canopy texture. Stand volume is low to moderate.	Low densities **(SDI < 280)** of medium diameter trees **(17 < QMD < 21 inches)**. Tree size distribution and spacing is variable and patchy. Tree diameters greater than 40 inches are rare.	
4S	Highly productive younger upland forests. Stand volume is moderate, but increasing rapidly. Crown competition is high. Canopy characteristics tend to be uniform, with high canopy closure and fine canopy texture.	High densities **(SDI > 280)** of medium-diameter trees **(17 < QMD < 21 inches)**. Tree size distribution and spacing tends to be more uniform. Tree diameters greater than 40 inches are rare.	
5H	Moderately productive older forests associated with wet, somewhat poorly drained land types. Canopy closure, texture, and structure tend to be variable and patchy. Stand volume and annual growth is also variable and patchy.	Low densities **(SDI < 280)** of medium-diameter trees **(17 < QMD < 21 inches)**. Tree diameters greater than 40 inches are somewhat common, but not uniformly distributed throughout the stand.	
5N	Moderately productive older upland forests. Stand volume is moderate to high. Canopy characteristics tend to be variable, with moderate canopy closure and coarse canopy texture.	Low densities **(SDI < 280)** of medium-to-large diameter trees **(17< QMD < 21 inches)**. Tree size distribution and spacing is variable and patchy. Tree diameters greater than 40 inches are common, but not uniformly distributed throughout the stand.	
5S	Highly productive upland forests. Stand volume is high. Canopy characteristics tend to be uniform, with moderate to high canopy closures.	High densities **(SDI > 280)** of medium-diameter trees (**17 < QMD < 21 inches)**. Tree size distribution and spacing tends to be uniform. Tree diameters greater than 40 inches are somewhat common, but not uniformly distributed throughout the stand.	
67	Highly productive forests associated with riparian areas, alluvial fans, colluvial toe slopes, karst geology, and wind-protected uplands. Stand volume is high. Stand age can vary. Canopy closure is low to moderate and canopy texture is coarse.	Low densities **(SDI < 280)** of large-diameter trees **(QMD > 21 inches)**. Tree diameters greater than 40 inches are common and uniformly distributed throughout the stand.	

[1] SDI=Stand Density Index; QMD=Quadratic Mean Diameter; >=greater than; <=less than

Old-Growth Habitat

There are approximately 5 million acres of POG forest on the Tongass National Forest. Of this amount, approximately 16 percent is low-volume POG (SD 4H type), 42 percent is medium volume POG (SD 4N, 4S, and 5H types), and 42 percent is high-volume POG (SD 5S, 5N, and 67 types), of which 25 percent is large-tree POG (SD 67 type; Table 3.9-3). Table 3.9-3 provides the distribution of existing POG forest by biogeographic province. The greatest amounts of POG forest are located in the Admiralty Island, Revilla Island/Cleveland Peninsula, and North Central Prince of Wales biogeographic provinces. These biogeographic provinces also contain the most high-volume POG, but there are also six additional biogeographic provinces which each contain over 100,000 acres of high-volume POG (Table 3.9-3). Large-tree POG is not as well distributed across the Forest, with close to 40 percent concentrated in the North Central Prince of Wales and Admiralty Island biogeographic provinces.

Elevation is considered one of the most significant landscape variables influencing the distribution and availability of POG forest. Lower elevation stands (at or below 800 feet) hold the highest value for many wildlife species because they remain relatively accessible during winter (see the *Wildlife* section for additional discussion). Forest-wide, approximately 59 percent of POG forest occurs at low elevations (Table 3.9-4).

Table 3.9-3
Distribution of Productive Old-Growth Forest on the Tongass National Forest by Biogeographic Province (NFS Lands Only)

		POG Type							
		Low Volume		Medium Volume		High Volume			
	Biogeographic Province	SD4H	SD4N	SD4S	SD5H	SD5N	SD5S	SD67 (Large-tree)	Total POG[1]
1	Yakutat Forelands	7,236	9,462	17,655	2,027	4,810	9,786	44,086	95,063
2	Yakutat Uplands	2,818	6,338	19,613	940	2,928	7,955	3,422	44,014
3	East Chichagof Island	62,554	53,403	102,274	22,113	45,303	79,309	34,249	399,206
4	West Chichagof Island	14,370	12,889	24,961	1,942	6,255	10,205	2,021	72,643
5	East Baranof Island	10,238	15,056	28,694	4,581	12,165	15,934	1,999	88,668
6	West Baranof Island	32,287	38,900	80,413	7,190	19,561	32,010	4,095	214,457
7	Admiralty Island	86,690	53,040	110,609	43,387	64,465	139,659	97,582	595,432
8	Lynn Canal	21,197	20,584	46,114	9,059	13,009	36,072	11,952	157,988
9	North Coast Range	35,539	38,193	88,207	23,434	42,808	72,156	22,346	322,684
10	Kupreanof/Mitkof Island	83,983	32,071	63,614	21,802	30,124	56,570	19,587	307,752
11	Kuiu Island	42,752	19,502	41,743	24,830	44,565	83,920	34,527	291,839
12	Central Coast Range	30,442	27,179	66,014	12,942	27,058	62,492	20,026	246,153
13	Etolin Island	49,821	24,777	54,019	11,892	25,011	43,053	12,483	221,055
14	North Central Prince of Wales	105,415	26,834	63,175	69,451	42,078	77,283	101,923	486,160

Table 3.9-3 (continued)
Distribution of Productive Old-growth Forest on the Tongass National Forest by Biogeographic Province (NFS Lands Only)

		POG Type							
		Low Volume		Medium Volume		High Volume			
	Biogeographic Province	SD4H	SD4N	SD4S	SD5H	SD5N	SD5S	SD67 (Large-tree)	Total POG
15	Revilla Island/Cleveland Peninsula	79,213	43,718	94,573	54,625	69,974	130,787	31,937	504,827
16	Southern Outer Islands	17,397	10,290	26,735	9,203	15,613	20,346	12,450	112,035
17	Dall Island and Vicinity	7,457	5,724	16,801	3,473	10,995	14,580	7,920	66,951
18	South Prince of Wales	25,437	11,198	32,240	10,316	11,043	22,010	38,830	151,074
19	North Misty Fiords	13,543	35,198	78,979	3,858	18,996	34,893	12,743	198,210
20	South Misty Fiords	52,861	40,471	104,917	11,396	29,521	55,878	14,089	309,132
21	Ice Fields	4,940	21,671	50,563	1,479	10,426	21,939	5,875	116,893
Forest-wide		786,196	546,500	1,211,915	349,950	546,711	1,026,839	534,143	**5,002,255**

[1] Totals may not sum or match exactly to other tables in this section due to rounding.

Table 3.9-4
Distribution of Old-Growth Forest on the Tongass National Forest by Elevation (NFS Lands Only)

Elevation Zone	Description	Productive Old Growth	Unproductive Old Growth	Total Old Growth
Less than 800 feet	All upland old growth below 800 feet in elevation	2,931,865	1,975,371	4,907,236
800 to 1,500 feet	All upland old growth between 800 and 1,500 feet in elevation	1,454,171	1,033,305	2,487,476
Greater than 1,500 feet	All upland old growth more than 1,500 feet in elevation	616,219	1,428,456	2,044,674
Total		5,002,255	4,437,131	9,439,386

Source: Tongass GIS database 2015

Young-Growth Forest

There are approximately 544,000 acres of young-growth forest on the Tongass National Forest, of which approximately 84 percent is a result of past timber harvest and approximately 15 percent a result of natural processes (e.g., wind, fire, glacial retreat). Over 90 percent of the harvested young growth is from even-age harvest. Approximately 20 percent of young growth from even-age harvest is 25 years old or younger, in the stand initiation stage. Of this age class, stands up to about 10 years tend to have high species diversity, in particular their shrub layer, which expands as a result of the open canopy after harvest. The remaining approximately 80 percent of young growth is older and mostly in the stem exclusion stage. This type of stand condition has very low species diversity. Some of these older young-growth stands are considered suitable for timber harvest, and could help support the Tongass National Forest's transition

to young-growth harvest. See the *Timber* section for additional discussion on young-growth harvest and suitability. Table 3.9-5 shows the distribution of young-growth forest across the Tongass National Forest. Approximately 62,000 acres of previously harvested young-growth occur in the beach and estuary fringe and an additional 64,000 acres of previously harvested young-growth occur in Riparian Management Areas (RMAs) (Table 3.9-5). There are also approximately 44,000 acres of previously harvested young growth within the Old-growth Habitat Land Use Designation (LUD). Management of young-growth stands through release, pre-commercial, and commercial thinning has the potential to increase biodiversity by concentrating growth in fewer, larger trees that, if allowed to grow over time, promote conditions that accelerate natural succession in order to achieve old-growth stand characteristics at a faster rate than would occur without treatment (Caouette et al. 2000; Carey 2003). Thinning also opens the canopy, which allows light needed for understory development to penetrate to the forest floor, and increases the amount of understory forage available for a variety of wildlife species. Most young-growth stands are pre-commercially thinned prior to 20 years of age. Commercial thinning may or may not occur.

Young-growth on the Tongass National Forest is not suitable under the 2008 Forest Plan for commercial timber production within Non-Development LUDs or within other reserve areas such as the 1,000-foot-wide beach fringe and RMAs. While these stands are not managed for timber production, they can be thinned to improve habitat quality.

Unproductive Forest

Approximately 27 percent of the Tongass is classified as unproductive forest (Table 3.9-2). Many unproductive forest stands meet the definition of old growth, but the trees are typically small and stunted (under 40 feet in height) and the canopy is open (10 to 40 percent canopy closure). Hemlock, cedar, and lodge pole pine are the most common trees; blueberry and rusty menzesia are the most common shrubs. Near wet bogs or muskegs, many plants in the heath family and graminoids (grasses, sedges, and rushes) assume increasing dominance. Past disturbance to this habitat type has occurred primarily as a result of road construction, which has resulted in some permanent reduction in total acres of these unproductive forest types, also classified as forested wetlands. This disturbance is discussed further in the *Wetlands* section.

Non-Forest Lands

Non-forest ecosystems provide valuable habitat types that include wetland and other areas of shrub and herbaceous types (e.g., muskegs, alder and willow brush, alpine, estuaries), non-vegetated areas (e.g., snow, rock, ice), and aquatic sites (e.g., streams, ponds, and lakes). These habitats contribute greatly to the species diversity on the Tongass National Forest by providing a mosaic of habitat types throughout the otherwise forest-dominated landscape. They also provide unique microsites and openings that contain shrub and herbaceous vegetation within forested stands. Approximately 40 percent of the Tongass National Forest consists of non-forest lands (Table 3.9-2). A majority of the non-forest land area consists of rock (30 percent), ice and snow fields (28 percent), and brush (16 percent); the remaining types each comprise less than 10 percent of the non-forest land area.

Table 3.9-5
Forest-wide Distribution of Young Growth (NFS Lands Only)[1]

Biogeographic Province		Natural Young Growth (acres)	Harvested Young Growth (acres)[2] 0-25 Years	26-50 Years	>50 Years	Total Harvested Young-growth	Total Young-growth[3] (acres)	Harvested Young Growth in the Beach and Estuary Fringe[4] (acres)	Harvested Young Growth in RMA[4] (acres)	Harvested Young Growth in Old-growth Habitat LUD[4] (acres)
1	Yakutat Forelands	36,670	1,213	2,363	24	40,262	40,314	13	116	10
2	Yakutat Uplands	11,869	708	666		13,242	13,258	-	94	0
3	East Chichagof Island	3,296	9,303	29,180	4,596	47,331	46,456	5,264	10,875	8,041
4	West Chichagof Island	329	0	0	0	329	337	-	-	-
5	East Baranof Island	868	2,192	4,799	6,214	14,283	14,117	2,988	2,932	1,667
6	West Baranof Island	864	6	9,938	6,468	17,716	17,348	2,410	5,302	3,027
7	Admiralty Island	5,280	457	2,094	3,179	14,103	11,088	3,707	1,065	-
8	Lynn Canal	2,951	863	4,519	0	8,320	8,338	480	1,937	1,051
9	North Coast Range	5,253	0	0	459	5,930	5,714	534	76	0
10	Kupreanof/Mitkof Island	1,652	7,714	23,153	4,329	39,036	36,888	5,735	2,523	3,533
11	Kuiu Island	3,463	4,236	18,584	2,121	30,934	28,473	3,585	2,918	1,231
12	Central Coast Range	2,750	589	2,324	3,388	9,269	9,054	1,306	1,382	95
13	Etolin Island	3,403	7,504	23,451	5,352	41,419	39,843	6,874	2,205	3,496
14	North Central Prince of Wales	51	33,570	102,636	25,911	170,306	162,363	14,155	21,197	14,619
15	Revilla Island/Cleveland Peninsula	555	13,969	15,619	14,067	49,119	44,346	9,336	4,905	3,999
16	Southern Outer Islands	258	2,191	12,007	1,042	18,114	15,525	2,634	1,465	920
17	Dall Island and Vicinity	-	0	0	285	1,299	285	762	75	4
18	South Prince of Wales	-	851	1,689	679	4,275	3,226	1,323	565	569
19	North Misty Fiords	280	0	1,001	77	6,549	1,357	673	1,629	313
20	South Misty Fiords	-	0	0	0	2,405	0	353	355	-
21	Ice Fields	3,333	5	4,007	51	10,006	7,395	-	2,457	1,759
	Forest-wide	**83,125**	**85,372**	**258,029**	**78,216**	**421,616**	**544,250**	**62,133**	**64,073**	**44,333**

[1] Totals may not sum or match exactly to other tables in this section due to rounding
[2] Includes 422,000 acres of stands from even-aged harvest.
[3] Includes 83,000 acres of natural young growth, 422,000 acres of managed stands from even-aged harvest, and about 40,000 acres of partial harvested stands.
[4] Includes all harvested acres from even-age and partial harvest.

Overview of Existing Levels of POG Forest on NFS Lands

This section provides a brief overview of past timber harvest on the Tongass National Forest. The amount of POG forest is compared to the amount present in 1954 prior to large-scale commercial timber harvest. Because management activities are most likely to affect productive forest, other habitat types are likely to be maintained and will contribute toward overall biodiversity. This analysis assumes that the biogeographic provinces with the greatest amounts of POG forest remaining will support the highest levels of OG associated species and help maintain the biodiversity associated with this habitat type.

Of the 5.4 million acres of original (1954) POG that occurred on National Forest System (NFS) lands on the Tongass National Forest, approximately 92 percent remains (Table 3.9-6). Low elevation, larger-tree stands have been disproportionately harvested on the Tongass National Forest. These highly productive and economical sites (i.e., those easiest to access) were targeted in the early years of commercial timber harvest because they tended to be adjacent to the beach and within floodplain riparian areas where large Sitka spruce were available and abundant. Forest-wide, 84 percent of the original high-volume POG and 82 percent of the original large-tree POG remains (Table 3.9-7). The greatest amount of timber harvest has occurred in the North Central Prince of Wales biogeographic province (74 percent of the total original POG forest remaining), followed by Etolin Island, East Baranof, Southern Outer Islands, East Chichagof Island and Kupreanof/Mitkof Islands biogeographic provinces (85, 87, 86, 90, and 89 percent of the original total POG forest remaining, respectively; Table 3.9-6). These biogeographic provinces, in addition to West Baranof Island biogeographic province, have also had the most harvest of high-volume and large-tree POG forest harvested. The Revilla Island/Cleveland Peninsula province also ranks among the highest when considering large-tree POG harvest. For additional discussion of past harvest on the Tongass, see the *Timber* section and Appendix C.

Table 3.9-6
Original and Percent Remaining Total POG, High-Volume POG (SD5S, SD5N, SD67) Total and Below 800 feet, and Large-Tree POG (SD67) Total and Below 800 feet by Biogeographic Province (NFS Lands Only)

		Acres Original POG[1/, 2/]					% Original POG remaining				
	Biogeographic Province	Total POG	High-Volume POG	High-Vol. POG <800 ft	Large-tree POG	Large-tree POG <800 ft	Total POG	High-Vol. POG	High-Vol. POG <800 ft	Large-tree POG	Large-tree POG <800 ft
1	Yakutat Forelands	98,656	61,377	61,240	45,164	45,073	96%	96%	96%	98%	98%
2	Yakutat Uplands	45,387	15,335	14,825	3,834	3,595	97%	93%	93%	89%	89%
3	East Chichagof Island	443,241	191,888	121,364	47,460	35,953	90%	83%	77%	72%	69%
4	West Chichagof Island	72,643	18,480	14,532	2,021	1,916	100%	100%	100%	100%	100%
5	East Baranof Island	102,083	40,159	30,513	6,023	5,492	87%	75%	70%	33%	33%
6	West Baranof Island	231,308	68,304	52,778	9,150	8,611	93%	81%	77%	45%	43%
7	Admiralty Island	604,254	308,323	175,317	100,229	63,447	99%	98%	96%	97%	96%
8	Lynn Canal	163,358	65,061	37,150	13,563	8,901	97%	94%	91%	88%	85%
9	North Coast Range	323,361	137,818	64,615	22,549	13,457	100%	100%	99%	99%	99%
10	Kupreanof/Mitkof Island	345,136	134,319	83,651	30,802	23,018	89%	79%	73%	64%	61%
11	Kuiu Island	319,310	183,616	127,805	42,768	27,964	91%	89%	86%	81%	74%
12	Central Coast Range	252,672	114,465	69,176	21,982	16,569	97%	96%	93%	91%	89%
13	Etolin Island	259,071	109,059	67,742	23,888	16,224	85%	74%	67%	52%	46%
14	North Central Prince of Wales	656,415	348,976	237,337	152,999	113,327	74%	63%	57%	67%	64%
15	Revilla Island/ Cleveland Peninsula	553,391	269,121	139,818	46,506	27,341	91%	86%	81%	69%	62%
16	Southern Outer Islands	129,891	61,801	44,041	17,807	12,997	86%	78%	74%	70%	65%
17	Dall Island and Vicinity	68,249	34,469	22,636	8,310	5,764	98%	97%	96%	95%	94%
18	South Prince of Wales	155,349	75,089	50,954	40,113	29,871	97%	96%	94%	97%	96%
19	North Misty Fiords	204,479	71,334	41,509	14,623	10,816	97%	93%	91%	87%	85%
20	South Misty Fiords	311,537	101,292	62,544	14,811	11,629	99%	98%	98%	95%	96%
21	Ice Fields	123,566	43,245	21,327	7,877	5,604	95%	88%	80%	75%	69%
Forest-wide		**5,463,379**	**2,453,537**	**1,540,877**	**672,481**	**487,571**	**92%**	**86%**	**82%**	**79%**	**77%**

[1]Original total POG acreages based on Forest Service GIS layer. To determine amount of high-volume POG, assumed 75% of total past harvest consisted of high-volume POG. To determine amount of large-tree POG (SD67 type), assumed 30 percent of total past harvest consisted of large-tree POG.

An intact, undeveloped landscape is assumed to be fully functional, maintaining rare and sensitive species, vegetation communities, and/or systems and their supporting ecological processes within their natural ranges of variability (Poiani et al. 2000). Thus, the intactness of a landscape is another measure of the degree to which biodiversity has been affected by human actions. Intact watersheds are defined as those having less than 5 percent of their POG harvested, which is consistent with a similar analysis conducted by Audubon Alaska and The Nature Conservancy (Albert and Schoen 2007). Based on this definition, a Value Comparison Unit (VCU), roughly equivalent to a large watershed, with at least 95 percent of the original POG remaining would be considered to be intact. VCUs are distinct geographic areas that generally encompass a drainage basin containing one or more large stream systems with boundaries that typically follow drainage basin divides (USDA Forest Service 2008a). Of the 947 VCUs on the Tongass National Forest 68 percent are considered intact (taking all landownerships into account) and are thus likely to maintain a high degree of biodiversity. Forest-wide approximately 12.7 million acres occur within intact watersheds, or 71 percent of all acreage (Table 3.9-7). Although landscapes with higher amounts of past harvest likely remain functional, this index represents areas that are in relatively pristine conditions and thus have the highest ecological integrity. Two biogeographic provinces have all VCUs intact (West Chichagoff Island and South Misty Fiords) and another two have 90 percent or more (Yakutat Uplands and North Misty Fiords). When acreage is considered, 16 of 21 biogeographic provinces have a majority (>50 percent) of the acreage within an intact watershed. Table 3.9-7 shows the distribution of intact VCUs by biogeographic province.

Table 3.9-7
Number and Acreage of Existing Intact[1] VCUs, Comparable to Large Watersheds, on the Tongass National Forest by Biogeographic Province (NFS and non-NFS lands)

	Biogeographic Province	Total number of VCUs	Percent of Intact Watersheds (VCUs)	Approximate Total Acreage in VCUs	Percent of Acreage in Intact Large Watersheds
1	Yakutat Forelands	24	88%	339,880	84%
2	Yakutat Uplands	26	96%	913,175	99%
3	East Chichagof Island	87	53%	1,134,726	49%
4	West Chichagof Island	31	100%	283,992	100%
5	East Baranof Island	22	55%	394,188	60%
6	West Baranof Island	43	65%	795,120	69%
7	Admiralty Island	60	87%	1,087,654	84%
8	Lynn Canal	50	76%	590,146	78%
9	North Coast Range	48	88%	911,106	92%
10	Kupreanof/Mitkof Island	35	40%	845,611	42%
11	Kuiu Island	30	73%	465,555	57%
12	Central Coast Range	28	86%	550,466	85%
13	Etolin Island	28	32%	519,357	30%
14	North Central Prince of Wales	117	22%	1,472,299	15%

Table 3.9-7 (continued)
Number and Acreage of Existing Intact[1] VCUs on the Tongass National Forest by Biogeographic Province (NFS and non-NFS lands)

	Biogeographic Province	Total number of VCUs	Percent of Intact Watersheds (VCUs)	Approximate Total Acreage in VCUs	Percent of Acreage in Intact Large Watersheds
15	Revilla Island/ Cleveland Peninsula	83	61%	1,262,389	63%
16	Southern Outer Islands	20	45%	214,933	57%
17	Dall Island and Vicinity	35	49%	200,936	34%
18	South Prince of Wales	36	71%	388,239	70%
19	North Misty Fiords	30	91%	892,125	88%
20	South Misty Fiords	54	100%	907,183	100%
21	Ice Fields	59	89%	2,769,480	90%
	Total	**947**	**68%**	**17,941,713**	**71%**

[1] Intact is defined here as those watersheds (VCUs) having less than 5 percent of their POG harvested.

The extent of fragmentation effects must be assessed in the context of an organism's ability to move between patches and the scale at which the organism interacts with the landscape (With 1999 as cited in D'eon et al. 2002). For example, species with limited dispersal capabilities (i.e., flying squirrel) appear to be more sensitive to habitat loss and resulting fragmentation than species with greater dispersal capabilities (i.e., goshawks; D'eon et al. 2002). Natural fragmentation of habitats can also affect the level of additional fragmentation that can be supported.

Landscape Connectivity and Fragmentation

The Tongass National Forest is characterized by an inherent level of fragmentation due to its island geography. The natural distribution of POG forest is also patchy and linear in many areas, as a result of the mosaic condition of our landscape created by muskeg, forested wetlands, alpine areas, other unproductive forest, and other non-forested habitats. This section provides an overview of the concepts of landscape connectivity and fragmentation and existing conditions on the Tongass National Forest.

Landscape connectivity has been defined as the degree to which the structure of a landscape helps or hinders the movement of wildlife species (Taylor et al. 1993). A landscape with a high degree of connectivity is one in which wildlife and other species can move readily between habitat patches over the long term (USDA Forest Service 2008a). On the Tongass, connectivity between areas of similar habitats (for example, between two patches of old-growth forest) or between high and low elevation habitats is important to maintaining well-distributed, viable wildlife populations and thus contributing to the ecological integrity of the landscape.

Landscape connectivity can be both structurally and functionally based. Structural connectivity refers to the physical connections between areas of habitat that facilitate movement of wildlife and other organisms. For example, intact stream buffers function as corridors providing structural connectivity between habitat patches. Likewise, the beach fringe may provide low elevation structural connectivity between watersheds and function as a transition zone between interior forest and saltwater influences (Julin 1997). Functional connectivity refers to the degree of movement or flow of organisms through broader linkage "zones" which contain an appropriate juxtaposition of habitats

and land uses that facilitate movement across the landscape. On the Tongass National Forest, matrix lands may provide both structural and functional connectivity between old-growth reserves (OGRs) and other non-development LUDs.

Empirical studies to date suggest that habitat loss has large, consistently negative effects on biodiversity. Habitat fragmentation per se has much weaker effects on biodiversity that are at least as likely to be positive as negative (Fahrig 2003). Fragmentation, both natural (e.g., wind throw, landslides, insects and diseases, and avalanches) and human-caused (e.g., timber harvest, road building and powerline development), reduces landscape connectivity by breaking apart larger contiguous blocks of habitat into smaller patches. The value of residual old growth habitat patches may decline if they become too small to support species with minimum area requirements or to support a subpopulation of a particular organism (i.e., the functional unit of a metapopulation, or population made up of spatially separated local populations that interact with each other). In the latter case, interaction occurs via dispersal as individuals move among patches. Populations may become isolated, and therefore at greater risk of local extirpation, if fragmentation hinders movement of individuals between subpopulations (Wilcove et al.1986). The degree to which this occurs depends on species-specific dispersal capabilities, the distance between habitat patches, and conditions within the matrix between habitat patches.

When fragmentation occurs there is an increase in the amount of forest edge habitat and a decrease in the amount of interior old growth forest habitat, with which many wildlife species are associated (see Section 3.10 – *Wildlife*). Fragmentation is often accompanied by a decline in native species diversity because habitat conditions along the edge (edge effects) may favor some species over others. Edge effects may include changes to vegetation structure, species composition (both plants and animals), predation rates, and disturbance (Murcia 1995; Nilon et al. 1995; As 1999). Although the number of species may be higher along edges (often favoring invasive species), the number of habitat specialists (such as those associated with interior old growth forest conditions and those that tend to be more sensitive or at-risk) decreases (As 1999; Nilon et al. 1995; Kissling and Garton 2008).

The extent or “depth” of edge effects varies with the contrast in the structure and composition of adjacent vegetative communities, the width of the habitat fragment, and the stability of the remaining vegetation as it relates to other environmental effects such as windthrow, and may be species-dependent (Harper et al. 2005; Euskirchen et al. 2006). Edge effects related to vegetation structure and composition typically occur within 165 feet (50 meters) of created forest edges (Harper et al. 2005), whereas edge effects related to habitat functionality for wildlife extend farther (i.e., up to 1,640 feet [500 meters] for edge-related nest predation in migratory songbirds; Wilcove 1987). However, uncertainties remain regarding the spatial and temporal nature of edge effects. Edges are a dynamic component of the landscape. On harvested landscapes, edge contrast may decrease over time with the regeneration of disturbed areas, a process called “edge softening” (Matlack 1994; Euskirchen et al. 2006). Additionally, recent studies suggest that the presence of multiple edges (i.e., three or more adjacent patch types) may affect the magnitude and extent of edge effects (Euskirchen et al. 2006; Li et al. 2007).

Forested corridors along streams and between old-growth habitats at different elevations have been reduced in size by past harvest in many areas of the Tongass. Remaining patches of old-growth forest may serve as the only habitat in

a landscape for many lichens, fungi, bryophytes, plants, and small-bodied animals, all of which contribute to the biodiversity and productivity of the old-growth forest ecosystem. These patches may be critical for species that are locally endemic, occur only in very specific conditions of forest structure or soil type, or have limited dispersal capabilities. Biogeographic provinces with the greatest levels of past timber harvest (Table 3.9-6) and fewest intact watersheds (Table 3.9-7) are at highest risk of not maintaining a full range of natural biodiversity (ecological integrity) and have the greatest reductions in landscape connectivity. Other biogeographic provinces are naturally fragmented by unproductive forest and non-forest habitats. Detailed analyses of landscape connectivity and fragmentation are typically conducted at the project level where individual patches of contiguous old-growth forest habitat and movement corridors can be identified. For this EIS, landscape connectivity and fragmentation are discussed qualitatively and with an overview by biogeographic province.

Tongass Forest Plan Conservation Strategy

The Tongass Forest Plan Conservation Strategy was developed to maintain the integrity of the old-growth forest ecosystem, and thereby conserve biodiversity across the Forest, by retaining intact, largely undisturbed habitat. This strategy, initially incorporated into the 1997 Forest Plan, was reviewed and amended for incorporation into the 2008 Forest Plan. The Conservation Strategy includes two major components: (1) a forest-wide network of variably sized OGRs allocated to the Old-growth Habitat LUD plus all small islands less than 1,000 acres, and (2) a series of standards and guidelines applicable to lands where timber harvest is permitted, also known as the matrix (USDA Forest Service 2008a, 2008b).

The reserve network was designed to maintain habitats of the species that have the highest viability concerns (USDA Forest Service 2008b), particularly those associated or dependent upon old growth forest characteristics. The reserve network also includes other non-development LUDs such as Wilderness, LUD II, Remote and Semi-Remote Recreation. These other non-development LUDs are comprised of representative habitat types found within the temperate rainforest of Southeast Alaska, including old-growth forest as well as other habitats. These non-development LUDs contribute to maintaining a variety of habitats important for species not necessarily dependent on old growth ecosystems. The intent of the reserve system is to help ensure the maintenance of well-distributed viable populations of all old-growth associated wildlife species across the Tongass, with focus on those species that are most sensitive to habitat loss and fragmentation. In general, the home range and dispersal capabilities of old-growth associated species of concern were considered in determining the size, number and spacing of reserves. . For a complete review of the Forest Plan Conservation Strategy, including assumptions underlying the design of the OGR system, refer to Appendix D of the 2008 Forest Plan FEIS (USDA Forest Service 2008b).

The recent Sealaska conveyance (Public Law 113-291) directly affected OGRs in 15 VCUs (3610, 3620, 3630, 5450, 5460, 5560, 5570, 5600, 5872, 5900, 5940, 6180, 6190, 6200, and 6850) reducing the size, fragmenting, and in some cases eliminating them. A summary of the status of the resulting, existing OGRs (post-post-conveyance) and their consistency with Forest Plan minimum acreage requirements is provided in Appendix E. To compensate for effects to the Conservation Strategy, an interagency group of biologists from the Forest Service, U.S. Fish and Wildlife Service, and Alaska Department of Fish and Game convened in 2015 to identify new locations or boundary modifications for the affected OGRs. These “Biologically Preferred” OGRs are proposed as part of this Forest Plan amendment under Alternatives 2, 3, 4, and 5 and are discussed in the Interagency Old-growth Review report, included as Appendix E.

Within the matrix areas outside of reserves, components of the old-growth ecosystem are maintained through standards and guidelines designed to provide for important ecological functions such as dispersal of organisms, movement between forest stands, and maintenance of ecologically valuable structural components such as down logs, snags, and large trees. Matrix lands where commercial timber harvest occurs include Modified Landscape, Scenic Viewshed, and Timber Production LUDs.

Matrix management complements the reserve system by providing habitat at smaller spatial scales, increasing the effectiveness of reserves, and maintaining landscape connectivity (USDA Forest Service 2008b). Standards and guidelines applicable to these lands include maintenance of the 1,000-foot beach and estuary buffer, variable-width stream buffers, project-level legacy forest structure retention requirements, high-hazard soils, steep slopes, karst terrain, and visually sensitive travel routes and use areas, and requirements for connectivity. These are all considered contributing elements of the Conservation Strategy. Finally, a number of species-specific standards and guidelines, such as raptor nest and wolf den buffers, set aside old growth, sometimes temporarily, to avoid impacts to these species. These standards and guidelines are also addressed in the *Wildlife* section of this EIS. Additional detail on the rationale behind the standards and guidelines within the matrix is provided in Appendix D of the 2008 Forest Plan FEIS (USDA Forest Service 2008b). Table 3.9-8 shows the distribution of POG and young-growth forest within the reserve system and matrix lands.

Table 3.9-8
Distribution of Existing POG and Young Growth within the Reserve System and Matrix Lands (NFS Lands Only)

Biogeographic Province	Within Reserves (Non-Development LUDs; acres)				Within Matrix ((Development LUDs; acres)			
	Productive Old-growth				Productive Old-growth			
	Total	High-volume (SD 5N, 5S, 67)	Large-tree (SD 67)	Young-growth[1]	Total	High-volume (SD 5N, 5S, 67)	Large-tree (SD 67)	Young-growth[1]
1	74,371	42,876	30,916	24	20,691	15,806	13,171	3,569
2	43,193	13,850	3,185	254	821	455	237	1,119
3	230,146	94,783	23,185	10,341	169,060	64,079	11,064	33,694
4	72,639	18,480	2,021	-	5	-	-	-
5	53,694	16,444	1,214	1,767	34,974	13,654	785	11,648
6	181,273	47,481	3,551	6,323	33,184	8,185	543	10,529
7	595,432	301,706	97,582	8,823	-	-	-	-
8	116,162	44,024	8,650	1,093	41,827	17,010	3,302	4,277
9	215,920	90,802	14,521	354	106,763	46,508	7,824	323
10	135,284	49,737	9,467	5,992	172,467	56,544	10,120	31,392
11	197,425	105,819	17,633	4,672	94,414	57,193	16,894	22,799
12	163,813	72,362	12,305	662	82,340	37,214	7,721	5,858
13	102,207	37,434	6,067	4,192	118,848	43,113	6,416	33,824
14	257,676	121,130	55,795	29,811	228,483	100,154	46,128	140,445
15	344,679	160,998	21,401	9,384	160,148	71,700	10,536	39,180
16	89,536	36,703	8,468	4,155	22,498	11,706	3,982	13,701
17	57,671	29,772	7,557	1,269	9,279	3,723	363	30
18	105,567	49,825	27,651	1,667	45,507	22,058	11,179	2,608
19	184,661	61,354	11,542	5,265	13,549	5,278	1,201	1,004
20	309,132	99,488	14,089	2,405	0	-	-	-
21	99,184	33,666	5,634	4,476	17,709	4,574	241	2,197
Forest-wide	**3,629,686**	**1,528,738**	**382,437**	**102,928**	**1,372,569**	**578,956**	**151,706**	**358,196**

[1] Previously harvested young growth, which could help contribute to the transition to young-growth harvest.

Invasive Species

Invasive species are known to diminish the natural biodiversity of a landscape by outcompeting native species and thereby changing the ecosystem components (species composition, structure, function and connectivity) of an area. Alaska has, until recently, been relatively isolated from invasive species, due to climatic conditions, large undeveloped areas, limited transportation routes, and sparse human population centers (Fay 2002). Schrader and Hennon (2005) assessed the current status of invasive species in Alaska's ecosystems, which include non-native plants, fish, wildlife, and other species, emphasizing the Chugach and Tongass National Forests. More than 130 non-native plant species have been recorded in Alaska through 2005 (AKEPIC 2006). Eighty-eight species of non-natives have been recorded on the Tongass, 46 have been formally ranked according to their invasive characteristics and threat to Alaska, with 29 of those species identified as having a potential threat to Alaska. Fifteen of the species found on the Tongass are among the species that pose a potential threat (see the *Plant* section in this chapter for additional discussion on non-native plants).

Although many non-native wildlife species have been introduced or transplanted in Alaska, with the exception of rats in coastal ecosystems and possibly slugs in estuaries, none is considered invasive at the present. Additional discussion on terrestrial wildlife invasives are discussed in the *Wildlife* section of this chapter.

Schrader and Hennon (2005) identified 11 aquatic invasive species in their assessment. Six species have already established breeding populations in National Forest System lands and other areas in Alaska and include northern pike (*Esox lucius* Linnaeus), yellow perch (*Perca flavescens*), red-legged frog (*Rana aurora*), Pacific chorus frog (*Pseudacris regilla*), rainbow trout (*Oncorhynchus mykiss* Walbaum), and brook trout (*Salvelinus fontinalis*). The other five species are not established in Alaska yet, but cause widespread problems in the lower 48 states and could become problematic in Alaska. These species are the Atlantic salmon (*Salmo salar)*, Chinese mitten crab (*Eriocheir sinesis*), New Zealand mudsnail (*Potamopyrgus antipodarum* Gray), goldfish (*Carassius auratus*), and the signal crayfish (*Pacifacstacus leniusculus*). In Alaska, established populations of northern pike with the exception of Pike Lakes on the Yakutat Ranger District pose the greatest immediate concern, while the Atlantic salmon, Chinese mitten crab, and New Zealand mudsnail species are likely to invade Alaska in coming years (Fay 2002). Invasive tree pathogens are not currently damaging Alaskan ecosystems, but there are numerous species that could cause widespread tree mortality if introduced.

Four introduced insects are currently established in Alaska and are cause for concern: the larch sawfly, alder woolly aphid, spruce aphid, and amber-marked birch leafminer. These insects can cause widespread tree defoliation and mortality. A number of exotic insects pose a potential threat and are related primarily to transport of infested plant and wood products.

The Forest Service is addressing invasive plant management through the Alaska Region Invasive Plant Strategy (USDA Forest Service 2005) and the Tongass National Forest Invasive Plant Management Guides (Lerum and Krosse 2005). Within the Forest Service, various approaches are in place to address four action elements (prevention, early detection and rapid response, control, and restoration) in the National Strategy and Implementation Plan for Invasive Species Management (USDA Forest Service 2004b). See the *Plants* section in this chapter for more information on management of non-native plant species.

Environmental Consequences

Direct and Indirect Effects Common to All Alternatives

Effects to the Old-Growth Forest Ecosystem

A functional and interconnected old-growth ecosystem is essential to maintaining ecological integrity of several biodiversity components, including: structural complexity (within-stand and landscape level); connectivity (unfragmented contiguous blocks of old growth and well as functional connectivity within the matrix); stand age and species composition; and various ecological functions (tree establishment, disturbance, and nitrogen fixation [USDA Forest Service 2008b]). Timber harvest in POG may reduce biodiversity by shifting the age-structure of the forest by replacing old growth trees by younger t, Franklin et al. 1997); changing the composition of understory vegetation (Deal and Tappeiner 2002); and removing key habitat features such as large decadent trees, snags, and downed logs. The amount of POG remaining and its distribution across the landscape provide a method to estimate the effects of the alternatives on biodiversity. It can be assumed that the alternatives that harvest the most POG (and therefore result in the greatest changes in the natural distribution and composition of the old-growth ecosystem) would result in the greatest adverse direct effects to the biodiversity of old-growth ecosystems. It should be noted that many other cover types contribute to the overall biodiversity on the Tongass, but the focus throughout this section is placed on old-growth forest because this is the focus of the Conservation Strategy and the cover type that has been most affected by timber management activities on the Tongass. Maximum POG harvest under the alternatives would range from 32,609 acres under Alternative 2 to 62,815 acres under Alternative 1 (Table 3.9-9).

Table 3.9-9
Existing Productive Old-Growth Forest within Reserves[1] and Matrix[2] Lands (minimum protected vs. maximum harvested) by Alternative[3]

				Amount in Matrix[2]			
		Amount in Reserves[1]		Estimated Protected		Estimated Harvested[4]	
Alt.	POG Category	Acres	Percent	Acres	Percent	Acres	Percent
	All POG	3,638,141	73%	1,301,262	26%	62,815	1%
1	High-Volume POG	1,533,696	73%	546,533	26%	27,464	1%
	Large-Tree POG	385,498	72%	139,342	26%	9,303	2%
	All POG	3,645,766	73%	1,323,880	26%	32,609	1%
2	High-Volume POG	1,538,571	73%	555,101	26%	14,022	1%
	Large-Tree POG	388,688	73%	140,827	26%	4,629	1%
	All POG	3,645,766	73%	1,320,921	26%	35,568	1%
3	High-Volume POG	1,538,571	73%	555,407	26%	13,716	1%
	Large-Tree POG	388,688	73%	141,771	26%	4,629	1%
	All POG	3,645,766	73%	1,313,892	26%	42,597	1%
4	High-Volume POG	1,538,571	73%	550,875	26%	18,248	1%
	Large-Tree POG	388,688	73%	139,435	26%	6,021	1%
	All POG	3,645,766	73%	1,314,009	26%	42,479	1%
5	High-Volume POG	1,538,571	73%	551,307	26%	17,816	1%
	Large-Tree POG	388,688	73%	139,651	26%	5,805	1%

[1] Reserves include all Natural Setting and Wilderness Group LUDs (e.g., Old-Growth Habitat, Semi-Remote Recreation, Remote Recreation, Wilderness, National Monument, etc.). Roadless areas in Development LUDs are not included.

[2] Matrix includes all Development LUDs (Timber Production, Modified Landscape, Scenic Viewshed, and Experimental Forest). Roadless areas in matrix are included.

[3] Numbers may not appear to sum correctly due to rounding.

[4] Estimated harvest over 100 years.

Young-growth harvest, particularly if repeated over time (i.e., under short rotations) can have similar effects by maintaining early to mid-seral habitats

instead of allowing these stands to mature to old-growth conditions. These changes may reduce the range of habitats that support diverse plant and animal communities and alter the ecological functions supported by the old-growth ecosystem. However, treatments such as pre-commercial and commercial thinning can result in benefits to biodiversity by increasing understory growth over the short-term, and by promoting the development of old-growth stands over the long-term when stands are allowed to mature. The extent of the effects is dependent on the type of young-growth treatment implemented and the time period over which young-growth harvest is implemented. The effects of young-growth harvest discussed throughout this section, as well as in Section 3.10-*Wildlife* represent the trade-off associated with the proposed transition young-growth harvest. The alternatives represent variations on this trade-off with those that propose quicker transition times, and therefore greater conservation of the POG ecosystem in a shorter time frame, requiring an expansion of the areas where young-growth harvest is permissible. The availability of suitable young-growth is currently limited, such that in order to achieved the desired volume additional areas would need to be made available for harvest over the first 10-15 years, after which time more of the current young-growth will become suitable for commercial harvest. In relation to the conservation of biodiversity, productive old-growth forests are some of the most biodiverse ecosystems in Southeast Alaska. Therefore, a transition to predominantly young-growth harvest would be expected to result in greater conservation of biodiversity than an old-growth-based timber program.

Alternatives 2, 3, 4, and 5 propose a transition from old-growth to young-growth timber harvest. The timing of the transition varies among the alternatives with some alternatives proposing a more aggressive transition by allowing young-growth harvest in non-development LUDs and other contributing elements of the conservation strategy (e.g., beach and estuary buffers and RMAs), and/or portions of Inventoried Roadless Areas (IRAs) (see Chapter 2 for a discussion of the transition to young-growth harvest and discussions below under each alternative). Young-growth forest stands are less structurally complex and do not support the full range of biodiversity found in old-growth forest stands. Therefore, a reduction in POG harvest over time in favor of young-growth harvest would have beneficial effects to old-growth dependent species on the Tongass. However, young-growth forests provide a range of functions that may be impacted by repeated harvest. These may include serving as dispersal corridors between old growth forest patches, providing buffers between areas of suitable habitat and human activity, softening edge effects, and serving as thermal cover which may be reduced by harvest.

Young-growth stands have the potential to return to old-growth conditions over the long term if left to mature on their own or managed with that end goal. Management of young-growth stands for timber production only (maintaining previously harvested stand in a perpetual young-growth state) would not allow a previously harvested stand to return to old-growth conditions and therefore would reduce the biodiversity of these stands. Maximum young-growth harvest under the alternatives would range from 209,882 acres under Alternative 1 to 335,334 acres under Alternative 2 (Table 3.9-10).

Table 3.9-10
Existing Young Growth[1] in Reserves[2] and in Matrix[3] Lands (minimum protected vs. maximum harvested) by Alternative[4]

	Amount in Reserves[2]				Amount in Matrix[3]			
	Estimated Protected		Estimated Future Harvest[5]		Estimated Protected		Estimated Future Harvest[5]	
Alt.	Acres	Percent	Acres	Percent	Acres	Percent	Acres	Percent
1	103,084	22%	0	0%	148,158	32%	209,882	46%
2	61,305	13%	43,281	9%	64,475	14%	292,063	63%
3	67,807	15%	36,779	8%	80,101	17%	276,437	60%
4	104,586	23%	0	0%	121,653	26%	234,885	51%
5	102,775	22%	1,811	<0.5%	74,205	16%	282,333	61%

[1] Young-growth in this table includes only young-growth originating from past timber harvest. It does not include natural young-growth (e.g., from blowdown).
[2] Reserves include all non-development LUDs (e.g., Old-Growth Habitat, Semi-Remote Recreation, Remote Recreation, Wilderness, National Monument, etc.); note under some alternatives limited harvesting of young-growth occurs in reserves.
[3] Matrix includes all development LUDs (Timber Production, Modified Landscape, Scenic Viewshed, and Experimental Forest).
[4] Numbers may not appear to sum correctly due to rounding.
[5] Estimated harvest over 100 years.

Alternatives that propose the greatest amounts of old-growth timber harvest would also result in the greatest effects to old-growth ecosystem biodiversity due to the associated fragmentation and loss of connectivity. Fragmentation may remove linkages between habitat patches, making it harder for organisms to move across the landscape. A continuously distributed population could become a series of small, subpopulations that rely on the ability of dispersing individuals for genetic interchange and recolonization in the event of local extirpation. Remaining patches would become smaller and less suitable for some species, for example those associated with interior forest conditions. The extent of these effects depends in part on the dispersal capabilities of the organism, its need for interior forest conditions, and the type of treatment implemented (e.g., creation of a harder edge by even-aged harvest or a softer edge through uneven-aged harvest).

However, these effects would be reduced to some extent under alternatives that propose the greatest amount of young-growth timber harvest (i.e., those with more rapid transition to young-growth harvest). These stands are intrinsically low in biodiversity particularly during the stem exclusion stage of stand development (Franklin et al. 2002)and as such, would remain so in perpetuity, at least in the development LUDs (because young-growth stands in non-development LUDs will be allowed to reach old-growth conditions after the transition period). However, young-growth harvest would still have some effects associated with fragmentation because older young-growth stands in particular provide connectivity and also can also buffer edge effects to old-growth stands (i.e., when located between areas of even-aged harvest and old-growth forest).

At the project level, where harvest units and roads can be identified, fragmentation and loss of connectivity can be evaluated in terms of changes in remnant forest patch size, spacing, or other physical characteristics. This is not possible at the forest planning level; therefore, in this analysis changes in the number of intact landscapes (VCUs maintaining at least 95 percent of the original POG; see the Affected Environment section above for discussion) provide an index of fragmentation.

Old-Growth Reserve Modifications

Appendix E includes an analysis of pre-conveyance, post-conveyance, and Biologically Preferred (identified by the Interagency Review Team) OGRs based on Forest Plan minimum acreage requirements included in Appendix K of the 2008 Forest plan, and design criteria in Appendix D of the 2008 Forest Plan FEIS. Proposed OGR modifications are the same under all of the alternatives. To the extent possible, the Biologically Preferred OGR locations were intended to compensate for reductions in the old-growth reserve acreage, connectivity between reserves and/or shoreline areas, and incorporate the best remaining habitats (e.g., the largest blocks of remaining POG forest, low elevation POG, etc.) available in the affected VCUs. The proposed OGR modifications would result in a net increase in 6,171 acres of OGR under the Conservation Strategy and a net increase of 7,148 acres of POG in the reserve system. Additional discussion of increases in other habitat components important to wildlife are included in the *Wildlife* section of this EIS.

Effects to the Tongass Conservation Strategy

Under all of the alternatives, long-term protection of POG would continue to occur under the Conservation Strategy. The system of OGRs and other non-development LUDs is intended to maintain the ecological integrity of the old-growth ecosystem. Within the matrix, old-growth between reserves is maintained through Forest-wide standards and guidelines for stream buffers, the beach and estuary fringe, legacy forest structure, and others that preclude or limit POG timber harvest for other resources under all alternatives. Collectively, these measures would facilitate organism dispersal and maintain the functionality and interconnectedness of the old-growth ecosystem (USDA Forest Service 2008b). Tables 3.9-9 and 3.9-10 show the current level of protection for POG and young-growth forest, both within the reserves and the matrix.

However, the alternatives differ in terms of the extent to which young growth may be harvested within the reserve system, non-development LUDs, and other elements of the Conservation Strategy, including beach and estuary buffers, RMAs, and in matrix management standards and guidelines. Table 3.9-11 shows the proposed acres of young-growth harvest within the beach fringe and estuary fringe, riparian management areas, Old-growth Habitat LUD, and other non-development LUDs. Alternatives 2 and 3 propose the most young-growth harvest within Conservation Strategy elements (Table 3.9-11). Young-growth harvest within the reserve system, beach and estuary fringe, or RMAs has the potential to affect the integrity of the Conservation Strategy. Effects can include reduced functionality of these areas, reduced or fragmented buffers, and increased edge effects. However, these effects would be localized, and in some instances temporary (Alternative 5 would have a one-time entry into the Old-growth Habitat LUD, beach and estuary fringe, and RMAs). Ultimately, the substantial reduction in old-growth harvest relative to what is allowed under the 2008 Forest Plan and the transition to young-growth harvest would enhance biodiversity and the functioning of the Conservation Strategy over the long-term under all alternatives. An analysis was developed to ascertain how well the overall integrity of the old-growth conservation strategy is maintained and was applied to each alternative. This analysis is included in Appendix D.

Table 3.9-11
Projected Harvest of Young-growth[1] and Old-growth in Beach Buffers, RMAs, Old-Growth Habitat LUD, other Non-Development LUDs, and 2001 Roadless Areas by Alternative

Conservation Strategy Component	Estimated Acres of Harvest over 100 Years									
	Alt 1		Alt 2[1]		Alt 3[2]		Alt 4[3]		Alt 5[4]	
	YG	OG	YG	OG	YG	OG	YG	OG	YG	OG
Harvest in Beach Buffer	0	0	21,871	0	30,769	0	11,114	0	3,903	0
Harvest in RMA	0	0	26,030	0	0	0	0	0	1,089	0
Harvest In OG Habitat LUD	0	0	31,640	0	26,186	0	0	0	1,811	0
Harvest in other Non-Development LUD	0	0	12,868	0	12,857	0	0	0	0	0
Maximum Harvest in 2001 Roadless Rule Inventoried Roadless Areas	0	0	9,118	2,171	11,810	17,037	0	0	0	0

[1] Alt 2 Prescriptions: Young Growth - Clearcutting is permitted in Beach Buffer for first 15 years; thereafter, only Commercial Thinning is permitted. Only Commercial Thinning is permitted in RMAs. Clearcutting is permitted in Old Growth Habitat LUD, Non-Development LUDs, and previously roaded Roadless Areas (this is inconsistent with the Roadless Rule for harvest to occur in these areas and the Roadless Rule would have to change to reflect the on-the-ground conditions), unless otherwise restricted. Old Growth - Clearcutting is permitted in previously roaded Roadless Areas.

[2] Alt 3 Prescriptions: Young Growth - Only Commercial Thinning is permitted in Beach Buffers. Clearcutting is permitted in OG Habitat LUD, Non-Development LUDs, and Roadless Areas (this is inconsistent with the Roadless Rule for harvest to occur in these areas and the Roadless Rule would have to change or the Tongass Roadless Rule exemption would need to be reinstated), unless otherwise restricted. Old Growth - Clearcutting is permitted in Roadless Areas.

[3] Alt 4 Prescriptions: Young Growth - Only Commercial Thinning is permitted in Beach Buffers.

[4] Alt 5 Prescriptions: Young Growth - Created openings of ≤ 10 acres and Commercial Thinning are permitted in Beach Buffers, OGRs, and RMAs for first 15 years and with maximum of 35% of the original stand harvested; thereafter, no harvest is permitted.

Invasive Species

None of the alternatives propose changes to the management framework of the Tongass in relation to invasive species. The Alaska Region of the Forest Service is currently updating an invasive species strategy that will apply the principles of prevention, early detection, control, and rehabilitation in cooperation with various agencies and partners to reduce or eliminate invasive species establishment (Stensvold 2015 - in progress). Under all alternatives, timber harvest, road construction, and development of renewable energy projects would contribute to additional opportunities for invasive species introduction and establishment. However, none of the alternatives propose increased old growth harvest and road development levels above the 2008 Forest Plan. Although the action alternatives propose varying levels of young growth harvest and changes to where that harvest would be allowed, the 2008 standards and guidelines for invasive species would apply. Therefore, no increase in invasive species risk is anticipated under any of the alternatives. See also the *Plants* section.

LUD Changes – Renewable Energy and Transportation

Under Alternatives 2, 3, 4, and 5 the existing Transportation and Utility System overlay LUD would be replaced by Forest-wide management direction for Renewable Energy and for Transportation Systems Corridors. This replacement would be to allow greater flexibility in renewable energy development and help Southeast Alaska communities reduce fossil fuel energy dependence. An overview of the existing LUD and proposed standards and guidelines is included in the Energy Resource Report (Tetra Tech 2015).

Renewable energy projects and associated infrastructure such as roads and utility lines have the potential to result in both temporary and long-term adverse localized effects to biodiversity. This may occur due to ground-disturbing activities (road construction, powerhouse construction, pipeline locations, etc.) or through inundation (water level increase associated with hydroelectric projects), which alter or remove vegetation communities, both forested and non-forested. The extent of these effects depends on the size and location of each project and the existing level of disturbance. The *Renewable Energy* section provides an overview of existing and foreseeable renewable energy projects in Southeast Alaska. Not all future project locations are known. Any renewable energy project proposed on NFS land or requiring Forest Service approval would undergo a separate, project-specific NEPA level review; therefore, individual projects are not addressed in detail here.

Ultimately, renewable energy projects would offset carbon dioxide emissions generated by facilities that burn fossil fuels, a primary contributor to climate change. Changes in temperature, precipitation, water availability, and sea level associated with climate change have the potential to affect ecosystems through habitat shifts, increased invasive species survival, enhanced competition for limited resources, and amplification of existing stressors, such as habitat fragmentation and pollution which can result in changes in biodiversity. Therefore, renewable energy development could have both a positive as well as negative contribution to old-growth ecosystems and overall forest biodiversity.

Direct and Indirect Effects Specific to Each Alternative

Alternative 1

Alternative 1 represents the 2008 Forest Plan. Under Alternative 1, there would be no effects related to additional or modified Forest Plan components because none are proposed.

Under Alternative 1, approximately 62,815 acres of POG forest including 27,464 acres of high-volume POG, of which 9,303 acres are large-tree POG, would be available for timber harvest (Table 3.9-9). Alternative 1 would maintain at least 99 percent of the existing total POG, 99 percent of the existing high-volume POG, and 98 percent of the existing large-tree POG Forest-wide. Approximately 73 percent of the existing total POG would be maintained within the reserve system and 26 percent within the matrix (Table 3.9-9).

Effects of Alternative 1 to biodiversity in the old-growth ecosystem associated with the removal of POG forest and fragmentation would be greatest in the East Chichagof Island, East Baranof Island, Kupreanof/Mitkof Islands, Kuiu Island, Etolin Island, and North Central Prince of Wales biogeographic provinces where 2 percent reductions in the amount of original total POG would occur. Reductions of 0 to 1 percent of the original total POG would occur all other biogeographic provinces.

Under Alternative 1 approximately 209,882 acres of young-growth would be available for harvest (Table 3.9-10). No young-growth harvest would occur in contributing elements of the Conservation Strategy including the beach and estuary fringe, OGRs, RMAs, or other non-development LUDs (Table 3.9-11), except for limited amounts of treatments aimed at improving habitat conditions as allowed under the 2008 Forest Plan. Another 251,242 acres of young-growth would be maintained within the reserve system or would be protected by matrix standards and guidelines (Table 3.9-10). These acres (approximately 5 percent of the original total POG) would be allowed to mature and eventually develop into POG forest.

Forest-wide and assuming maximum timber harvest over the planning horizon, approximately 90 percent of the original total POG, 85 percent of the original high-volume POG, and 78 percent of the original large-tree POG would be maintained under Alternative 1 (Tables 3.9-12, 3.9-13, and 3.9-14). By biogeographic province, 72 to 100 percent of the original total, 62 to 100 percent of the original high-volume, and 33 to 100 percent of the original large-tree POG would be maintained.

Alternative 1 would result in a reduction in the number of intact watersheds, and acreage within intact watersheds, over the planning horizon. After 100+ years, the percentage of intact watersheds would be reduced from 68 percent to 59 percent (Table 3.9-15).

Table 3.9-12
Estimated Percent of Original POG Remaining (Total and in Reserves) after 100 Years by Biogeographic Province and Alternative (NFS lands only)

		POG		% Original POG Remaining after 100+ Years (Total / In Reserves) by Alternative				
No.	Biogeographic Province	Original Acres	% Remaining in 2015	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5
1	Yakutat Forelands	98,656	96	95 / 75	96 / 75	96 / 75	96 / 75	96 / 75
2	Yakutat Uplands	45,387	97	97 / 95	97 / 95	97 / 95	97 / 95	97 / 95
3	East Chichagof Island	443,241	90	88 / 52	89 / 52	89 / 52	89 / 52	89 / 52
4	West Chichagof Island	72,643	100	100 / 100	100 / 100	100 / 100	100 / 100	100 / 100
5	East Baranof Island	102,083	87	85 / 53	86 / 53	86 / 53	86 / 53	86 / 53
6	West Baranof Island	231,308	93	92 / 78	93 / 78	92 / 78	93 / 78	93 / 78
7	Admiralty Island	604,254	99	99 / 99	99 / 99	99 / 99	99 / 99	99 / 99
8	Lynn Canal	163,358	97	96 / 67	96 / 67	96 / 67	96 / 67	96 / 67
9	North Coast Range	323,361	100	100 / 67	100 / 67	100 / 67	100 / 67	100 / 67
10	Kupreanof/Mitkof Island	345,136	89	87 / 39	88 / 39	87 / 39	88 / 39	87 / 39
11	Kuiu Island	319,310	91	89 / 63	90 / 63	91 / 63	90 / 63	91 / 63
12	Central Coast Range	252,672	97	97 / 68	97 / 68	97 / 68	97 / 68	97 / 68
13	Etolin Island & Vicinity	259,071	85	83 / 39	84 / 39	84 / 39	83 / 39	83 / 39
14	North Central Prince of Wales	656,415	74	72 / 40	73 / 41	73 / 41	72 / 41	72 / 41
15	Revilla Island/ Cleveland Pen.	553,391	91	90 / 62	91 / 62	90 / 62	90 / 62	90 / 62
16	Southern Outer Islands	129,891	86	85 / 69	86 / 69	86 / 69	85 / 69	85 / 69
17	Dall Island and Vicinity	68,249	98	98 / 84	98 / 84	98 / 84	98 / 84	98 / 84
18	South Prince of Wales	155,349	97	97 / 68	97 / 68	97 / 68	97 / 68	97 / 68
19	North Misty Fiords	204,479	97	97 / 90	97 / 90	97 / 90	97 / 90	97 / 90
20	South Misty Fiords	311,537	99	99 / 99	99 / 99	99 / 99	99 / 99	99 / 99
21	Ice Fields	123,566	95	94 / 79	95 / 79	95 / 79	95 / 79	95 / 79
	Forest-wide	**5,463,379**	**92**	**90 / 67**	**91 / 67**	**91 / 67**	**91 / 67**	**91 / 67**

[1] Numbers may not appear to sum correctly due to rounding.

Table 3.9-13
Estimated Percent of Original High-Volume POG Remaining (Total and in Reserves) after 100 Years by Biogeographic Province and Alternative (NFS lands only)[1]

		High-volume POG		% Original High-volume POG Remaining after 100+ Years (Total / In Reserves) by Alternative				
No.	Biogeographic Province	Original Acres	% Remaining in 2015	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5
1	Yakutat Forelands	61,377	96	94 / 70	95 / 70	96 / 70	96 / 70	96 / 70
2	Yakutat Uplands	15,335	93	93 / 90	93 / 90	93 / 90	93 / 90	93 / 90
3	East Chichagof Island	191,888	83	81 / 49	82 / 49	82 / 49	82 / 49	82 / 49
4	West Chichagof Island	18,480	100	100 / 100	100 / 100	100 / 100	100 / 100	100 / 100
5	East Baranof Island	40,159	75	73 / 41	74 / 41	74/ 41	74/ 41	74/ 41
6	West Baranof Island	68,304	81	81 / 70	81 / 70	81 / 70	81 / 70	81 / 70
7	Admiralty Island	308,323	98	98 / 98	98 / 98	98 / 98	98 / 98	98 / 98
8	Lynn Canal	65,061	94	93 / 63	93 / 63	93 / 63	93 / 63	93 / 63
9	North Coast Range	137,818	100	100 / 66	100 / 66	100 / 66	100 / 66	100 / 66
10	Kupreanof/Mitkof Island	134,319	79	77 / 37	78 / 37	78 / 37	78 / 37	78 / 37
11	Kuiu Island	183,616	89	86 / 59	88 / 59	88 / 59	87 / 59	88 / 59
12	Central Coast Range	114,465	96	95 / 67	96/ 67	95 / 67	95 / 67	96 / 67
13	Etolin Island & Vicinity	109,059	74	72 / 34	73 / 34	73 / 34	72 / 34	72 / 34
14	North Central Prince of Wales	348,976	63	62 / 35	62 / 37	63 / 37	62 / 37	62 / 37
15	Revilla Island/ Cleveland Pen.	269,121	86	85 / 60	86 / 60	86 / 60	86 / 60	86 / 60
16	Southern Outer Islands	61,801	78	77 / 59	78 / 59	78 / 59	77 / 59	77 / 59
17	Dall Island and Vicinity	34,469	97	97 / 86	97 / 86	97 / 86	97 / 86	97 / 86
18	South Prince of Wales	75,089	96	95 / 66	95 / 67	95 / 67	95 / 67	95 / 67
19	North Misty Fiords	71,334	93	93 / 86	93 / 86	93 / 86	93 / 86	93 / 86
20	South Misty Fiords	101,292	98	98 / 98	98 / 98	98 / 98	98 / 98	98 / 98
21	Ice Fields	43,245	88	88 / 76	88 / 76	88 / 76	88 / 76	88 / 76
	Forest-wide	**2,453,537**	**86**	**85 / 63**	**85 / 63**	**85 / 63**	**85/ 63**	**85 / 63**

[1] High-volume POG incudes SD5S, SD5N, and SD67 classes.
[2] Numbers may not appear to sum correctly due to rounding.

Table 3.9-14
Estimated Percent of Original Large-Tree POG Remaining (Total and in Reserves) after 100 Years by Biogeographic Province and Alternative (NFS lands only)[1]

		Large-tree POG		% Original Large-tree POG Remaining after 100+ Years (Total / In Reserves) by Alternative				
No.	Biogeographic Province	Original Acres	% Remaining in 2015	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5
1	Yakutat Forelands	45,164	98	95 / 68	97 / 68	98 / 68	98 / 68	98 / 68
2	Yakutat Uplands	3,834	89	89 / 83	89 / 83	89 / 83	89 / 83	89 / 83
3	East Chichagof Island	47,460	72	71 / 49	72 /49	72 / 49	72 / 49	71 / 49
4	West Chichagof Island	2,021	100	100 / 100	100 / 100	100 / 100	100 / 100	100 / 100
5	East Baranof Island	56,023	33	33 / 20	33 / 20	33 / 20	33 / 20	33 / 20
6	West Baranof Island	9,150	45	47 / 41	47 / 41	47 / 41	47 / 41	47 / 41
7	Admiralty Island	100,229	97	97 / 97	97 / 97	97 / 97	97 / 97	97 / 97
8	Lynn Canal	13,563	88	88 / 58	88 / 58	88 / 58	88 / 58	88 / 58
9	North Coast Range	22,549	99	99 / 64	99 / 64	99 / 64	99 / 64	99 / 64
10	Kupreanof/Mitkof Island	30,802	64	62 / 31	62 / 31	62 / 31	62 / 31	62 / 31
11	Kuiu Island	42,768	81	77 / 43	79 / 43	79 / 43	78 / 43	79 / 43
12	Central Coast Range	21,982	91	91 / 60	91 / 60	91 / 60	91 / 60	91 / 60
13	Etolin Island & Vicinity	23,888	52	51 / 25	51 / 25	51 / 25	51 / 25	51 / 25
14	North Central Prince of Wales	152,999	67	64 / 38	66 / 40	66 / 40	65 / 40	65 / 40
15	Revilla Island/ Cleveland Pen.	46,506	69	68 / 46	68 / 46	68 / 46	68 / 46	68 / 46
16	Southern Outer Islands	17,807	70	68 / 48	68 / 48	68 / 48	68 / 48	68 / 48
17	Dall Island and Vicinity	8,310	95	95 / 91	95 / 91	95 / 91	95 / 91	95 / 91
18	South Prince of Wales	40,113	97	96 / 69	96 / 69	96 / 69	96 / 69	96 / 69
19	North Misty Fiords	14,623	87	87 / 79	87 / 79	87 / 79	87 / 79	87 / 79
20	South Misty Fiords	14,811	95	95/ 95	95/ 95	95/ 95	95/ 95	95/ 95
21	Ice Fields	7,877	75	75/ 68	75/ 68	75/ 68	75/ 68	75/ 68
	Forest-wide	**672,481**	**79**	**78 / 57**	**79 / 58**	**79 / 58**	**79 / 58**	**79 / 58**

[1] Large tree POG is defined as the SD 67 classes (a subset of high-volume POG).
[2] Numbers may not appear to sum correctly due to rounding.

Table 3.9-15
Number and Acreage within Intact VCUs, Comparable to Large Watersheds , after 100+ Years by Biogeographic Province and Alternative (NFS and Non-NFS lands)[1]

No.	Biogeographic Province	Number of and Acreage within Large Watersheds		% of Watersheds/Percent of Acreage					
		No.	Acres	Existing	Alt 1	Alt 2	Alt 3	Alt 4	Alt 5
1	Yakutat Forelands	24	339,880	88/84	63/73	71/77	75/82	75/82	75/82
2	Yakutat Uplands	26	913,175	96/99	93/99	93/99	93/99	93/99	93/99
3	East Chichagof Island	87	1,134,726	53/49	46/41	48/43	52/48	52/48	52/48
4	West Chichagof Island	31	283,992	100/100	100/100	100/100	100/100	100/100	100/100
5	East Baranof Island	22	394,188	55/60	45/50	45/50	45/50	45/50	45/50
6	West Baranof Island	43	795,120	65/69	51/59	51/59	51/59	51/59	51/59
7	Admiralty Island	60	1,087,654	87/84	80/79	80/79	80/79	80/79	80/79
8	Lynn Canal	50	590,146	76/78	57/60	59/62	59/62	59/62	59/62
9	North Coast Range	48	911,106	88/92	67/77	67/77	67/77	67/77	67/77
10	Kupreanof/Mitkof Island	35	845,611	40/42	34/37	34/37	29/27	34/38	34/38
11	Kuiu Island	30	465,555	73/57	67/52	70/55	73/57	73/57	73/57
12	Central Coast Range	28	550,466	86/85	75/69	75/69	75/69	75/69	79/74
13	Etolin Island & Vicinity	28	519,357	32/30	32/30	32/30	32/30	32/30	32/30
14	North Central Prince of Wales	117	1,472,299	22/15	19/12	19/12	19/12	19/12	19/12
15	Revilla Island/ Cleveland Pen.	83	1,262,389	61/63	51/52	51/52	48/51	51/52	51/52
16	Southern Outer Islands	20	214,933	45/57	40/53	45/57	40/53	40/53	40/53
17	Dall Island and Vicinity	35	200,936	49/34	31/19	31/19	31/19	31/19	31/19
18	South Prince of Wales	36	388,239	71/70	60/62	60/62	60/62	60/62	60/62
19	North Misty Fiords	30	892,125	91/88	84/83	84/83	84/83	84/83	84/83
20	South Misty Fiords	54	907,183	100/100	100/100	100/100	100/100	100/100	100/100
21	Ice Fields	59	2,769,480	89/90	86/89	86/89	86/89	86/89	86/89
	Forest-wide	**947**	**17,941,713**	**68/71**	**59/65**	**60/65**	**61/65**	**61/66**	**61/66**

[1] Large-watershed are defined here by VCUs.
[2] Intact is defined here has having less than 5 percent of original POG harvest.
[3] Numbers may not appear to sum correctly due to rounding.

Alternative 2

Alternative 2 proposes the most aggressive transition to young-growth harvest. POG harvest would be in Phase 1, 2, and 3 lands (same as 2008 Forest Plan) under Alternative 2. Alternative 2 would allow young-growth harvest in development LUDs including within the beach and estuary fringe and RMAs, and in some non-Development LUDs. Clearcutting of young-growth stands would be allowed within the beach and estuary fringe, although only during the first 15 years with only commercial thinning thereafter, and non-development LUDs under Alternative 2. Alternative 2 would also maintain a 1,000-foot buffer adjacent to even-aged (clearcut) harvest units within the beach and estuary fringe, effectively moving the buffer inland. Alternative 2 would also allow POG and young-growth harvest in the roaded roadless portions of IRAs (approximately 2,171 acres and 9,118 acres, respectively; Table 3.9-11), after new rulemaking to

update the boundaries. Harvest in any portion of IRAs is inconsistent with the 2001 Roadless Rule and could not occur until there was a change in the 2001 Roadless Rule. Harvest in these areas would be deferred until there was a rule change.

Under Alternative 2, approximately 32,609 acres of POG forest including 14,022 acres of high-volume POG and 4,629 acres of large tree POG would be available for timber harvest (Table 3.9-9). Alternative 2 would maintain at least 99 percent of the existing total POG, 99 percent of the existing high-volume POG, and 99 percent of the existing large-tree POG Forest-wide. Approximately 73 percent of the POG forest would be maintained within the reserve system and 26 percent within the matrix (Table 3.9-9).

Effects of Alternative 2 to biodiversity in the old-growth ecosystem associated with the removal of POG forest and fragmentation would be comparable among biogeographic provinces. Reductions of 0 to 1 percent of the original total POG would occur in each biogeographic provinces (Table 3.9-12).

Assuming maximum timber harvest over the planning horizon, approximately 91 percent of the original total POG, 85 percent of the original high-volume POG, and 79 percent of the original large-tree POG would be maintained under Alternative 2. By biogeographic province, 73 to 99 percent of the original total, 62 to 100 percent of the original high-volume, and 33 to 100 percent of the original large-tree POG would be maintained (Tables 3.9-12, 3.9-13, and 3.9-14).

Alternative 2 would result in a reduction in the number of intact watersheds, and acreage within intact watersheds, over the planning horizon. After 100+ years the percentage of intact watersheds would be reduced from 68 percent to 60 percent (Table 3.9-15).

Under Alternative 2 approximately 335,344acres of young growth would be available for harvest (Table 3.9-10). This includes approximately 21,872 acres within the beach and estuary fringe, 26,030 acres within RMAs, 31,640 acres within Old-Growth Habitat LUD, and 12,868 acres within other non-development LUDs (Table 3.9-11). Another 125,780 acres of young growth would be maintained within the non-development LUDs which contribute to the Conservation Strategy or would be protected by matrix standards and guidelines (Table 3.9-10). These acres (approximately 2 percent of the original total POG) would be allowed to mature and eventually develop into POG forest.

Alternative 3

Alternative 3 proposes the second most aggressive transition to young-growth harvest. POG harvest would occur only in Phase 1, 2, and 3 lands (same as the 2008 Forest Plan) under Alternative 3. Alternative 3 would allow young-growth harvest in development LUDs, including within the beach and estuary fringe, and in some non-Development LUDs. However, only commercial thinning would be allowed in the beach and estuary fringe; no young-growth harvest would occur in RMAs. Both POG and young-growth harvest would be allowed in IRAs (11,810 acres and 17,037 acres, respectively; Table 3.9-11) if new rulemaking allowed for it. Harvest in IRAs is inconsistent with the 2001 Roadless Rule and could not occur until there was a change in the 2001 Roadless Rule. Harvest in these areas would be deferred until there was a rule change.

Under Alternative 3, approximately 35,568 acres of POG forest including 13,716 acres of high-volume POG and 4,629 acres of large tree POG would be available for timber harvest (Table 3.9-9). Alternative 3 would maintain at least 99 percent of the existing total POG, 99 percent of the existing high-volume POG, and 99

percent of the existing large-tree POG Forest-wide. Approximately 73 percent of the POG forest would be maintained within the reserve system and 26 percent within the matrix (Table 3.9-9).

Effects of Alternative 3 to old-growth ecosystem biodiversity associated with the removal of POG forest and fragmentation would be greatest in the Kupreanof/Mitkof Island biogeographic province where there would be a reduction of 2 percent of the original total POG; reductions of 0 to 1 percent of the original total POG would occur in all other biogeographic provinces (Table. 3.9-12).

Assuming maximum timber harvest over the planning horizon, approximately 91 percent of the original total POG, 85 percent of the original high-volume POG, and 79 percent of the original large-tree POG would be maintained under Alternative 3 (Tables 3.9-12, 3.9-13, and 3.9-14). By biogeographic province, 73 to 100 percent of the original total, 63 to 100 percent of the original high-volume, and 33 to 100 percent of the original large-tree POG would be maintained.

Alternative 3 would result in a reduction in the number of intact watersheds, and acreage within intact watersheds, over the planning horizon. After 100+ years the percentage of intact watersheds would be reduced from 68 percent to 61 percent (Table 3.9-15).

Under Alternative 3 approximately 313,216 acres of young growth would be available for harvest (Table 3.9-10). This includes approximately 30,769 acres within the beach and estuary fringe, 26,186 acres within OGRs, and 12,857 acres within other non-development LUDs; no young-growth harvest would occur in RMAs (Table 3.9-11). Another 147,902 acres of young growth would be maintained within the non-development LUDs that contribute to the Conservation Strategy or would be protected by matrix standards and guidelines. These acres (approximately 3 percent of the original total POG) would be allowed to mature and eventually develop into POG forest.

Alternative 4

Alternative 4 proposes the least aggressive transition to young-growth harvest. POG harvest under Alternative 4 would be allowed in only Phase I lands (less than the 2008 Forest Plan). Under Alternative 4 young-growth harvest would be limited to development LUDs, including the beach and estuary fringe. Only commercial thinning would be allowed in beach and estuary fringe. No POG or young-growth harvest would be allowed in RMAs, IRAs or non-development LUDs including OGRs under Alternative 4.

Under Alternative 4, approximately 42,597 acres of POG forest including 18,248 acres of high-volume POG and 6,021 acres of large tree POG would be available for timber harvest (Tables 3.9-9). Alternative 4 would maintain at least 99 percent of the existing total POG, 99 percent of the existing high-volume POG, and 99 percent of the existing large-tree POG Forest-wide. Approximately 73 percent would be maintained within the non-development LUDs and 26 percent within the matrix (Table 3.9-9).

Effects of Alternative 4 to old-growth ecosystem biodiversity associated with the removal of POG forest and fragmentation would be greatest in Etolin Island, and North Central Prince of Wales biogeographic provinces where reductions of 2 percent of the original total POG would occur (Table 3.9-12). Reductions of 0 to 1 percent of the original total POG would occur in all other biogeographic provinces.

Assuming maximum timber harvest over the planning horizon, approximately 91 percent of the original total POG, 85 percent of the original high-volume POG, and 79 percent of the original large-tree POG would be maintained under Alternative 4 (Tables 3.9-12, 3.9-13, and 3.9-14). By biogeographic province, 72 to 100 percent of the original total, 62 to 100 percent of the original high-volume, and 33 to 100 percent of the original large-tree POG would be maintained.

Alternative 4 would result in a reduction in the number of intact watersheds, and acreage within intact watersheds, over the planning horizon. After 100+ years the percentage of intact watersheds would be reduced from 68 percent to 61 percent (Table 3.9-15).

Under Alternative 4 approximately 234,885 acres of young growth would be available for harvest (Table 3.9-10). This includes approximately 11,114 acres within the beach and estuary fringe; no young-growth harvest would occur within RMAs, OG Habitat LUD, or other non-Development LUDs (Table 3.9-11). Another 226,239 acres would be maintained within the non-development LUDs or would be protected by matrix standards and guidelines (Table 3.9-10). These acres (approximately 4 percent of the original total POG) would be allowed to mature and eventually develop into POG forest.

Alternative 5

Alternative 5 proposes the third-most aggressive transition to young-growth harvest. POG harvest under Alternative 5 would occur in Phase 1, 2, and 3 lands (same as the 2008 Forest Plan). Under Alternative 5, young-growth harvest would be allowed in development LUDS, including in beach and estuary fringe (group selection with less than 10-acre openings or commercial thinning) outside of a 200-foot buffer and RMAs (group selection with less than 10-acre openings or commercial thinning), and in the Old-Growth Habitat LUD but not in other non-development LUDs. A one-time entry stipulation would be implemented for young-growth harvest in the Old-growth Habitat LUD, beach and estuary fringe and RMAs. No POG or young-growth harvest would occur in IRAs under Alternative 5.

Under Alternative 5, approximately 42,479 acres of POG forest including 17,816 acres of high-volume POG and 5,805 acres of large tree POG would be available for timber harvest (Table 3.9-9). Alternative 5 would maintain at least 99 percent of the existing total POG, 99 percent of the existing high-volume POG, and 99 percent of the existing large-tree POG Forest-wide. Approximately 73 percent would be maintained within the reserve system and 26 percent within the matrix (Table 3.9-9).

Effects of Alternative 5 to biodiversity in the old-growth ecosystem associated with the removal of POG forest and fragmentation would be greatest in the Kupreanof/Mitkof Island, Etolin Island, and North Central Prince of Wales biogeographic provinces where the amount of original POG remaining would be reduced by 2 percent. Reductions of 0 to 1 percent of the original total POG would occur in all other biogeographic provinces.

Assuming maximum timber harvest over the planning horizon, approximately 91 percent of the original total POG, 85 percent of the original high-volume POG, and 79 percent of the original large-tree POG would be maintained under Alternative 5 (Tables 3.9-12, 3.9-13, and 3.9-14). By biogeographic province, 72 to 100 percent of the original total, 62 to 100 percent of the original high-volume, and 33 to 100 percent of the original large-tree POG would be maintained.

Alternative 5 would result in a reduction in the number of intact watersheds, and acreage within intact watersheds, over the planning horizon. After 100+ years the percentage of intact watersheds would be reduced from 68 percent to 61 (Table 3.9-15).

Under Alternative 5 approximately 324,144 acres of young-growth would be available for harvest (Table 3.9-10). This includes approximately 3,903 acres within the beach and estuary fringe, 1,089 acres within RMAs, 1,811 acres in OGRs; no young-growth harvest would occur in other non-Development LUDs (Table 3.9-11). Another 176,980 acres of young-growth would be maintained within the non-development LUDs which contribute to the Conservation Strategy or would be protected by matrix standards and guidelines (Table 3.9-10). These acres (approximately 4 percent of the original total POG) would be allowed to mature and eventually develop into POG forest.

Cumulative Effects

Historically, harvest in Southeast Alaska has been more extensive on non-NFS lands than on NFS lands (Table 3.9-16). The cumulative effects analysis for old-growth ecosystem biodiversity takes into account all of Southeast Alaska, including all lands within the Tongass National Forest boundary from the Yakutat area to the south of Ketchikan, and the area of Glacier Bay National Park, and the areas around Haines and Skagway. To estimate the future harvest of POG on non-NFS lands, it was assumed that 75 percent of the remaining POG would be harvested on Native corporation lands and 50 percent of the remaining POG would be harvested on state lands, other private lands, and lands owned by municipalities, over the life of the Forest Plan (100 years). A list of all projects considered in the cumulative effects analysis is provided in Appendix C of this EIS.

Approximately 875,700 acres of POG have been harvested across the Tongass, including both NFS lands and non-NFS lands, resulting in a reduction to 86, 79, and 68 percent of the original total, high-volume, and large-tree POG in Southeast Alaska, respectively (Tables 3.9-16, 3.9-17, and 3.9-18). Approximately 83 percent of the original POG would remain on the Tongass after full implementation of the 2008 Forest Plan (Alternative 1) and future non-NFS harvest in 100+ years (Table 3.9-16). Future representation of high-volume POG and large-tree POG would be expected to be approximately 76 and 63 percent of the original amount, respectively, after 100+ years under the 2008 Forest Plan (Table 3.9-17 and 3.9-18). POG harvest on NFS lands under Alternatives 2, 3, 4, 5 would all be less than Alternative 1, but would also maintain approximately 83 percent of the total original POG remaining on the Tongass after implementation of alternatives and future non-NFS harvest (Table 3.9-16). Future representations of high-volume POG and large-tree POG under the alternatives would be expected to be approximately 76 percent and 63 percent of the original amounts, respectively, under Alternatives 2, 4, and 5 after 100+ years, and 76 percent and 64 percent of the original amounts, respectively under alternative 4 after 100+ years (Tables 3.9-17 and 3.9-18). This does not include maturing young growth that develops older forest characteristics during that time period (estimated to be approximately 2 to 5 percent of the original POG that would be represented by mature young- growth, in non-development LUDs, which would be beginning to take on older forest characteristics; Table 3.9-9).

All action alternatives would contribute to the cumulative reduction in POG and associated increase in fragmentation and loss of connectivity, which has the potential to reduce biodiversity. Timber harvest on NFS, including micro-sales and personal use, as well as on non-NFS lands would result in similar effects. Future land adjustments and remaining land conveyances would also be assumed to affect POG as these lands become available for harvest. Collectively, the implementation of the Forest Plan under all of the alternatives in

combination with ongoing and foreseeable projects would increase in the number of smaller patches on the landscape, reducing the amount of interior forest and increasing the occurrence of forest edge habitat. Edge effects such as shifts in species composition may reduce natural biodiversity over time by favoring some species over others. These effects would be lessened by the action alternatives which propose a transition to young-growth harvest, which would reduce the long-term cumulative effects to old-growth ecosystem biodiversity by reducing the total amount of POG harvest and associated fragmentation. The actual amount of harvest that has occurred to date on the Tongass is far less than that projected under the 2008 Forest Plan FEIS, and would continue to be less under all of the alternatives (see Appendix D of this EIS for additional discussion).

Overall, biodiversity on the Tongass and in Southeast Alaska remains in good condition and the landscape continues to be dominated by old-growth forest ecosystems. As development continues through timber harvest and associated activities such as road building, and community expansion, particularly in areas where extensive development has already occurred (i.e., Prince of Wales Island), maintaining connectivity and roadless refugia will become increasingly important, particularly for wide-ranging species whose distribution depends on some level of connectivity across the landscape. In addition, the management of human resources will continue to play a role in maintaining biodiversity across the Tongass. Within the Tongass National Forest boundary, the Conservation Strategy was designed to address the more extensive harvest on non-NFS lands through the old-growth reserve system and Forest-wide standards and guidelines, both of which were intended to maintain ecological components needed to maintain the ecological integrity important to a variety of organisms and maintain connectivity across the landscape, with or without much contribution from non-NFS lands.

Table 3.9-16
Cumulative Percent of Original Total POG Remaining on All Landownerships after 100 Years of Forest Plan Implementation by Biogeographic Province and Alternative (NFS and Non-NFS Lands)

No.	Biogeographic Province	Estimated Original Total POG (Acres)	Percent Original Total POG Remaining	Percent Total POG Remaining after 100+ Years[1,2]				
				Alternative				
				1	2	3	4	5
1	Yakutat Forelands	123,675	85%	79%	79%	80%	80%	80%
2	Yakutat Uplands	45,426	97%	97%	97%	97%	97%	97%
3	East Chichagof Island	507,958	84%	79%	80%	80%	80%	80%
4	West Chichagof Island	72,958	100%	100%	100%	100%	100%	100%
5	East Baranof Island	103,046	87%	84%	85%	85%	85%	86%
6	West Baranof Island	247,420	92%	88%	89%	89%	89%	89%
7	Admiralty Island	634,873	95%	94%	94%	94%	94%	94%
8	Lynn Canal	180,172	97%	90%	91%	91%	91%	91%
9	North Coast Range	382,583	94%	88%	88%	88%	88%	88%
10	Kupreanof/Mitkof Island	406,907	82%	76%	77%	77%	77%	77%
11	Kuiu Island	327,703	91%	88%	89%	90%	89%	89%
12	Central Coast Range	259,558	97%	95%	96%	95%	95%	95%
13	Etolin Island	275,571	85%	80%	82%	81%	81%	81%
14	North Central Prince of Wales	906,143	63%	56%	57%	57%	56%	56%
15	Revilla Island/ Cleveland Peninsula	648,823	88%	81%	82%	81%	81%	81%
16	Southern Outer Islands	141,131	83%	79%	80%	80%	79%	80%
17	Dall Island and Vicinity	135,765	68%	57%	57%	57%	57%	57%
18	South Prince of Wales	192,458	88%	82%	82%	82%	82%	82%

Table 3.9-16 (continued)
Cumulative Percent of Original Total POG Remaining on All Landownerships after 100 Years of Forest Plan Implementation by Biogeographic Province and Alternative (NFS and Non-NFS Lands)

No.	Biogeographic Province	Estimated Original Total POG (Acres)	Percent Original Total POG Remaining	Percent Total POG Remaining after 100+ Years[1,2]				
				Alternative				
				1	2	3	4	5
19	North Misty Fiords	207,657	96%	96%	96%	96%	96%	96%
20	South Misty Fiords	311,823	99%	99%	99%	99%	99%	99%
21	Ice Fields	123,674	95%	94%	94%	95%	95%	95%
	Total for Southeast Alaska[3]	**6,235,343**	**86%**	**83%**	**83%**	**83%**	**83%**	**83%**

[1] The estimate assumes all scheduled suitable POG is harvested; does not account for Model Implementation Reduction Factor (MIRF).
[2] Based on an inventory of existing harvest on non-NFS lands and the estimation of future harvest by major landowner category. To estimate the future harvest of POG on non-NFS lands, it was assumed that 75 percent of the remaining POG would be harvested on Native corporation lands and 50 percent of the remaining POG would be harvested on state lands, other private lands, and lands owned by municipalities, over the life of the Forest Plan (100 years).
[3] Does not include land area in biogeographic provinces 22 and 23 which are almost exclusively non-NFS land.

Table 3.9-17
Cumulative Percent of Original High-Volume POG Remaining on All Landownerships after 100 Years of Forest Plan Implementation by Biogeographic Province and Alternative (NFS and Non-NFS Lands)

No.	Biogeographic Province	Estimated Original High-Volume POG (Acres)	Percent Original High-Volume POG Remaining	Percent Original High-Volume POG Remaining after 100+ Years[1,2]				
				Alternative				
				1	2	3	4	5
1	Yakutat Forelands	74,753	83%	79%	80%	81%	81%	81%
2	Yakutat Uplands	15,384	93%	93%	93%	93%	93%	93%
3	East Chichagof Island	225,290	75%	72%	72%	72%	72%	72%
4	West Chichagof Island	18,598	100%	100%	100%	100%	100%	100%
5	East Baranof Island	40,496	75%	73%	74%	74%	73%	74%
6	West Baranof Island	74,710	81%	78%	78%	78%	78%	78%
7	Admiralty Island	325,440	94%	93%	93%	93%	93%	93%
8	Lynn Canal	71,127	94%	89%	90%	90%	90%	90%
9	North Coast Range	165,343	91%	86%	87%	87%	87%	87%
10	Kupreanof/Mitkof Island	166,887	69%	65%	66%	65%	66%	65%
11	Kuiu Island	186,894	89%	85%	87%	87%	86%	87%
12	Central Coast Range	117,349	95%	94%	94%	94%	94%	94%
13	Etolin Island	116,073	73%	70%	70%	70%	70%	70%
14	North Central Prince of Wales	485,130	52%	48%	49%	49%	48%	48%
15	Revilla Island/ Cleveland Peninsula	310,772	83%	78%	78%	78%	78%	78%
16	Southern Outer Islands	67,773	74%	71%	72%	72%	71%	72%
17	Dall Island and Vicinity	70,553	60%	55%	55%	55%	55%	55%
18	South Prince of Wales	93,875	83%	80%	80%	80%	80%	80%
19	North Misty Fiords	72,780	93%	92%	92%	92%	92%	92%

Table 3.9-17 (continued)
Cumulative Percent of Original High-Volume POG Remaining on All Landownerships after 100 Years of Forest Plan Implementation by Biogeographic Province and Alternative (NFS and Non-NFS Lands)

No.	Biogeographic Province	Estimated Original High-Volume POG (Acres)	Percent Original High-Volume POG Remaining	Percent Original High-Volume POG Remaining after 100+ Years[1,2] Alternative 1	2	3	4	5
20	South Misty Fiords	101,392	98%	98%	98%	98%	98%	98%
21	Ice Fields	43,282	88%	88%	88%	88%	90%	88%
Total for Southeast Alaska[3]		**2,845,053**	**79%**	**76%**	**76%**	**76%**	**76%**	**76%**

[1] The estimate assumes all scheduled suitable POG is harvested; does not account for Model Implementation Reduction Factor (MIRF).
[2] Based on an inventory of existing harvest on non-NFS lands and the estimation of future harvest.
[3] Does not include land area in biogeographic provinces 22 and 23 which are almost exclusively non-NFS land.

Table 3.9-18
Cumulative Percent of Original Large-tree POG Remaining on All Landownerships after 100 Years of Forest Plan Implementation by Biogeographic Province and Alternative (NFS and Non-NFS Lands)

No.	Biogeographic Province	Estimated Original SD67 POG (Acres)	Percent Original SD67 POG Remaining	Percent SD67 POG Remaining after 100+ Years[1,2] Alternative 1	2	3	4	5
1	Yakutat Forelands	52,545	87%	84%	85%	86%	86%	86%
2	Yakutat Uplands	3,841	89%	89%	89%	89%	89%	89%
3	East Chichagof Island	65,774	60%	55%	56%	56%	55%	55%
4	West Chichagof Island	2,079	100%	97%	98%	98%	97%	98%
5	East Baranof Island	6,192	35%	33%	33%	34%	33%	33%
6	West Baranof Island	12,468	52%	42%	42%	42%	42%	42%
7	Admiralty Island	109,747	90%	90%	90%	90%	90%	90%
8	Lynn Canal	16,623	89%	78%	79%	78%	78%	78%
9	North Coast Range	37,331	77%	64%	66%	67%	65%	66%
10	Kupreanof/Mitkof Island	48,728	49%	44%	45%	45%	45%	45%
11	Kuiu Island	44,459	81%	78%	79%	79%	78%	78%
12	Central Coast Range	23,494	89%	72%	80%	81%	76%	75%
13	Etolin Island	27,581	53%	48%	48%	48%	48%	48%
14	North Central Prince of Wales	228,389	51%	48%	48%	48%	48%	48%
15	Revilla Island/ Cleveland Peninsula	68,569	64%	55%	55%	55%	55%	55%
16	Southern Outer Islands	21,098	63%	9%	60%	60%	59%	59%
17	Dall Island and Vicinity	28,220	44%	36%	36%	36%	36%	36%
18	South Prince of Wales	50,376	83%	80%	80%	80%	80%	80%

Table 3.9-18 (continued)
Cumulative Percent of Original Large-tree POG Remaining on All Landownerships after 100 Years of Forest Plan Implementation by Biogeographic Province and Alternative (NFS and Non-NFS Lands)

No.	Biogeographic Province	Estimated Original SD67 POG (Acres)	Percent Original SD67 POG Remaining	Percent SD67 POG Remaining after 100+ Years[1,2] Alternative 1	2	3	4	5
19	North Misty Fiords	15,397	85%	84%	84%	84%	84%	84%
20	South Misty Fiords	14,861	95%	95%	95%	95%	95%	95%
21	Ice Fields	7,896	75%	75%	75%	75%	75%	75%
Total for Southeast Alaska		**886,260**	**68%**	**63%**	**63%**	**64%**	**63%**	**63%**

[1] The estimate assumes all scheduled suitable POG is harvested; does not account for Model Implementation Reduction Factor (MIRF).
[2] Based on an inventory of existing harvest on non-NFS lands and the estimation of future harvest by major landowner category.
[3] Does not include land area in biogeographic provinces 22 and 23 which are almost exclusively non-NFS land.

Wildlife

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Affected Environment

This section describes the wildlife resources on the Tongass National Forest. The following subsections address the old-growth habitat conservation strategy; threatened, endangered, and candidate species; Management Indicator Species (MIS); Alaska Region Sensitive Species; migratory birds; endemic species; and invasive species. Consumptive uses of wildlife on the Tongass National Forest are discussed in the *Subsistence* section.

Old-Growth Habitat and the Conservation Strategy

Typical of Southeast Alaska, vegetation on the Tongass National Forest is dominated by temperate coastal rain forests at lower elevations (less than 2,000 feet elevation), with interspersed muskegs, other wetlands, and other non-forest types. At higher elevations, alpine vegetation, rock, glaciers, and snowfields dominate. Although many wildlife species on the Tongass are associated with more than one habitat type, most inhabit old-growth forests or prey on species that inhabit old-growth forests. Therefore, this analysis focuses on the old-growth ecosystem. In Southeast Alaska, old-growth forests are typically greater than 150 years old, and are characterized by complex canopies; an interspersion of trees of multiple age classes; the presence of snags, decadent trees, and fallen trees; and a variation in the amounts and distribution of live trees. These features create intricate habitat niches that support many wildlife species (Spies 2004).

The 1997 Tongass Forest Plan established a comprehensive, science-based Conservation Strategy to provide for wildlife sustainability and viability across the Tongass (USDA Forest Service 1997a, 1997b). The Conservation Strategy was developed to maintain the integrity of a functional and interconnected old-growth ecosystem on the Tongass by retaining intact, largely undisturbed habitat well-distributed across the Forest. The Conservation Strategy includes two major components: (1) a forest-wide network of large, medium, and small OGRs allocated to the Old-Growth Land Use Designation (LUD) and other non-development LUDs plus all small islands less than 1,000 acres, and (2) a series of standards and guidelines applicable to lands where timber harvest is permitted (the matrix; USDA Forest Service 2008a, 2008b).

The OGR system was designed to maintain habitats of the old-growth associated and dependent species (USDA Forest Service 2008a). The forested areas of other non-development LUDs such as Wilderness, LUD II, Remote and Semi-Remote Recreation also maintain the old-growth ecosystem. The intent of the reserve system was to help ensure the maintenance of well-distributed viable populations of old-growth associated wildlife species across the Tongass, with focus on those species that are most sensitive to habitat loss and fragmentation. For a complete review of the Forest Plan Conservation Strategy, including

assumptions underlying the design of the OGR system, refer to Appendix D of the 2008 Forest Plan Final Environmental Impact Statement (FEIS; USDA Forest Service 2008a).

Within the matrix (areas outside of reserves), components of the old-growth ecosystem are maintained through a series of standards and guidelines designed to provide for important ecological functions such as dispersal of organisms, movement between forest stands, and maintenance of ecologically valuable structural components such as down logs, snags, and large trees (USDA Forest Service 2008a). Matrix lands include Modified Landscape, Scenic Viewshed, and Timber Production LUDs; Experimental Forest is also a development LUD, however timber harvest occurs only for research purposes. Standards and guidelines applicable to these lands include the 1,000-foot beach and estuary buffer, Riparian Management Areas (RMAs), legacy forest structure standards and guidelines, and a number of species-specific standards and guidelines (e.g., raptor nest buffers and wolf den buffers). A more detailed description of the Tongass Conservation Strategy, and the basis for its development, is provided in the *Biodiversity* section.

There are currently approximately 5.0 million acres of POG forest on the Tongass National Forest, of which 2.1 million acres are high-volume POG and half a million acres are large-tree POG, representing 92, 84, and 82 percent of these forest types estimated to have been originally existing in 1954 prior to the beginning of commercial timber harvest (Tables 3.9-3 and 3.9-6). There are approximately half a million acres of young-growth forest on the Tongass National Forest, of which 84 percent are a result of past harvest and 16 percent are natural young-growth (Table 3.9-5). The *Biodiversity* Section provides a description POG forest and other cover types and a discussion of past timber harvest on the Tongass National Forest.

Landscape Connectivity and Fragmentation

Landscape connectivity is defined as the degree to which the structure of a landscape helps or hinders the movement of wildlife species (Taylor et al. 1993). A landscape with a high degree of connectivity is one in which wildlife move readily between habitat patches over the long term (USDA Forest Service 2008a). On the Tongass, connectivity between areas of similar habitats (i.e., old-growth forest) or between high and low elevation habitats is important to maintaining well-distributed, viable wildlife populations of some species.

Fragmentation by both natural and human-caused actions reduces landscape connectivity by breaking apart larger contiguous blocks of habitat into smaller patches. Populations may become isolated, and therefore at greater risk of local extirpation, if fragmentation hinders movement of individuals between subpopulations (Wilcove et al. 1986). The degree to which this occurs depends on species-specific dispersal capabilities, the distance between habitat patches, and conditions within the matrix between habitat patches. Empirical studies to date suggest that habitat loss has large, consistently negative effects on biodiversity. Habitat fragmentation per se has much weaker effects on biodiversity that are at least as likely to be positive as negative (Fahrig 2003). The concepts of landscape connectivity and fragmentation are described in the *Biodiversity* section.

Wildlife Species

The following sections describe threatened and endangered species, candidates for listing, management indicator species (MIS; 1982 planning rule), Alaska Region sensitive species, and other species of interest. Table 3.10-1 provides a comprehensive list of these species and identifies those carried forward in the analysis based on known occurrences or the presence of suitable habitat in the planning area.

Threatened, Endangered, and Candidate Species

Federally listed threatened and endangered species are those plant and animal species formally listed by the U.S. Fish and Wildlife Service (USFWS) or National Marine Fisheries Service (NMFS) under authority of the Endangered Species Act (ESA) of 1973, as amended. An endangered species is defined as one that is in danger of extinction throughout all or a significant portion of its range. A threatened species is defined as one that is likely to become an endangered species within the foreseeable future throughout all or a significant portion of its range.

The federally listed threatened and endangered wildlife species known to occur within the boundary of the Tongass National Forest include the humpback whale (*Megaptera novaeangliae*), fin whale (*Balaenoptera physalus*), sperm whale (*Physeter microcephalus*), short-tailed albatross (*Phoebastria albatrus*), and Steller sea lion (*Eumetopias jubata;* western Distinct Population Segment [DPS]). There are also several listed fish species which are addressed in the *Fish* section of this EIS. Pursuant to Section 7 of the ESA, a Biological Assessment (BA) evaluating the effects of the selected alternative of this Forest Plan amendment on these species was prepared; one BA for the marine mammals and fish species was submitted to the NMFS and another containing the short-tailed albatross was submitted to the USFWS for review and concurrence. The remaining federally listed species are not addressed further because the Tongass is outside of their known range or suitable habitat is not present (Table 3.10-1). Currently, no candidates for federal listing occur within the boundary of the Tongass National Forest (Table 3.10-1). In accordance with Forest Service Manual 2670, a Biological Evaluation (BE) covering federally listed threatened and endangered wildlife species and Region 10 sensitive species was also prepared; this BE contains an evaluation and comparison of all alternatives. The BA and BEs for this Forest Plan Amendment are included in the project record.

Short-tailed Albatross

The short-tailed albatross was federally listed as endangered throughout its range on July 31, 2000 (65 Federal Register [FR] 147:46643-46654). It is a pelagic seabird species that forages offshore and in shelf-break waters throughout the North Pacific Ocean and Bering Sea. The short-tailed albatross primarily breeds in Japan but single nest sites have been documented on Midway Island, Hawaii. Outside of the breeding season, it occurs in the waters of the Bering Sea, Aleutian Islands, and Gulf of Alaska (USFWS 2012). Primary threats to this species include loss of nesting habitat as well as interactions with fishing operations (e.g., entanglement with gear), ingestion of plastic debris, contamination from oil spills, and predation at breeding colonies.

Based on the most recent USFWS 5-year review for the species (USFWS 2014), the short-tailed albatross population is making progress toward recovery. Data from breeding colony surveys, suggest a total population of estimate of 4,454 individuals at the end of the 2013-2014 breeding season.

Previously the waters adjacent to the Tongass National Forest were thought to be outside of the range of this species (USFWS 2008b); however, more recent satellite tracking of adult (in 2006-2008) and juvenile (in 2008-2012) albatrosses has helped to provide a more complete picture of the marine distribution of this species (USFWS 2014). The satellite tracking data indicates that there are marked differences in the marine distribution of juvenile and adult albatrosses, with juvenile and sub-adult birds (up to 2 years old) traveling to the west coast of North America (including Southeast Alaska), and more extensively between Hawaii and Alaska, than adult birds. This species may forage in nearshore

waters adjacent to the outer coast of the Tongass, particularly where the continental shelf break is close to shore. Therefore, it could be exposed to water quality effects associated with land management activities on the Tongass National Forest.

Table 3.10-1
Federally Listed Threatened and Endangered Species, Candidate Species Under the ESA, and Forest Service Alaska Region Sensitive Species and Potential for Occurrence on the Tongass National Forest

Common Name	Scientific Name	Habitat Association	Potential for Occurrence in the Planning Area	Status1
ESA Species Under USFWS Jurisdiction				
Eskimo curlew	*Numenius borealis*	Arctic tundra.	No, outside of species' range.	E
Short-tailed albatross	*Phoebastria albatrus*	Winters in waters of the Bering Sea, Aleutian Islands, and Gulf of Alaska; breeds in Japan (USFWS 2012a).	Yes, may occur in nearshore waters near islands and mainland coastlines of southeast Alaska.	E
Spectacled eider	*Somateria fischeri*	Coastal waters in northern and western Alaska (USFWS 2012b).	No, outside of species' range.	T
Steller's eider	*Polysticta stelleri*	Occurs in northern and western Alaska (USFWS 2012c).	No, outside of species' range.	T
Polar bear	*Ursus maritimus*	Sea ice and coastlines of western Alaska and along the North Slope.	No, outside of the species' range.	T
Pacific walrus	*Odobenus rosmarus divergens*	Continental shelf waters of Bering and Chukchi seas.	No, outside of the species' range.	C
ESA Species Under NMFS Jurisdiction				
Blue whale	*Balaenoptera musculus*	Off-shore (pelagic) marine waters of the Bering Sea, Chukchi Sea, North Pacific Ocean and/or Gulf of Alaska (NMFS 2009a). Critical habitat designated for North Pacific right whales in the Bering Sea and the Gulf of Alaska (NMFS 2009a).	No, very rarely observed in Southeast Alaska.	E
Beluga whale	*Delphinaperus leucas*			
Bowhead whale	*Blaena mysticetus*			
Northern Pacific right whale	*Eubalaena japonica*			
Sei whale	*Balaenoptera borealis*			
Humpback Whale	*Megaptera novaeangliae*	Common in the inside waters of the Alexander Archipelago and are regularly sighted in the Inside Passage and coastal waters of the Southeast Alaska panhandle (NMFS 1991).	Yes, likely to occupy marine waters surrounding the Tongass. May occur in shallow coastal areas.	E
Fin whale	*Balaenoptera physalus*	Typically off-shore (pelagic) marine waters of the Bering Sea, Chukchi Sea, North Pacific Ocean and/or Gulf of Alaska (NMFS 2009a); two more recent sightings in lower Clarence Strait (Dahlheim et al. 2009).	Yes, may occur seasonally in marine waters surrounding the Tongass, but in proximity to the open ocean.	E
Sperm whale	*Physeter macrocephalus*	Typically off-shore marine waters of the Bering Sea, Gulf of AK, Southeast AK and Aleutian Islands (Allend and Angliss 2014).	Yes, may occur seasonally in marine waters around Tongass, but in proximity to the open ocean.	E

Table 3.10-1 (continued)
Federally Listed Threatened and Endangered Species, Candidate Species Under the ESA, and Forest Service Alaska Region Sensitive Species and Potential for Occurrence on the Tongass National Forest (continued)

Common Name	Scientific Name	Habitat Association	Potential for Occurrence in the Planning Area	Status[1]
Bearded seal Ringed Seal	*Erignathus barbatus* *Phoca hispida*	Sea-ice habitats in Bering Sea, Chukchi Sea, Beaufort seas (77 FR 76740-76768, 77 FR 76706-76738).	No, outside of species' range.	C – bearded seal; T – ringed seal
Northern sea otter, SW Alaska population	*Enhydra lutris kenyoni*	Coastal marine habitats.	No, outside of species range.	T
Steller sea lion – Western AK DPS[2]	*Eumetopias jubatus*	Marine and terrestrial areas from Prince William Sound westward (west of 144° west longitude).	Yes, DPS occurs in waters surrounding the Tongass. Critical habitat has also been designated.	E
Green sea turtle	*Chelonia mydas*	Occur in the Gulf of Alaska and some species are found as far west as the Aleutian Islands. Adults are highly migratory, but the details and locations of migrations are largely unknown (NMFS 2009b).	No, only rarely observed in Southeast Alaska.	T
Loggerhead sea turtle	*Caretta*			T
Olive Ridley sea turtle	*Lepidochelys olivacea*			T
Leatherback sea turtle	*Dermochelys coriacea*			E
Forest Service Alaska Region Sensitive Species[3]				
Steller sea lion – Eastern AK DPS[3]	*Eumetopias jubatus*	Marine and terrestrial areas in Southeast Alaska (east of 144° west longitude).	Yes, occurs in waters surrounding the Tongass.	S
Queen Charlotte goshawk	*Accipiter gentiles laingi*	Mature/old-growth forests.	Yes, known to occur on the Tongass.	S
Aleutian Tern	*Sterna aleutica*	Nests on islands, shrub-tundra, grass or sedge meadows and freshwater and coastal marshes.	Yes, known to occur on the Tongass.	S
Black oystercatcher	*Haematopus bachmani*	Rocky shorelines along the coast; forages in sheltered areas where low-sloping gravel or rock beaches with abundant prey occur.	Yes, known to occur on the Tongass.	S
Kittlitz's murrelet	*Brachyramphus brevirostris*	Breeds in the vicinity of glaciers and cirques in high elevation alpine areas with little or no vegetative cover; northern Gulf of Alaska and Bering Sea coast (Day et al. 1999).	Yes, known to occur on the Tongass.	S

[1] T = Federally threatened; E = Federally endangered; C = candidate for Federal listing; S = Alaska Region Sensitive Species
[2] DPS = Distinct Population Segment.
[3] Regional Forester's Sensitive Species List (February 2009). The Steller sea lion Eastern DPS was added as a sensitive species afte federal ESA delisting. The Western DPS remains federally endangered.

Alaska Region Sensitive Species

The Alaska Region Sensitive Species list was updated in 2009 and supersedes previous lists (USDA Forest Service 2009b). The following summarizes the 2009 updates to the Alaska Region Sensitive Species list for animal species that occur on the Tongass National Forest. Three animal species were removed from the list and include the Trumpeter swan, American osprey, and Peale's peregrine

falcon. Two animal species were added to the list and include Black Oystercatcher and Aleutian tern. Two animal species were retained on the list and include the Kittlitz's murrelet and Queen Charlotte goshawk.

Although not on the 2009 list, the Steller sea lion (eastern DPS) is now an Alaska Region Sensitive Species. A species removed from listing under the ESA because recovery criteria have been met will automatically be added to the sensitive species list for at least 5 years (FSM 2672.11, R-10 2600-2005-1). On November 4, 2013, the NMFS issued a final rule (78 FR 66140) to remove the eastern DPS of Steller sea lion from the List of Endangered and Threatened Wildlife and therefore will be analyzed as a sensitive species through at least 2018.

Species that are candidates for listing under the ESA are also automatically considered an Alaska Region Sensitive Species. Pacific walrus is a USFWS candidate for listing, but this species does not occur on the Tongass and is not considered further here (Table 3.10-1).

Queen Charlotte Goshawk

The Queen Charlotte goshawk (*Accipiter gentilis laingi*) is included by Stenhouse and Senner (2005) on Audubon's Alaska WatchList. The Queen Charlotte goshawk is recognized as a distinct subspecies of the northern goshawk (*Accipiter gentilis*) that occurs only in coastal areas of British Columbia and in Southeast Alaska. In 2007, in response to a court-ordered remand on a petition to list the species, the USFWS updated a 1997 status review for the Queen Charlotte goshawk, and concluded that Alaska supports a DPS of this species though listing of this DPS was not warranted (USFWS 2007). On August 1, 2012, the British Columbia DPS of the Queen Charlotte goshawk was listed as threatened under the ESA (FR 45870-45893). The Alaska DPS was not listed in part due to the protections provided by the Tongass Forest Plan Conservation Strategy.

The goshawk is a year-round resident in Southeast Alaska and may occupy different or overlapping breeding and winter territories. Goshawk breeding territories can be described hierarchically in terms of the nest site, the nest area, post-fledging area, and foraging area (see Reynolds et al. 1992 and USDA Forest Service 2008b). Goshawks in Southeast Alaska typically nest in large patches of tall, mature, and old trees with dense canopies. When mature and old-growth habitats are not available, they will nest in maturing young growth with sufficient structure (Reynolds et al. 2006; Boyce et al. 2006). Nesting in mature young growth is less common, and occurs in proportion to the amount of this habitat available on the landscape, suggesting goshawks neither prefer nor avoid its use (USFWS 2007).

Goshawk foraging areas typically consist of mature and old-growth forest stands, though they will also forage in young forest as well as along edges and in openings as long as suitable perches from which to observe and attack prey are present (Iverson et al. 1996; Bosakowski et al. 1999; McClaren 2004; Boyce et al. 2006; Reynolds et al. 2006). Prey species vary geographically, and include blue grouse, red squirrels, and a variety of forest-dwelling birds (spruce grouse, Steller's jay, and ptarmigan; Lewis 2001). High-volume POG represents optimal nesting and foraging habitat for goshawks due to the presence of large trees and snags. Existing amounts of this forest type on the Tongass are discussed in the *Biodiversity* section. Approximately 84 percent of the original high-volume POG existing in 1954, the time at which commercial timber harvest began on the Tongass National Forest, remains (Table 3.9-6).

Timber harvest in both old-growth and mature young-growth forest may locally limit the availability of nest sites through removal of suitable nest trees, or through removal of forest surrounding these trees. Nest trees optimally should be surrounded by patches of mature or old-growth forest large enough to include several alternate nests and provide post-fledging habitat. Timber harvest may also decrease foraging habitat quality through reductions in prey abundance and availability. Dense young growth stands are difficult for goshawks to hunt, reducing availability of prey, even where prey populations may otherwise be adequate. The availability of adequate prey resources has been linked to goshawk territory occupancy and breeding success (Doyle and Smith 1994; Salafsky et al. 2005; Keane et al. 2006; Salafsky et al. 2007). Conservation measures for this species include requirements for project surveys for nesting goshawks, retention of confirmed or probable nest stands, and retention of legacy old-growth forest structure in old-growth harvest units larger than 20 acres, where logging has been most intensive (USDA Forest Service 2008a). The system of OGRs and other non-development LUDs also maintains habitat for this species, although a recent study suggests that some uncertainty remains with respect to the ability of Forest Plan conservation measures to contribute sufficient habitat to sustain well-distributed, viable populations of northern goshawks throughout Southeast Alaska (Smith 2013). Continued inventories and monitoring of established nest protection buffers will help to inform future decisions.

Kittlitz's Murrelet

The Kittlitz's murrelet (*Brachyramphus brevirostris*) was retained as a 2009 sensitive species because it was a USFWS candidate (USDA Forest Service 2009b). On October 3, 2013, the USFWS issued a 12-month finding (78 FR 61763) that listing the Kittlitz's murrelet is not warranted. However, until the Alaska Region Sensitive Species list has been updated, the Kittlitz's murrelet will continue to be analyzed as a sensitive species. During its 2013 review, the USFWS concluded that the rangewide Kittlitz's murrelet population declined by approximately 30 percent per year between 1989 and 2000, but since then appears to have stabilized or may be declining at a much slower rate (USDI 2013). Declines have been attributed to glacial retreat and changes in the ocean environment which may alter foraging habitat and prey populations; other factors include predation, oil pollution, gill-net by-catch, disturbance by commercial and recreational boaters, and flightseeing operations (USFWS 2006b).

More than 95 percent of the global population is estimated to breed in Alaska, with the remainder occurring in the Russian Far East. The largest breeding populations are believed to be in Glacier Bay National Park and Preserve, Prince William Sound, Kenai Fjords, and Icy Bay (Kendall and Agler 1998 as cited in Day et al. 2000). Breeding season core population centers adjacent to the Tongass include Icy Bay, Malaspina Forelands, and Yakutat Bay where the species is closely associated with glacial habitats (Kissling et al. 2011). The Forest Plan contains direction to "provide for the protection and maintenance of known Kittlitz's murrelet nesting habitat."

Black Oystercatcher

The black oystercatcher (*Haematopus bachmani*) was added to the Alaska Region Sensitive Species list in 2009. The Alaska Shorebird Conservation Plan also notes it as a species of high concern due to concerns with population size, breeding and nonbreeding threats, and nonbreeding distribution (Alaska Shorebird Group 2008). It is also a Bird of Conservation Concern, and is on the Audubon Society's Watch List (Tessler et al. 2007).

The black oystercatcher occurs along the North American Pacific coast from the Aleutian Islands to Baja California (Andres and Falxa 1995), with over half of the global population residing in Alaska primarily in Prince William Sound and the Kodiak Archipelago (Tessler et al. 2007). They favor rocky shorelines and forage exclusively on intertidal macroinvertebrates (e.g., limpets and mussels) found in sheltered areas of high tidal variation (Tessler et al. 2007).

Breeding oystercatchers are highly territorial and breeding pairs tend to be widely distributed (Tessler et al. 2007). After breeding, black oystercatchers aggregate into winter flocks ranging from tens to hundreds of individuals. Winter flocks typically concentrate on protected, ice-free tidal flats or rocky islets with dense mussel beds.

Because black oystercatchers solely use the intertidal zone, where they may congregate in large numbers, they are especially vulnerable to disturbance from marine industrial pollution and human disturbance from tourism and fishing. Threats include predation, recreational disturbances, flooding, vessel wakes, and shoreline contamination (Tessler et al. 2007).

Surveys specifically targeting black oystercatchers in Alaska are limited and the Northern Pacific Pelagic Seabird Database (NPPDS) serves as one of the largest data sources, although it may underestimate the number of birds because it is not specific to oystercatcher (Tessler et al. 2007). Kodiak Island is currently the only documented area in Alaska that supports large concentrations of black oystercatchers (Tessler et al. 2007), but they have been observed and are known to nest in low densities along shorelines and use intertidal areas adjacent to the Tongass National Forest. Historically, they have been documented in Sitka Sound/Necker Islands, the Myriad Islands, the outer coast of Baranof Island, and the Forrester Island group but breeding birds are generally sparsely distributed (Tessler et al. 2007). From Baranof Island south to the Canadian border, the NPPSD shows only 57 incidental observations of black oystercatchers between 1972 and 2003, most (65 percent) of which are from the Forrester Island group (Tessler et al. 2007). There is no specific 2008 Forest Plan direction for this species because it was added to the sensitive species list after the 2008 Forest Plan was approved.

Aleutian Tern

The Aleutian tern (*Sterna aleutica*) is a migratory seabird that breeds exclusively in Alaska and eastern Siberia. It is a USFWS Bird of Conservation Concern and is protected under the Migratory Bird Treaty Act (MBTA) and is listed as an Alaska Region sensitive species by the Forest Service. In Alaska, Aleutian tern colonies are located throughout the Aleutian Islands, north to the southeastern Chukchi Sea and east to the Alaska Peninsula, Yakutat, and Glacier Bay (USFWS 2012d).

Aleutian terns breed in loose colonies, often in association with Arctic terns, in coastal sites located at the heads of bays, reefs, island, estuaries, and river mouths (USFWS 2012d). Nests are located on the ground in a variety of habitats including shrub tundra, grass or sedge meadows, and freshwater and coastal marshes (USFWS 2006b). One of the largest breeding colonies of Aleutian terns occurs on Black Sand Spit in the Yakutat Forelands, which supports approximately one third of Alaska's population. Due to its importance as a breeding colony, Black Sand has been identified as an Audubon Important Bird Area. Most other known occurrences of Aleutian terns are not located on the Tongass. Little is known about this species outside of the breeding season; however, it is known to winter in the eastern Pacific.

Threats to this species include human disturbance at nest sites, marine oil spills, and change in forage fish populations (USFWS 2012d). Timber harvest associated activities (i.e., log transport, use of log transfer facilities [LTFs], and helicopter activity) could have the potential to affect this species through disturbance to nesting colonies or through water quality impacts to prey species. Although most known colonies are in remote sites, some do exist in areas where Forest Service permitting may have the potential to cause disturbance (USDA Forest Service 2009b). There is no specific Forest Plan direction for this species but the standards and guidelines for Seabird Colonies apply (USDA Forest Service 2008a).

Steller Sea Lion Eastern DPS

The Steller sea lion (*Eumetopias jubatus*) was emergency-listed as threatened under the ESA in April 1990 by NMFS due to rapid population declines in the western portion of its range (55 FR 12645). In 1997, the NMFS designated two DPS, occurring west and east of 144 degrees west longitude, respectively. Due to persistent decline, the western DPS was reclassified as endangered, while the increasing eastern DPS was delisted in November 2013. On November 4, 2013, NMFS issued a final rule (78 FR 66140) to remove the eastern DPS of Steller sea lion from the List of Endangered and Threatened Wildlife. A species removed from listing under the ESA because of recovery criteria have been met will be automatically added to the Alaska Region Sensitive Species list for at least 5 years (FSM 2672.11, R-10 2600-2005-1). The western DPS is analyzed in the BA. Steller sea lions are also protected by the Marine Mammal Protection Act (MMPA) under which they are designated as “depleted” (NMFS 2013a, 2013b).

Steller sea lions are widely distributed over the continental shelf and throughout the coastal waters of the Gulf of Alaska. The eastern DPS is known to occur in the waters surrounding the Tongass, although intermigration between the eastern and western populations has been documented, particularly north of Frederick Sound.

Steller sea lions forage in nearshore and pelagic waters where they are opportunistic predators. They feed primarily on a wide variety of fishes and cephalopods (squid and octopus). Steller sea lions use terrestrial haulout sites to rest and take refuge. They also gather on well-defined, traditionally used rookeries to pup and breed. These habitats are typically gravel, rocky, or sand beaches; ledges; or rocky reefs (NMFS 2013b).

Critical habitat was designated for the Steller sea lion by NMFS in 1993 and represents areas considered essential for the continued survival and recovery of this species (NMFS 1993). Adult Steller sea lions congregate at rookeries for breeding and pupping. Rookeries are generally located on relatively remote islands, often in exposed areas that are not easily accessed by humans or mammalian predators. These rookeries, as well as haulouts, have been officially designated as critical habitat in Southeast Alaska (NMFS 2001).

NMFS defines critical habitat for Southeast Alaska to include a “terrestrial zone, aquatic zone, and an air zone, that extend 3,000 feet landward, seaward, and above, respectively, for each major rookery and major haulout in Southeast Alaska.” Critical habitat provides notice to federal agencies that a listed species is dependent on these areas for its continued existence and that any federal action that may affect these areas is subject to the consultation requirements of Section 7 of the ESA. To date, 3 major rookeries and 11 major haulouts have been identified as critical habitat on or adjacent to the Tongass. Two additional haulouts have been identified in Southeast Alaska (Cape Fairweather and

Graves Rock) but these locations are within Glacier Bay National Park. In light of the delisting of the Eastern DPS and listing of the Western DPS as endangered, as well as availability of new science, NMFS is currently conducting a review of critical habitat for this species.

Steller sea lions are sensitive to disturbance and harassment or displacement from haulouts and rookeries. Human activities such as boating, recreation, aircraft, LTFs, and log raft towing are concerns related to the long-term conservation of the sea lion in Southeast Alaska. Forest Plan standards and guidelines for Steller sea lions provide protection to sea lion habitats and regulate activities in proximity to this species.

Former Management Indicator Species

The 1982 Planning Rule directed the use of Management Indicator Species (MIS) in forest planning to help display the effects of forest management. The 1997 Forest Plan selected 13 wildlife MIS which carried through to the 2008 Forest Plan Amendment. Because this EIS is analyzing an amendment to the 2008 Forest Plan done under the 1982 Planning Rule, these species are analyzed here even though the 2012 Planning Rule does not use MIS for evaluating effects. Most of these species are associated with POG forests of Southeast Alaska either directly or rely on prey species associated with these habitats.

A series of workshops were held in 2011 with representatives from the Alaska Department of Fish and Game (ADF&G), NMFS, USFWS, and the Forest Service to evaluate the current Tongass MIS and develop a set of proposed MIS that would more effectively serve the Tongass. After following a structured process used to revise MIS elsewhere on National Forest System (NFS) lands (Hayward et al 2001), the group recommended retaining deer, marten, brown bear, black bear, mountain goat, and bald eagle on the wildlife species MIS list (Hayward and Jacobson 2011); however, all original MIS are discussed below.

Sitka Black-Tailed Deer

Sitka black-tailed deer (*Odocoileus hemionus sitkensis*) are indigenous to the coastal regions of Southeast Alaska and northwest British Columbia. They are an important game hunting and subsistence species. They are also an important prey species for the Alexander Archipelago wolf (discussed below).

Sitka black-tailed deer use lower elevation (below 800 feet elevation) POG forest habitats during the winter period. The quantity, quality, distribution and arrangement of winter habitat are considered the most important limiting factors for Sitka black-tailed deer in Southeast Alaska. However, spring, summer, and fall habitats (non-winter) are also important for deer reproduction and population recovery following severe winters, and for building up pre-winter body reserves. During these seasons, and during mild winters, deer will forage in young-growth stands less than about 25 years old and other open non-forested habitats.

For consistency with the 1997 Forest Plan revision FEIS and 2008 Forest Plan Amendment FEIS, the interagency deer habitat capability model was used to assess existing habitat capability within the planning area (USDA Forest Service 1997b, 2008b). This model has a number of limitations, which are described in the 2008 Forest Plan FEIS (USDA Forest Service 2008b). In particular, the model does not account for the biological value of young-growth stands or young-growth management in providing summer forage for deer because it assigns one value to all young growth (and one value to all types of timber harvest, whether even-aged or uneven-aged harvest). That is, it does not reflect

any benefits from commercial thinning, precommercial thinning, development of canopy gaps, or other treatments. Table 3.10-2 presents modeled deer habitat capability by biogeographic provinces. Forest-wide, approximately 89 percent of the original (1954) habitat capability remains, ranging from 72 to 100 percent depending on the biogeographic province. The greatest reductions in deer habitat capability have occurred in provinces where timber harvest has been concentrated (the North Central Prince of Wales, East Baranof, and Etolin Island biogeographic provinces).

The Forage Resources Evaluation System for Habitat (FRESH) model developed by the USDA Forest Service Pacific Northwest Research Station (Hanley et al. 2012; http://cervid.uaa.alaska.edu/deer/Home.aspx) was also used to quantify the relative value of available deer forage under different alternatives in the planning area.

The FRESH model is a food-based model that takes into account the quantity (biomass) and quality (digestible energy and digestible protein, two of the most common nutritional limiting factors for deer) of the estimated food resources in relation to user-specified metabolic requirements of deer (which depend on age, sex, season, and reproductive status). The model uses a linear algorithm to determine the suitable forage that can sustain deer at this metabolic requirement, and produces the number of deer days per unit area that the available food resources (within the habitat patch or landscape) are capable of supporting. One deer day represents the food required to support one animal for one day at the specified level of nutritional requirements. The output of the model is a "snapshot" of habitat conditions based on estimated food availability and quality at one point in time which can be used to make a relative comparison of conditions within a habitat patch or landscape under different conditions (i.e., before and after implementation of a management activity).

Table 3.10-2
Existing Forest-wide Deer Habitat Capability Using the Interagency Deer Model (NFS Lands Only)

	Biological Province	Existing Habitat Capability 2015 (Deer per Square Mile)	Original (1954) Habitat Capability (Deer per Square Mile)	% Original Habitat Capability Remaining	No. WAAs with Modeled Deer Density of at least 18 Deer per Square Mile[1/]
1	Yakutat Forelands	13.3	13.7	97%	2
2	Yakutat Uplands	2.3	2.4	98%	0
3	East Chichagof Island	11.7	13.7	86%	1
4	West Chichagof Island	14.5	14.5	100%	1
5	East Baranof Island	7.0	8.5	82%	0
6	West Baranof Island	12.2	13.7	89%	4
7	Admiralty Island	17.6	17.9	98%	10
8	Lynn Canal	5.5	5.8	95%	1
9	North Coast Range	6.2	6.2	100%	0
10	Kupreanof/Mitkof Island	16.9	19.2	88%	7
11	Kuiu Island	25.5	28.1	91%	7
12	Central Coast Range	9.0	9.5	96%	1
13	Etolin Island	15.7	18.9	83%	3
14	North Central Prince of Wales	17.7	24.5	72%	11
15	Revilla Island/Cleveland Peninsula	13.5	15.0	90%	7
16	Southern Outer Islands	28.1	32.1	88%	9
17	Dall Island and Vicinity	30.4	30.6	99%	3

Table 3.10-2 (continued)
Existing Forest-wide Deer Habitat Capability Using the Interagency Deer Model (NFS Lands Only)

	Biological Province	Existing Habitat Capability 2015 (Deer per Square Mile)	Original (1954) Habitat Capability (Deer per Square Mile)	% Original Habitat Capability Remaining	No. WAAs with Modeled Deer Density of at least 18 Deer per Square Mile[1/]
18	South Prince of Wales	21.8	22.2	98%	5
19	North Misty Fiords	3.7	3.8	99%	2
20	South Misty Fiords	8.4	8.4	100%	0
21	Ice Fields	0.7	0.8	94%	0
	Forest-wide	**10.1**	**11.3**	**89%**	**57**

[1] For WAAs that overlap a biological province boundary only the overlapping portion counted toward the total.
[2] Note that the model treats harvested stands in the stem exclusion stage (25 years old or older) the same value regardless of thinning treatments that are implemented.[3] Note that wolves very rarely occur on Admiralty, Baranof, and Chichagof Islands.

The FRESH model has not yet been reviewed by an interagency team for widespread use; however, it does provide a supplemental way to compare management activities for possible effects to deer. As with any model, it has a number of limitations, which are that (1) it is a calculator, rather than a simulation model, providing a snapshot analysis of habitat quality at a user specified point in time (i.e., habitat quality values do not represent annual or seasonal averages), (2) it does not take into account other factors on the landscape that affect habitat quality beyond forage (i.e., it assumes all habitat is available to the animal), and (3) it does not account for the more complex relationships between plants and herbivores such as mineral and micronutrient requirements or the effects of plant secondary chemistry (such as tannins) which may affect forage palatability and the preference/avoidance of certain forages (Hanley et al. 2012).

Values for the available forage biomass and its nutritional quality (digestible energy and digestible protein concentrations) on the Tongass were based on a variety of sources including the Tongass Wide Young-Growth Study (2007, 2008, 2010, 2011, 2012, 2013), Prince of Wales Commercial Thin Study (Forest Sciences Lab Juneau 2014, unpublished), 2011 Tongass Young-growth Inventory (2011), Second Growth Management Project, Size-Density Accuracy Assessment and other unpublished studies from southeast Alaska (see the Project Record for more information). It is assumed that all available vegetation is potential food, and there is no accounting for long-term herbivore-plant dynamics (i.e., the effects of overbrowsing; Hanley et al. 2012). Thinning and logging slash have the potential to inhibit deer access; however, the current body of literature does not provide sufficient information for making adjustments to FRESH model output to reflect these limitations.

For this analysis, forage resources were analyzed with the GIS-based model application for a doe in the winter season. Deer metabolic requirements for winter were the following: dry matter digestibility 48 percent, digestible protein 1.8 percent, and dry matter intake 525 grams/day (see Hanley et al. 2012 for rationale and sources).

The FRESH model requires an estimate of snow depth on February 1 at sea level in a level open area. To reflect the geographic variation in snow depth in Southeast Alaska, the planning area was divided into six snow zones with average snow depth estimated for each under current climate conditions. Climate data from 1981-2010 were used to model PRISM-based “precipitation as snow” which was then converted to snow depth using the relationship of snow

depth and elevation in the FRESH model snow sub-model (see metadata in the project record for additional information). The FRESH model then reduces the biomass of each forage in proportion to its height profile that is "buried" in snow (see Hanley et al. 2012 for details).

Table 3.10-3 provides the existing habitat conditions on the Tongass based on FRESH model output. Existing habitat quality on NFS lands ranges from 3.0 deer days per hectare in the Ice Fields biogeographic province to 153.9 deer days per hectare in the South Prince of Wales Island biogeographic province (Table 3.10-3). In the North Central Prince of Wales biogeographic province, where past harvest has been concentrated, existing habitat quality is 137.0 deer days per hectare.

The effects of timber harvest on deer may not be fully realized for decades. During the first 25 years or so (stand initiation), openings created by even-aged timber harvest (both old-growth and young-growth) provide abundant forage for deer as sunlight is allowed to penetrate to the forest floor enhancing growth of understory vegetation (Farmer and Kirchhoff 2007); however, access to forage may be limited during winter in moderate to high snow years, without the canopy of old-growth forest. However, as the forest grows, a dense canopy can form that shades out understory vegetation (stem exclusion) thereby reducing foraging habitat—a period which may last up to 150 years after harvest. Deer abundance has been shown to be lower in these forage-poor habitats (Brinkman 2009; Person 2010). Long-term young-growth management that includes intermediate treatments, which would maintain managed stands with more open canopies than unmanaged young-growth stands, may prolong the short-term beneficial effects of shrub and forb production used as forage.

Table 3.10-3
Existing Habitat Conditions Using the FRESH Deer Model (NFS Lands Only)

	Biological Province	Existing Habitat Conditions in 2015 (Average Deer Days/Hectare)[1/]	Range of Habitat Conditions Within Individual WAAs (Average Deer Days/Hectare)[1/]
1	Yakutat Forelands	0.0	0.0-0.0
2	Yakutat Uplands	0.0	0.0-0.0
3	East Chichagof Island	35.7	0.0-127.4
4	West Chichagof Island	89.1	0.0-93.9
5	East Baranof Island	30.6	0.0-62.6
6	West Baranof Island	56.9	0.0-114.7
7	Admiralty Island	50.6	14.2-130.4
8	Lynn Canal	24.4	1.4-74.6
9	North Coast Range	19.3	0.0-20.5
10	Kupreanof/Mitkof Island	96.8	0.0-146.7
11	Kuiu Island	64.8	0.0-119.9
12	Central Coast Range	31.8	0.0-78.7
13	Etolin Island	72.9	0.0-85.6
14	North Central Prince of Wales	137.0	0.0-133.0
15	Revilla Island/ Cleveland Peninsula	68.8	0.0-232.3
16	Southern Outer Islands	126.1	0.0-121.0
17	Dall Island and Vicinity	130.3	7.0-130.3
18	South Prince of Wales	153.9	6.9-126.5
19	North Misty Fiords	21.6	0.0-34.3
20	South Misty Fiords	56.3	0.0-88.9
21	Ice Fields	3.0	0.0-6.8
	Forest-wide[2/]	**46.9**	**NA**

[1] Calculated as weighted averages based on WAA area (total or portion coinciding with the biogeographic province)
[2] No snow zone was assigned to biogeographic provinces 1 and 2 due to very low use by deer; therefore, model not run

Mountain Goat

Mountain goats (*Oreamnos americanus*) inhabit alpine and subalpine areas and adjacent POG forests on the mainland portions of the Tongass and have been introduced to several islands. Steep glacial valleys and peaks provide escape terrain from predation by wolves and bears. Adjacent meadows provide forage and, at lower elevations, POG forests provide cover as well as evergreen shrubs and forbs for winter forage (Porter 2010).

Mountain goats are sensitive to human disturbance, which can cause the temporary or permanent abandonment of habitat, increased stress, altered behaviors, and potentially excess energy expenditure (Goldstein et al. 2005; Olliff et al.1999). Prolonged exposure to disturbance may have demographic consequences (e.g., effects to vital rates such as survival and reproduction), though this relationship is not completely understood. Industrial activities such as timber harvest, mining, road construction and hydroelectric development have the potential to have adverse effects on mountain goat populations through disturbance or removal of habitat. However, this species spend much of its time outside of areas where timber harvest has occurred or are likely to occur in the future. Existing Forest Plan standards and guidelines were developed to reduce the impacts of other activities (e.g., helicopter over-flights for recreation) and impacts associated with facilities.

Black Bear

Black bears are an important species for hunting, recreation and tourism. In Southeast Alaska, black bears are present throughout the mainland and on the islands south of Frederick Sound. Black bears in Southeast Alaska are part of a population (Alexander Archipelago black bears) endemic to coastal British Columbia and Southeast Alaska, except Admiralty, Baranof, and Chichagof islands (Stone and Cook 2000; Peacock et al. 2007).

Black bears will use habitats from sea level to the alpine but appear to prefer estuarine, riparian, and forested coastal habitats (USDA Forest Service 2008b). Black bears use small openings, and areas such as wetlands, clearcuts, and subalpine meadows for foraging.

Past timber harvest, especially in areas adjacent to salmon streams, has decreased black bear habitat suitability through the removal of POG forest. While early successional habitats may provide abundant food (berries), over the long term dense young-growth stands provide poor habitat for black bears due to the lack of forage and large hollow trees for denning. Also, over the long term, reduction of den sites may result from a lack of availability of large tree root structures (Davis et al. 2012). There are approximately 43,300 acres of young-growth within the beach and estuary fringe and 38,320 acres of young-growth within RMAs due to past timber harvest on the Tongass (Table 3.9-5). Small OGRs and other Non-development LUDs provide some connectivity on a local scale to shoreline and riparian habitats preferred by black bears.

Timber harvest may also impact black bears through increased human access on roads. This can result in increased harvest-related mortality; however it should be noted that black bear harvest risk is not tied to a particular road density level.

River Otter

River otter (*Lutra canadensis*) are associated with coastal and freshwater aquatic environments and the immediately adjacent (within 100 to 500 feet) upland habitats. River otters are distributed throughout Southeast Alaska, and across the Tongass National Forest, along coastal and inland waters (MacDonald and Cook 2007).

Old-growth forests have the highest habitat value for river otters, providing canopy cover, large-diameter trees and snags, and burrow and den sites. River otters rest in cavities or beneath the roots of large conifers or snags in POG forests with open understories (high-volume POG forest; Ben-David et al. 1996; Bowyer et al. 2003). Young-growth forests provide lower quality habitat. There are approximately 2.1 million acres of high-volume POG forest on the Tongass (Table 3.9-3). There are 43,300 acres of young-growth forest within the beach and estuary fringe and 38,320 acres of young-growth within RMAs (excluding TTRA buffers) resulting from past timber harvest on the Tongass (Table 3.9-5). Protection under the Forest Plan is provided through standards and guidelines for beaches, estuaries, and riparian areas (USDA Forest Service 2008a).

American Marten

The American marten (*Martes americana*) is an important furbearer that is associated with old-growth forests. Although only one species of marten is formally recognized in Southeast Alaska two distinct lineages exist. Although there is some uncertainty, recent taxonomic evidence suggests the potential existence of two species (Dawson and Cook 2012). Within the Alexander Archipelago, the coastal form *caurina* is thought to occur only on Kuiu and Admiralty Islands, though a preliminarily identified specimen of this subspecies has been collected on Dall Island (USDA Forest Service unpublished data). The continental form occurs elsewhere in their range (Cook et al. 2006).

Coastal habitats (beach fringe) and riparian areas have the highest habitat value for marten, followed by upland forested habitats below 1,500 feet in elevation (USDA Forest Service 2008a). Marten favor large- and medium-sized old-growth forests because they intercept snow, provide cover and denning sites, and provide habitat for marten prey species (Flynn and Schumacher 2001; Flynn et al. 2004). These forests are also used by deer during winter, and winter-kill carcasses of deer represented a significant portion of marten diet in winter (Ben-David et al. 1997). These forests have also experienced past timber harvest. Consequently, the quantity and quality of winter habitat is a limiting factor for marten in Southeast Alaska. Therefore, the availability of deep-snow marten habitat, defined as high-volume POG below 800 feet in elevation, provides a measure of habitat quality for marten. There are approximately 3 million acres of high-volume POG forest below 800 feet elevation on the Tongass National Forest (Table 3.9-4). Young-growth forests provide lower habitat value but may be used if they support abundant forage and small mammal populations (Flynn et al. 2004). More recent research indicates more prevalent use of young-growth forests than once thought (Goldstein 2013), emphasizing these forest in the matrix and within the reserve system for providing structural connectivity for movement and dispersal.

Marten populations fluctuate greatly over time in response to habitat conditions, prey densities, and trapping pressure. Marten are easily trapped and can be overharvested. The ADF&G currently permits unlimited trapping of marten in all of the Game Management Units (GMUs) covering the Tongass National Forest (GMUs 1, 2, 3, 4, and 5) with the exception of Kuiu Island, which is currently closed.

Old-growth timber harvest reduces habitat quality for marten through the removal of forest cover, fragmentation of old-growth habitat (reductions in travel corridors and/or functional connectivity between spatially isolated populations), and reductions in habitat for some prey species. Increased human access associated with new roads may result in increased marten harvest-related mortality. Although closed roads still facilitate access (e.g., off-highway vehicle, pedestrian), open roads that receive the highest and most consistent use are likely to have the greatest effect on marten. Existing road densities (all elevations included) on the Tongass are listed in Table 3.10-4.

Table 3.10-4
Existing Estimated Average Road Densities and Percentage of WAAs in Road Density Categories on NFS Lands and All Lands Combined for All Roads and Open Roads Only within the Tongass National Forest Boundary (All Elevations)

Road Density Category (miles per square mile)	Existing Road Densities (percentage of WAAs)	
	NFS Lands	All Lands[1]
All Roads		
0	47.6%	43.5%
0 to 0.7	37.7%	35.1%
0.7 to 1.0	6.3%	5.8%
1.0 to 2.0	7.9%	12.6%
2.0 to 3.0	0.5%	3.1%
>3.0	0.0%	0.0%
Total	**100%**	**100%**
Average Total Road Density – All WAAs	**0.195**	**0.334**
Open Roads[2]		
0	57.1%	49.7%
0 to 0.7	39.3%	37.7%
0.7 to 1.0	2.6%	4.7%
1.0 to 2.0	1.0%	6.3%
2.0 to 3.0	0.0%	1.6%
>3.0	0.0%	0.0%
Total	**100%**	**100%**
Average Open Road Density – All WAAs	**0.089**	**0.218**

[1] Percentages are based on all 191 WAAs inside the Forest boundary, including Annette Island; includes roads and streets within municipalities
[2] Open roads on NFS land were calculated using Maintenance Levels 2, 3, 4, and 5 (see Transportation section for maintenance level description)

Roadless areas and OGRs and other non-development LUDs provide refugia for marten from trapping pressure. However, marten home ranges are well distributed across the landscape and include areas with timber harvest and roads, emphasizing the importance of habitat within matrix lands. Legacy Forest Structure standards and guidelines, in combination with the beach fringe and riparian buffers, aid in providing habitat and connectivity for marten on NFS lands (USDA Forest Service 2008a).

Brown Bear

Southeast Alaska is home to one of the highest concentrations of brown bears (*Ursus arctos*) in the world (ADF&G 2000). Brown bears are present on the mainland and on most the islands north of Frederick Sound. They are occasionally reported on Mitkof, Etolin, Revillagigedo, and Wrangell Islands south of Frederick Sound, but are not found on any of the other islands in Southeast Alaska. Admiralty, Baranof, Chichagof, Kruzof, Yakobi, and neighboring islands consistently support the highest densities of brown bears on the Tongass National Forest (GMU 4).

Brown bears are important both for hunting (including both outfitter guided and non-guided hunting) and to the recreation and tourism industry of Southeast Alaska. On the Tongass, ADF&G permits harvest of brown bears in GMUs 1, 3, 4, and 5. As tourism grows in Southeast Alaska, there is increasing demand for more bear viewing opportunities such as those provided by Pack Creek and Anan Creek.

Brown bears use areas from sea level to the alpine and are habitat generalists. The late-summer season has been identified as the most critical or limiting period for brown bears when they must build up energy reserves that are adequate to

survive the winter and successfully reproduce (Hilderbrand et al. 1999). During this season, many brown bears concentrate along low elevation valley bottoms and salmon streams, with most use occurring within 500 feet of streams (Schoen and Beier 1990; Titus and Beier 1999), where their efforts focus on consuming large quantities of fish in order rebuild their body condition and lay on essential fat reserves. These are often the same areas of highest human use and most intense resource development activities (Flynn et al. 2007).

Flynn et al. (2007) found bears, particularly females, in heavily altered watersheds (i.e., with more road building and timber harvest) tended to occur farther away from salmon streams than bears in watersheds with more intact streamside vegetation suggesting that bears are not making optimal use of available salmon resources in heavily altered landscapes. A study on the Kenai Peninsula reported that female brown bears with cubs tended to avoid areas used by other bears and by humans, apparently in an effort to increase offspring survival, and used less productive salmon spawning areas despite having high nutritional requirements (Suring et al. 2006). Thus, even less productive streams may be important to brown bear population productivity (Wielgus and Bunnell 1995).

Roads and other human developments can also be detrimental to bears because they increase the opportunity for human-induced mortality of bears through legal hunting, defense of life or property kills, and illegal killing. Additionally, poorly maintained or constructed roads can affect water quality and productivity of salmon streams.

Alexander Archipelago Wolf

The Alexander Archipelago wolf (*Canis lupus ligoni*) is thought to be a subspecies of gray wolf endemic to Southeast Alaska and British Columbia. It inhabits the mainland of Southeast Alaska and coastal British Columbia west of the Coast Mountain Range, and larger islands (those south of Frederick Sound) except Admiralty, Baranof, Chichagof islands, and on all of the Haida Gwaii or the Queen Charlotte Islands (USFWS 2015). Approximately 38 percent of the range-wide population of Alexander Archipelago wolves inhabits Southeast Alaska, where population trends are largely unknown, except for the population on Prince of Wales Island and the surrounding islands (collectively GMU 2), which appeared to decline in abundance in the past 20 years. A portion of Prince of Wales Island was sampled and estimates expanded to the entire GMU 2 suggesting an apparent decline of potentially 75 percent. Uncertainty in the apparent decline is most effectively considered through 95 percent confidence intervals on the 1994 (CI=148-564) and 2014 (CI=50-159) estimates (USFWS 2015). However, because GMU 2 constitutes approximately four percent of the range of the Alexander Archipelago wolf and six percent of the range-wide population, negative population impacts in GMU 2 likely do not affect the range-wide population significantly (USFWS 2015).The majority (62 percent) of the Alexander Archipelago wolf population occurs in coastal British Columbia and is thought to be stable (USFWS 2015). Although some research suggests that wolves inhabiting Prince of Wales Island may be genetically isolated from other populations in Southeast Alaska (Person 2001; Weckworth et al. 2005, 2010, 2011), there remains uncertainty about the degree of isolation (see the Alexander Archipelago Wolf Species Status Assessment (USFWS 2015) for more information).

In August 2011, the USFWS received a petition to list the subspecies as threatened or endangered, and to recognize Prince of Wales Island as a significant portion of its range (Center for Biological Diversity and Greenpeace 2011). The petition also requested that the USFWS consider those wolves found on Prince of Wales Island and adjacent islands (including Kosciusko, Tuxekan, Heceta, Suemez, Dall, and others proximate to Prince of Wales) as a DPS based on unique genetic, physical,

and ecological characteristics. In March 2014, the USFWS issued a 90-day finding that the petition to list the subspecies presented substantial information indicating that listing may be warranted (79 FR 17993). A status review of the Alexander Archipelago wolf to determine if listing is warranted was published in November 2015.In January 2016, the USFWS published a 12-Month Finding that listing of the subspecies was not warranted.

Wolves feed primarily on deer in certain areas, though waterfowl, beaver, spawning salmon, and marine mammals represent important prey when available (Lafferty et al. 2014; Darimont and Reimchen 2002; Szepanski et al. 1999). Wolves in Southeast Alaska also prey on moose and elk where available. Suitable habitats for wolves are those capable of supporting this prey base. Therefore, wolves in Southeast Alaska use a wide variety of prey habitats but spend most of their time in productive and unproductive old-growth forests at low elevations (below 270 feet); young-growth forests and clearcuts are typically avoided (Person 2001). Dens on Prince of Wales Island are located in root wads of large living or dead trees within old-growth forest stands less than 495 feet (150 meters) from freshwater (Person and Russell 2009).

Deer winter habitat was considered by Person et al. (1996) and Person (2001) to be a good measure of habitat quality for wolves in southern Southeast Alaska. Black-tailed deer are present in all Southeast Alaska GMUs where wolves occur. Forest Plan standards and guidelines state that where possible, the provision of sufficient deer habitat capability to first maintain sustainable wolf populations, and then to consider meeting estimated human deer harvest demands. This is generally considered to equate to the habitat capability to support a minimum of 18 deer per square mile (using interagency deer habitat capability model outputs; USDA Forest Service 2008a). However, other factors (e.g., local knowledge of habitat conditions, inherent capability of the landscape, spatial extent of the analysis) are to be considered by the biologist, as well, rather than solely relying upon model outputs (USDA Forest Service 1997b, Appendix N).

As required under the Forest Plan, the interagency deer habitat capability model was used to evaluate wolf habitat capability based on modeled deer habitat capabilities (see the 2008 Forest Plan FEIS for discussion of model limitations and assumptions). Table 3.10-5 summarizes existing conditions by biogeographic province. Forest-wide approximately 89 percent of the original (1954) habitat capability remains, ranging from 72 to 100 by biogeographic province.

Wolves are also a furbearer in Southeast Alaska. Harvesting of wolves is regulated by the Federal Subsistence Board and the State of Alaska Board of Game. Harvest regulations, both subsistence and sport, are intended to help ensure sustainable wolf populations. The ADF&G works cooperatively with the Alaska Board of Game and with federal land managers, including the Forest Service, to identify and address conservation concerns and propose regulation changes as needed for all wildlife in Southeast Alaska, including wolves.

Although wolves are often harvested by hunters and trappers working from boats (approximately 59 percent of harvest in GMU 2) harvest-related wolf mortality (both legal and illegal) is correlated with roads and other habitat features, which influence their vulnerability to harvest (Person and Russell 2008; Person and Logan 2012). Wolf mortality analyses (e.g., Person and Russell 2008, Person and Logan 2012) document the strong positive relationship between wolf mortality and road density. Person and Russell (2008) found that rate of harvest of both resident and non-resident (e.g., those dispersing or moving through unfamiliar territory) wolves increased with density of roads, which provide access to hunters and trappers; however, total road densities above 1.5 miles per square

Table 3.10-5
Modeled Deer Habitat Capability Using the Interagency Deer Model for Comparison to Forest Plan 18 Deer per Square Mile Standard and Guideline (NFS Lands Only)

	Biological Province	Existing Habitat Capability 2015 (Deer per Square Mile)	Original (1954) Habitat Capability (Deer per Square Mile)	% Original Habitat Capability Remaining	No. WAAs with Modeled Deer Density of at least 18 Deer per Square Mile[1/]
1	Yakutat Forelands	13.3	13.7	97%	2
2	Yakutat Uplands	2.3	2.4	98%	0
3	East Chichagof Island	11.7	13.7	86%	1
4	West Chichagof Island	14.5	14.5	100%	1
5	East Baranof Island	7.0	8.5	82%	0
6	West Baranof Island	12.2	13.7	89%	4
7	Admiralty Island	17.6	17.9	98%	10
8	Lynn Canal	5.5	5.8	95%	1
9	North Coast Range	6.2	6.2	100%	0
10	Kupreanof/Mitkof Island	16.9	19.2	88%	7
11	Kuiu Island	25.5	28.1	91%	7
12	Central Coast Range	9.0	9.5	96%	1
13	Etolin Island	15.7	18.9	83%	3
14	North Central Prince of Wales	17.7	24.5	72%	11
15	Revilla Island/Cleveland Peninsula	13.5	15.0	90%	7
16	Southern Outer Islands	28.1	32.1	88%	9
17	Dall Island and Vicinity	30.4	30.6	99%	3
18	South Prince of Wales	21.8	22.2	98%	5
19	North Misty Fiords	3.7	3.8	99%	2
20	South Misty Fiords	8.4	8.4	100%	0
21	Ice Fields	0.7	0.8	94%	0
	Forest-wide	**10.1**	**11.3**	**89%**	**57**

[1] For WAAs that overlap a biological province boundary only the overlapping portion counted toward the total.
[2] Note that the model treats harvested stands in the stem exclusion stage (25 years old or older) the same value regardless of thinning treatments that are implemented.[3] Note that wolves very rarely occur on Admiralty, Baranof, and Chichagof Islands.

mile had little additional effect on harvest rates. This study did not differentiate between open and closed roads though the authors stated that road status likely had an important influence on wolf mortality. Similarly, wolves are more easily observed in open habitats such as muskegs, meadows, and young clearcuts; therefore, use of these habitats, particularly in areas accessible to humans (i.e., the beach and roaded areas), increases the risk of harvest-related mortality (Person and Russell 2008). Harvest vulnerability may limit dispersal, and thus the ability of wolves to recolonize territories that have been vacated by trapping and hunting or may diminish genetic interchange between separate populations.

The 2008 Forest Plan states that a road density of 0.7 to 1.0 mile per square mile or less may be necessary to reduce harvest-related mortality risk where locally unsustainable wolf mortality has been identified through interagency analysis (USDA Forest Service 2008, p. 4-95; Person 1996). Existing road densities are presented in Table 3.10-4. Approximately 15.8 percent of Wildlife Analysis Areas (WAAs) exceed this guideline (all roads included), and approximately 7 percent exceed 1.5 mile per square mile.

Bald Eagle

The bald eagle (*Haliaeetus leucocephalus*) is associated with beach, estuary fringe, and riparian habitats. Bald eagles typically nest in large trees in spruce-hemlock forest, and over 90 percent of the nests are within 500 feet of a

saltwater beach. Nests are located within beach, estuary fringe, and riparian habitats. Since 1967, the USFWS has monitored, via aerial surveys, bald eagle populations along the north Pacific coast from southern British Columbia to the Alaska Peninsula (Hodges 2011). In Southeast Alaska, the population increased until the 1980s, but since then has remained stable, with an adult population of approximately 13,000-26,000 birds (Hodges 2011).

Bald eagles are especially sensitive to disturbance early in the breeding season. Activities associated with timber harvest can result in reproductive failure or cause bald eagles to abandon their nests completely (Fraser et al. 1985 as cited in Isaacs et al. 2005). They are also susceptible to water quality impacts that adversely impact their prey populations (e.g., herring, flounder, pollock, and salmon). Under the 2008 Forest Plan, the availability of nesting habitat is not seen as a significant limiting factor, in part due to the current protection of the 1,000-foot shoreline beach buffer on the Tongass National Forest (Hodges 2011). Further protection to bald eagles is afforded by Forest-wide standards and guidelines that require the maintenance of estuarine and riparian buffers and the raptor standards and guidelines (USDA Forest Service 2008a). Bald eagles are managed by the USFWS under the National Bald and Golden Eagle Protection Act and through the Bald Eagle Take Permit Program (USFWS 2009b).

Red Squirrel

The red squirrel is an important prey species for American marten and goshawk and is a management indicator species because of its preference for cone-producing trees and tree cavities and snags, which they use for denning and nesting (USDA Forest Service 2008b). It is one of only two arboreal rodents in Southeast Alaska. Red squirrels are also a small game species. Red squirrels are abundant on many of the islands in the Alexander Archipelago and the mainland.

Red squirrels use POG forests, but may also use young-growth stands once cone production begins about 40 years after timber harvest (USDA Forest Service 2008a). There are approximately 9.9 million acres of forested land (including all age classes and types of conifer forests) on the Tongass National Forest that provide potential habitat for red squirrels (Table 3.9-2).

Old-growth timber harvest reduces habitat quality for red squirrels through the removal of forest cover and fragmentation of forest habitats. However, recovery of habitat capability after timber harvest is much faster for red squirrels than other species because although post-harvest formation of structures favored for nesting and food storage (cavities) takes longer, the majority of habitat capability (food availability) is restored quickly as cone production typically begins 40 years after harvest. Commercial even-aged young-growth harvest would return stands to an early seral condition so would delay development of habitat capability for red squirrels. Forest Plan Reserve Tree/Cavity-Nesting Habitat and Legacy Forest Structure standards and guidelines maintain habitat for this species (USDA Forest Service 2008a).

Red-breasted Sapsucker, Hairy Woodpecker, and Brown Creeper

The red-breasted sapsucker (*Sphyrapicus ruber*), hairy woodpecker (*Leuconotopicus villosus*), and brown creeper (*Certhia americana*) are old-growth associated and snag dependent species. Hairy woodpeckers and red-breasted sapsuckers are primary cavity excavators that require snags and dying trees for foraging and nesting. Although they may be found in a variety of forested habitats, the brown creeper prefers large diameter old-growth trees (Hejl et al. 2002). Although no historic population estimates exist, it is likely that timber

harvest and associated activities have reduced populations from historic levels (Raphael 1988; Hejl et al. 2002). North American Breeding Bird Survey data collected between 2003 and 2013 suggest populations of all three species are increasing within the Northern Pacific Rainforest region, though none of the trends were statistically significant (Sauer et al. 2014).

The hairy woodpecker is an uncommon, permanent resident throughout southeast Alaska. The hairy woodpecker is typically associated with high-volume POG. They generally feed on insects on the surfaces of snags, the dead parts of live trees, and occasionally live trees during the summer. Hairy woodpeckers nest in large dead and live trees.

Red-breasted sapsuckers are the most common primary cavity excavators in southeast Alaska (Suring 1988 as cited in USDA Forest Service 2008b), and provide obligatory habitat for secondary cavity nesters including other birds and northern flying squirrels who are unable to create their own cavities (Wagner 2011). However, red-breasted sapsuckers are weak excavators and therefore require rotted or soft substrates in order to create cavities for nesting and roosting. The red-breasted sapsucker inhabits all of southeast Alaska during spring, summer, and fall but typically winters in the coastal portions of its breeding range. The red-breasted sapsucker is an interior old-growth forest species typically associated with low-volume POG. Nest sites contain a lower volume of trees, trees intermediate in size, increased incidence of fungal infection, and older decay classes of coarse woody debris (Wagner 2011).

Brown creepers are considered uncommon, permanent residents throughout southeast Alaska. They are an interior old-growth forest species and have been shown to abandon sites that have been subjected to even light tree clearing if it includes the removal of large, mature trees (Wiggins 2005).

All three species are associated with interior old-growth forest conditions (Kissling and Garton 2008). In a study of the responses of forest-dwelling birds to varying forested beach buffer widths in southeast Alaska, hairy woodpeckers and brown creepers were absent from forest buffers less than 830 feet wide (250 meters wide), indicating that these species may avoid edge habitats; 83 percent of brown creepers were detected in undisturbed control plots (Kissling 2003; Kissling and Garton 2007). Densities of red-breasted sapsuckers were positively correlated with buffer width, with the greatest densities occurring in buffers at least 1,000 feet wide (300 meters wide; Kissling 2003).

Old-growth timber harvest activities that remove large, live trees and dead or dying trees reduce nesting and foraging habitat for these species (Hejl et al. 2002). Timber harvest may also reduce local habitat quality by creating fragmented forest patches, reducing the amount of interior old-growth forest habitat with which these species are associated. Brown creeper and hairy woodpecker would be most affected by harvest activities that reduce the number of large diameter trees and snags. Commercial thinning activities as well as commercial young growth harvest may result in increased openness, tree “wounding,” and slash, creating habitats that could be used by these species for foraging (James 1984; Hagar et al. 1996, 1994). Hagar and Friesen (2009) found that the positive influence of thinning persisted for at least 10 years for some species including the red-breasted sapsucker.

Past timber harvest has reduced and altered the habitat used by the red-breasted sapsucker, hairy woodpecker, and brown creeper. Of the 5.0 million acres of POG forest on the Tongass National Forest, approximately 2.1 million acres are high-volume POG, and 790,000 acres are low-volume POG that provide potential habitat for these species (Table 3.9-3). Maintenance of habitat

for these species under the Forest Plan is provided in the reserve tree and legacy standards and guidelines, beach and riparian buffers, and the OGR system (USDA Forest Service 2008a).

Vancouver Canada Goose

The Vancouver Canada goose (*Branta canadensis fulva*) is associated with wetlands (both forested and non-forested) in the estuary, riparian, and upland areas of the Forest (USDA Forest Service 2008b). The Vancouver Canada goose is primarily a non-migratory subspecies of Canada goose that occurs year-round throughout Southeast Alaska, with an estimated resident population of 25,000 birds (Hupp et al. 2010). However, geese do move locally between nesting, brood rearing, molting, and wintering grounds. This species nests in forested habitats associated with beach and estuary buffers, and riparian habitats. Hupp et al. (2010) documented nests in forests adjacent to muskegs. During winter, marine grasses and salt marsh plants commonly found in intertidal areas are important forage resources, and Vancouver Canada geese exhibit strong fidelity, returning repeatedly to such winter sites.

Potential habitats for Vancouver Canada geese are located along the shorelines of lakes as well as in the forested riparian and estuarine areas. There are approximately 1.3 million acres of forested wetlands on the Tongass National Forest (see the *Wetlands* section for additional discussion).

Timber harvest activities may result in disturbance to geese, particularly if they occur in the vicinity of nest sites or brood rearing areas, and habitat removal. However, timber harvest in these areas has generally been minimal because these sites are fairly unproductive. However, modifications to shoreline and riparian habitats can occur in association with young-growth harvest and roads and utility corridors if these habitats are crossed. Protection from direct impact to habitat is provided by Forest Plan Standards and Guidelines for waterfowl and shorebird, wetland, and riparian standards and guidelines; overall goose habitat is provided by the Forest Plan Conservation Strategy (USDA Forest Service 2008a).

Other Species

Migratory Birds

Executive Order 13186 provides for the conservation of migratory birds and their habitats and requires the evaluation of the effects of Federal actions on migratory birds, with an emphasis on species of concern. The Executive Order directs agencies to take certain actions to further comply with the migratory bird conventions, the MBTA, the Bald and Golden Eagle Protection Act, and other pertinent statutes. Agencies are required to support the conservation and intent of the migratory bird conventions by integrating bird conservation principles, measures, and practices into agency activities and by avoiding or minimizing, to the extent practicable, adverse impacts on migratory bird resources when conducting agency actions.

Birds protected under the MBTA include all common songbirds, waterfowl, shorebirds, hawks, owls, eagles, ravens, crows, native doves and pigeons, swifts, martins, swallows, and others, including their body parts (e.g., feathers, plumes), nests, and eggs. The Tongass National Forest is located in the Northern Pacific Rainforest Bird Conservation Region (BCR 5). The Northern Pacific Rainforest BCR is one of five BCRs designated in Alaska to provide a framework to facilitate coordinated conservation efforts (U.S. NABCI Committee, September 2000; Rich et al. 2004).

Priority migratory bird species identified in the Landbird Conservation Plan (BPIF 1999; Rich et al. 2004) for Southeast Alaska with the potential to occur on the Tongass National Forest are listed in Table 3.10-6. Of these species, 14 use hemlock/spruce/cedar forest (both old-growth and young-growth) as primary habitat for known or probable breeding; the remaining 6 use this forest as secondary habitat. These species include ground-nesting birds (blue grouse), cavity- and bark-nesting birds (woodpeckers, the brown creeper, swallows, forest owls, and wrens), tree- and shrub-nesting birds (flycatchers, warblers, forest raptors, crossbills, thrushes, kinglets, and corvids), and specialized nesters (dippers). Migratory birds are likely to be present in upland forest, riparian, and coastal habitat. There are 5.0 million acres of POG on the Tongass National Forest that provide primary or secondary habitats for these species (note that many of these species are also shrub nesters; Table 3.9-3).

The main management issue for migratory birds in BCR 5 is the harvest of old-growth coniferous forests. Timber harvest directly removes perching, foraging, and nesting habitat and results in habitat fragmentation, which may reduce the suitability of remaining forest for species associated with old-growth interior forest conditions, such as the Pacific-slope flycatcher, varied thrush, golden-crowned kinglet, Townsend's warbler, and brown creeper (BPIF 1999, Kissling 2003; Sperry 2006). Fragmentation may increase the exposure of birds to edge-related predators and parasites, though there remain many unknowns about the effects of fragmentation on landbird populations in Alaska (Robinson 1992; Hoover et al. 1995; BPIF 1999). As the landscape becomes more fragmented, forest buffers become increasingly important for migratory birds to mitigate the effects of habitat loss (Kissling 2003). There is already an existing level of fragmentation on the Tongass, both natural in association with the distribution of forested and non-forested cover types, and in association with past timber harvest and other development activities. Riparian forests are also important for many species, such as the American dipper, western screech owl, western wood-pewee, and Hammond's flycatcher. This habitat has been altered by road construction and other human activities; however, the Forest Plan Conservation Strategy maintains these areas mitigating some of these effects. Timber harvest and related activities may also directly impact migratory birds through disturbances of adults or young through the removal of active bird nests or by causing nest abandonment. Protection under the Forest Plan is provided by beach fringe and riparian buffers and standards and guidelines for waterfowl, shorebirds, raptors, and legacy forest structure.

Table 3.10-6
Migratory and Resident Birds Identified as Species of Concern in Southeast Alaska[1]

Common Name	Scientific Name	General Habitat	Preferred Habitat[2]	Abundance and Occurrence
Sooty Grouse	*Dendragapus fuliginosus*	Habitat affinities vary by season and region. Coastal birds tend to remain in old-growth or recently logged forests all year. Inland birds prefer forest edges in summer, coniferous forests in winter (Kaufman 1996). Found in coniferous and mixed forests in Southeastern Alaska; also in dwarf conifer forests at treeline.	2, 3	Rare; breeding, winter
Western Screech-Owl	*Megascops kennicottii*	Open coniferous and deciduous forests and along rivers, creeks, ponds and bogs. Also forest edges and in suburban areas in parks, orchards and gardens. Often nest near water (Campbell et al. 1990). In southern part of range in mesquite groves and saguaros (Kaufman 1996). Probably non-migratory in Alaska due to sufficient habitat to meet year-round requirements (P. Schempf, pers. commun.). In Yakutat, appears to favor riparian spruce (B. Andres, pers. commun.).	2	Uncommon; breeding, winter
Black Swift	*Cypseloides niger (borealis)*	Appear to be restricted to river valleys with steep unvegetated cliffs. Although nesting has not been confirmed in Southeastern Alaska, summer sightings in adequate habitat suggest Black Swifts are a probable breeder.	5	Rare; breeding
Vaux's Swift	*Chaetura vauxi*	Nests in coniferous and mixed forests, especially old growth. Often observed foraging over lakes, rivers, open country and clearcuts. Many records from Southeastern Alaska are along rivers and estuaries.	2	Uncommon; migration, breeding
Rufous Hummingbird	*Selasphorus rufus*	Found in a variety of habitats throughout breeding range including old growth, young growth, thickets, and shrubby hillsides	2	Common; migration, breeding
Red-Breasted Sapsucker	*Sphyrapicus ruber*	Often associated with mature stands, especially hemlock and/or spruce in Pacific Northwest and Southeastern Alaska, but may not be an obligate old-growth species.	2	Abundant; breeding
Olive-sided Flycatcher	*Contopus cooperi*	In Central Alaska, most often found in open conifer forest. Usually associated with openings (muskegs, meadows, burns, and logged areas) and water (streams, beaver ponds, bogs, and lakes). Apparently requires an uneven canopy or openings for aerial hawking, and wet areas productive of insect prey.	3	Uncommon; breeding
Western Wood-Pewee	*Contopus sordidulus*	In Southeastern Alaska, occurs along large mainland rivers, much less common on islands.	3	Uncommon; breeding
Hammond's Flycatcher	*Empidonax hammondii*	In Southeastern Alaska, found in riparian deciduous forests.	2, 3	Uncommon; breeding
Pacific-slope Flycatcher	*Empidonax difficilis*	Prefers old-growth coniferous forests, especially near streams.	2, 3	Common; breeding
Steller's Jay	*Cyanocitta stelleri*	In Alaska, found predominately in coniferous forests	2	Abundant; breeding, winter

Table 3.10-6 (continued)
Migratory and Resident Birds Identified as Species of Concern in Southeast Alaska[1]

Common Name	Scientific Name	General Habitat	Preferred Habitat[2]	Abundance and Occurrence
Northwestern Crow	*Corvus caurinus*	Coastal beaches, rocky shores, estuaries, coastal ponds and inshore islands.	2, 6, 7, 8	Abundant; breeding, winter
Chestnut-backed Chickadee	*Poecile rufescens*	In Southeastern Alaska, common in mature hemlock/spruce forests and also in pole and sawtimber stages of successional forests	2	Abundant; breeding, winter
American Dipper	*Cinclus mexicanus*	Dippers are a riparian-obligate species and are totally dependent on the productivity of streams and rivers.	4, 5	Fairly common; breeding
Varied Thrush	*Ixoreus naevius*	Found mostly in thick, wet, coniferous forests of the coast.	1, 2, 3	Abundant; migration, breeding, winter
Townsend's Warbler	*Dendroica townsendi*	Largely restricted to mature forests with tall coniferous trees throughout its breeding range. Most abundant in large undisturbed tracts of contiguous forest, but will also use forests in late successional stages.	2, 3	Common; breeding
Blackpoll Warbler	*Dendroica striata*	Habitat preference variable, but usually found in tall shrubs (riparian woodland) or in coniferous or deciduous forest or woodland	2	Rare; migration
MacGillivray's Warbler	*Oporornis tolmiei*	In southeastern Alaska, it is found in shrubs along hemlock/spruce edges, deciduous woodlands with shrubs, clearcuts, and riparian shrubs.	1	Uncommon; breeding
Golden-crowned Sparrow	*Regulus satrapa*	Prefers low to tall alder and willow scrub on hillsides and near tundra. Commonly found in proximity to lakes, streams, and bogs. In winter prefers uninterrupted brushland, streamside thickets, and chaparral.	1	Fairly common; breeding, winter
Golden-crowned kinglet	*Zonotrichia atricapilla*	Found in coniferous forests (spruce, fir, and hemlock) all times of year; also in mixed forests in south coastal and central Alaska. In winter and migration, can be found in other trees and shrubs.	1, 3	Common; breeding, winter

[1] Source: Boreal Partners in Flight Landbird Conservation Plan for Alaska Biogeographic Regions (1999)
[2] 1=shrub thicket; 2=hemlock/Sitka spruce/cedar forest; 3=mixed deciduous/spruce woodland; 4=fluvial waters; 5=cliffs, bluffs, and screes; 6=moraines, alluvia, and barrier islands; 7=beaches and tidal flats; 8=rocky shores and reefs.

Bats

There are seven species of bats that are known to occur in Alaska (Parker et al. 1997, Olson et al. 2014). Little is known about the distribution, migration, habitat associations, and population status of these species (Loeb et al. 2014; Boland et al. 2009). ADF&G has established a network of year-round acoustic monitoring stations across Southeast Alaska to learn more about their seasonal activity patterns across the region. Of the bat species that occur in Southeast Alaska, the little brown bat (*Myotis lucifugus*) is the most common and wide spread. Others include the silver-haired bat (*Lasionycteris noctivagans*), Keen's myotis (*M. keenii)*, California myotis (*M. californicus*), the long-legged myotis (*M. californicus*), Yuma myotis (*M. yumanensis*), and the big brown bat (*Eptesicus fuscus*). All species are associated with mature forested habitats which provide roosting, breeding, and foraging sites, and bat activity appears rare, for most species, in second-growth forest (Tessler et al. 2014; Walton et al. 2013a-e; Parker et al. 1996). Tree-roosting species, such as the Keen's myotis and silver-

haired bat often roost in mature forest patches with large numbers of suitable cavity trees. Other species, such as the little brown bat, roost in caves associated with the karst system. Foraging activities vary depending on vegetation density, and studies have found higher foraging activity from bats in intact forest patches and along the patch edges, with less activity in clear-cut areas (Patriquin and Barclay 2003). Throughout its range, the little brown bat has undergone dramatic declines due to white-nose syndrome (a fungal infection that affects bats while in hibernation), and is of particular management interest as white-nose syndrome has not yet been detected in Alaska. Bats are generally relatively rare in Alaska and reproductive rates for bats in higher latitudes are generally lower than farther south. These factors may make these species more susceptible to habitat loss and other factors, however further research is needed to better understand current bat populations and how they respond to habitat loss and other factors (Boland et al. 2009). Timber harvest, particularly even-aged harvest, has the potential to remove roosting and foraging habitat for bats.

Marbled Murrelet

In March 2006, a status review for the marbled murrelet was initiated by the USFWS for the northern part of the species range to support ESA deliberations over the listing of the species as threatened in the southern part of its range (California, Oregon, and Washington; Piatt et al. 2007). Genetic analysis conducted as part of the review identified three distinct population segments: one in the central and western Aleutian Islands; one ranging from the eastern Aleutians to northern California; and one in central California.

Marbled murrelets are widely distributed across marine waters in Southeast Alaska. They spend the majority of their lives at sea, but travel inland up to 50 miles to nest in old-growth forest stands (Piatt et al. 2007). Marbled murrelets typically nest on mossy-limbed branches of large, mature coniferous trees within stands of structurally complex, coastal high-volume old-growth forest (DeGange 1996; Kuletz et al. 1995; Ralph and Miller 1995). However, on some treeless islands in Southeast Alaska marbled murrelets lay eggs on bare talus slopes in mountainous areas (Piatt et al. 2007).

Timber harvest, through the removal of POG forest, can directly remove nest trees, and also increases habitat fragmentation and associated edge effects, such as increased rates of nest predation (Andren 1994; Chalfoun et al. 2002). Some avian predators of murrelets, especially corvids (i.e., ravens, crows, jays), are known to increase both with forest fragmentation and proximity to human activity (Burger 2002). In a study of the edge effects and nest predation risk on marbled murrelets, Malt and Lank (2007) found that disturbances by avian predators at nests were significantly more frequent at hard edges (clearcuts) relative to interiors, but less frequent at soft edges (regenerating forest); there were no edge effects at natural-edged (riparian) sites. Thus, edge-associated predation risk may subside with the progression of forest succession. Forest Plan standards and guidelines pertaining to marbled murrelets include maintaining a 600-foot radius no-cut buffer zone around identified murrelet nests (Forest Service 2008a).

Amphibians

There are eight species of amphibians known to occur in Southeast Alaska; two of which, the Pacific chorus frog *(Pseudacris regilla)* and the red-legged frog *(Rana Aurora),* are introduced (MacDonald and Cook 2007). Native species include the western toad (*Bufo boreas*), wood frog (*Rana sylvatica*), Columbia spotted frog (*Rana luteiventris*), rough-skinned newt (*Taricha granulosa*), long-toed salamander (*Ambystoma macrodactylum*), and northwestern salamander

(*Ambystoma gracile*). Within Alaska, most of these species are confined to the southeast, with the exception of the western toad which ranges as far north as Prince William Sound (MacDonald and Cook 2007), and the wood frog, which is widespread throughout Alaska, and persists north of the arctic circle (Lee-Yaw et al. 2008). Amphibians have specific requirements for both aquatic and terrestrial habitats in order to complete their life-cycle. This makes them useful indicator taxa of forest change and effects on habitat elements such as canopy shade, soil moisture, and coarse woody material. All factors that can be critical for maintaining populations within a forest stand (Olsen et al. 2014; Semlitch et al. 2009; Bunnel et al. 1999). Clearing of trees can result in increased solar radiation to the forest floor, resulting in changes in moisture and soil temperatures; these effects can be reduced using selective thinning (Verschuyl et al. 2011). Amphibians are often vulnerable to road construction and increased road traffic as many species migrate from streams and other waterbodies to upland habitats. This often involves crossing of roads, and amphibians are often slow moving and behaviorally susceptible to vehicular mortalities (Trombulak and Frissel 2000). In addition, contaminants from roads, run-off and habitat changes (such as changes in hydrology and drier soils along the edge of the road) from construction can have deleterious effects on amphibian physiology and behavior, such as changes in migration (Jochimsen et al. 2004; Reeves et al. 2010). Climate change has the potential to disproportionately affect amphibians due to their limited range sizes, dependence on both moist terrestrial and aquatic habitats, and ectothermic physiology (affecting larval development, oxygen availability in water, resistance to diseases and parasites, and general physiology) (Wake and Vredenburg 2008).

Endemism

The USFWS defines endemic as “a species native and confined to a certain region; having comparatively restricted distribution” (http://www.fws.gov/endangered/about/glossary.html). The 2008 Forest Plan standards and guidelines for endemic mammals direct the Forest to “maintain habitat to support viable populations and improve knowledge of habitat relationships of rare or endemic terrestrial mammals that may represent unique populations with restricted ranges.” Likewise, the NFMA directs that management prescriptions “shall preserve and enhance the diversity of plant and animal communities, including endemic(s).”

Due to its archipelago geography and highly dynamic glacial history, southeast Alaska has been found to be a region with an especially high degree of endemism (Demboski et al. 1998). Approximately 20 percent of the small mammal taxa (species and subspecies) known to occur in Southeast Alaska are endemic to an island or a group of islands (Dawson et al. 2007). There remain many uncertainties about the extent of endemism in Southeast Alaska because research to date has primarily focused on mammals, thus the level of endemism in other organisms such as plants, birds, amphibians, and invertebrates is largely unknown. Centers of endemism (areas with the presence of a high number of endemic species) have been identified in Southeast Alaska which are thought to have been refugia during the last glacial event (Cook et al. 2001, 2006). Some of these locations coincide with areas that have also experienced high levels of timber harvest and which may be ready for YG harvest.

Due to their restricted ranges, specific habitat requirements, and sensitivity to human activity, insular endemic species (i.e., those restricted to islands or groups of islands) are highly susceptible to extirpation and eventually extinction (Soule 1983; Reid and Miller 1989; Burkey 1995). Species tied to island archipelagos are more sensitive to the effects of introduced non-natives, including pathogens and disease, and natural events, such as climate change, than other managed landscapes due to their limited mobility and isolation from other subpopulations

(Cook et al. 2006). The 2008 Forest Plan FEIS (USDA Forest Service 2008b) provides a detailed discussion on endemism and its implications on the Tongass National Forest.

There are 24 known endemic wildlife species (mammals and birds) on the Tongass National Forest (Table 3.10-7; ISLES 2013). The Alaska Natural Heritage Program (ANHP) is currently working on compiling a list of endemic species for Alaska and associated range maps. This information will be incorporated into the EIS if it becomes available. Two of the more well-studied species, the Prince of Wales flying squirrel and Prince of Wales spruce grouse, are endemic to portions of the Tongass National Forest where much of the past timber harvest has been concentrated and are described in more detail below. Other species such as the Coronation Island long-tailed vole, Admiralty Island ermine and vole, and the Warren Island red-backed vole occur where little to no past harvest has occurred. The Alexander Archipelago wolf and Alexander Archipelago black bear are also thought to be endemic taxa and are described above.

Table 3.10-7
Endemic Wildlife Species Documented on the Tongass National Forest

Species	Known Distribution
Prince of Wales spruce grouse (*Falcipennis canadensis isleibi*)	Prince of Wales Island and nearby island including Heceta, Suemez, Warren, Kosciusko, Zarembo, and Mitkof
Admiralty Island beaver (*Castor canadensis phaeus*)	Admiralty Island
Prince of Wales flying squirrel (*Glaucomys sabrinus griseifrons*)	Prince of Wales Archipelago
Pacific marten (*Martes caurina*)	In Southeast Alaska, restricted to Admiralty and Kuiu islands
Coronation Island long-tailed vole (*Microtus longicaudus coronarius*)	Coronation, Warren, and Forrester islands
Sitka root vole (*Microtus oeconomus sitkensis*)	Baranof and Chichagof islands complex
Admiralty Island meadow vole (*Microtus pennsylvanicus admiraltiae*)	Admiralty Island
Baranof Island ermine (*Mustela ermine initis*)	Baranof and Chichagof islands
Admiralty Island ermine (*Mustela erminea salva*)	Admiralty Island
Revillagigedo Island red-backed vole (*Myodes gapperi solus*)	Revillagigedo Island
Warren Island red-backed vole (*Myodes gapperi wrangeli*)	Wrangell and Sergief islands
Keen's myotis (*Myotis keenii*)	Records from Juneau south
Alexander Archipelago mink (*Neovison vison nesolestes*)	Admiralty Island
Forrester Island deermouse (*Peromyscus keeni oceanicus*)	Forrester Island
Sitka deermouse (*Peromyscus keeni sitkensis*)	Baranof, Chichagof, Warren, Coronation, and Duke islands
Insular dusky shrew (*Sorex monticolus elassodon*)	Alexander Archipelago and Haida Gwaii
Warren Island dusky shrew (*Sorex monticolus malitiosus*)	Warren Island
Alexander Archipelago black bear (*Ursus americanus pugnax*)	Throughout Southeast Alaska, except Admiralty, Baranof, and Chichagoff islands

Table 3.10-7 (continued)
Endemic Wildlife Species Documented on the Tongass National Forest

Species	Known Distribution
"Glacier bear" (*Ursus americanus emmonsii*)	Yakutat/Glacier Bay region
Yakutat brown bear (*Ursus arctos dallli*)	North mainland from Yakutat to Glacier Bay
Sitka brown bear (*Ursus arctos sitkensis*)	Alexander Archipelago and northern mainland

Source: ISLES 2013

Old-growth timber harvest has the potential to remove habitat used by some endemic species, such as snags and hollow trees used by the Keen's myotis and the Prince of Wales flying squirrel, but may also create habitat for some species e.g., regenerating forest stands for spruce grouse. Fragmentation of habitat patches could limit the ability of some species, e.g., flying squirrels, to disperse between areas of suitable habitat. In addition, for those species that are hunted, roads have the potential to increase hunter access and thus may increase harvest rates along the road system and the areas that these roads access (note that there are no known road thresholds relative to road density for these species).

Prince of Wales Flying Squirrel

The Prince of Wales flying squirrel is endemic to the Prince of Wales Island complex (Demboski et al. 1998; Smith 2005). The flying squirrel plays an important role in the dynamics of coniferous forest ecosystems (Carey 2000a) because it, along with other animals, disperses ectomycorrhizal fungi (Maser and Maser 1988), a food source that is lacking in young-growth forest (Flaherty et al. 2008). Due to its close association with old-growth forest structure and processes and because of its specific habitat requirements for efficient movement, some authors have expressed concern about the long-term viability of this species because much of its range overlaps areas that have been affected by old-growth timber harvest (Carey 2000a; Scheibe et al. 2006; Shanley et al. 2013).

Prince of Wales flying squirrels are associated with POG forest and den sites are typically located in areas with lower levels of fragmentation than elsewhere on the landscape (Pyare et al. 2010). The Prince of Wales flying squirrel is capable of crossing open areas such as meadows or riparian zones; however, this subspecies has a limited gliding range (approximately 250 feet), a distance substantially less than the average clearcut width (Flaherty et al. 2008). Recent research also indicates that the Prince of Wales flying squirrel relies on its sense of smell, hearing, and vision for movement. These movements are limited in clearcuts and young-growth forests; Flaherty et al. 2008). Flaherty et al. (2008) speculated that Prince of Wales flying squirrels are unlikely to venture beyond their perceptual (i.e., smell, hearing, and vision abilities) ranges, and thus may become isolated by large clearings (i.e., those that exceed 250 feet). Thus, successful dispersal of the species depends on the functional connectivity of the landscape (Smith et al. 2005).

Under the Forest Plan Conservation Strategy, the system of small OGRs was designed to provide for the distribution of flying squirrels in every major watershed and facilitate functional connectivity between larger reserves (USDA Forest Service 1997a). However, some biologists suggest that many reserves

on Prince of Wales Island may be too small or spaced too far apart to support populations of Prince of Wales flying squirrels over the long term or maintain functional connectivity to support a back-and-forth exchange between flying squirrel populations (Pyare and Smith 2005; Smith et al. 2011). In addition to the system of OGRs, connectivity between reserves for flying squirrels is also provided by the legacy forest structure, stream, estuary, lake, and beach buffer standards and guidelines. These features represent significant structural elements providing functional connectivity among landscape elements.

Prince of Wales Spruce Grouse

The Prince of Wales spruce grouse (spruce grouse) is a subspecies endemic to Prince of Wales and nearby islands in southern Southeast Alaska. The spruce grouse is associated with muskegs, high-volume POG, and mixed conifer (scrub) habitats but will also use young-growth forest (15-30 years following timber harvest) with a well-developed middle story; they avoid clearcuts (Russell 1999). Though they are closely associated with conifer forests, the highest densities of spruce grouse are supported by areas with a mosaic of older coniferous habitats interspersed with regenerating patches of dense trees. Spruce grouse are poor long-distance flyers and are generally sedentary, with some limited migratory movement (typically less than a mile; Dickerman and Gustafson 1996) between summer and winter habitats (Boag and Schroeder 1992; Williamson et al. 2008).

Spruce grouse are an important prey species for goshawks and marten. Forest birds, including spruce grouse, comprised a larger proportion of goshawk diets during the breeding season on Prince of Wales Island than elsewhere in Southeast Alaska (Lewis et al. 2006). Thus, impacts to spruce grouse could also impact goshawk and marten populations. Spruce grouse are managed as a game species by ADF&G.

Timber harvest and associated fragmentation may lead to population declines if open areas are too large or forested patches are spread too far apart to enable spruce grouse to move between them (greater than 1 mile). Clearcuts may also present a dispersal barrier to this species due to the thick logging debris often present which could inhibit walking, this species preferred method of movement (Russell 1999).

Spruce grouse are a small game species that are particularly vulnerable to hunting along road systems, and thus are susceptible to overexploitation near roads and human populations (Williamson et al. 2008; Rabe 2009). Existing total road densities are provided in Table 3.10-4. The current season for grouse is August 1 through May 15 with a bag limit of five per day in GMU 2 (ADF&G 2015d). The Forest Plan Conservation Strategy maintains connectivity within matrix lands that will help facilitate dispersal and interchange between spruce grouse populations.

Invasive Species

Species are considered invasive if they are not native to an ecosystem, and are likely to cause harm to human health, the economy, or the environment (Executive Order 13112). Due to its remote landscape and climate, Alaska has relatively few invasive species compared to the rest of the United States. However, factors such as altered disturbance patterns, climate change, and the expansion of the transportation network in Alaska are expected to increase the prevalence of invasive species. Global climate change also creates conditions suitable for new invasive by altering geographic range limits and by making habitats no longer suitable for native species.

Invasive species can affect native species by preying on them, competing with them, hybridizing with them, disrupting or destroying their habitat, or introducing

pathogens or parasites that sicken or kill them. At least eight terrestrial species have been introduced into coastal Alaska habitats: Norway rat (*Rattus norvegicus*), European black slug (*Arion atter*), garden slug (*Arion* spp.), leopard slug (*Limax maximus*), elk (*Cervus elaphus*), house mouse (*Mus musculus*), starling (*Sturnus vulgaris*), and rock dove (*Columba livia*). Raccoons and snowshoe hares have also been introduced; however, due to their small population size and limited distribution, these species are not currently considered a threat to coastal Alaska ecosystems (Schrader and Hennon 2005). At this time, only rats are considered to be causing substantial ecological harm in coastal ecosystems and thus invasive, though there is concern about the expanding elk population (Schrader and Hennon 2005). With the exception of elk, which were introduced intentionally as part of a collaborative effort between ADF&G and the USDA Forest Service and are a desired non-native in some areas, all other species were unintentionally introduced.

Norway rats likely became established along the Alaska coast following shipwrecks of early European explorers and now occur in areas of human habitation and along coastal islands where food supplies are abundant (Schrader and Hennon 2005). The primary concern with this species is the adverse effects it may have on ground-nesting birds, as evidenced by rat populations on the Aleutian and Queen Charlotte Islands that prey on bird nests and have substantially impacted breeding bird colonies.

Elk were introduced to Alaska to develop additional hunting opportunities. As recently as 1987, ADF&G introduced elk on Etolin Island. Since then, elk have spread to other islands and areas in the Southeast. A population occurs on Zarembo Island, and there have been reports of elk on other nearby islands including Onslow, Wrangel, Mitkof, Kupreanof, Kashevaroff, Prince of Wales, Brushy, Shrubby, and Farm islands. They have also been spotted on the mainland as far north as Cape Fanshaw, and one of the original transplanted and radio-collared elk was located at the mouth of the Stikine River (J. Brainard, retired USDA Forest Service biologist, Petersburg District, personal communication). Elk are considered a desired non-native species on Etolin and Zarembo islands, but there are still many unknowns about their presence and potential ecological effects elsewhere. The ADF&G Division of Wildlife Conservation has prepared a draft elk management plan for Southeast Alaska to manage and better understand the elk population and its potential effect on native plants and animals (ADF&G 1999). The main concern is competition with native Sitka black-tailed deer due to the high degree of dietary overlap of the two species (ADF&G 1999). This is primarily an issue on deer winter range, where deer are most limited by resource availability. Elk may reduce the available winter forage for deer through browsing, physically displace deer, alter predator-prey dynamics, and directly compete for food. The degree of dietary overlap between the species is the highest reported in the literature, indicating a high potential for direct competition (Kirchhoff and Larsen 1998). Pellet-count surveys on Etolin Island between 1991 and 1998 documented a doubling of the elk population while deer population declined by 56 percent (ADF&G 1999). An associated issue is that a decline in deer numbers could lead to fewer deer hunting opportunities. One recommendation for managing the elk population outside Etolin and Zarembo islands is to increase harvest pressure on elk.

There are also two invasive aquatic amphibian species that are present in coastal Alaska. The red-legged frog (*Rana aurora*), which is native to the Pacific Northwest, has established populations in several drainages on Chichagof Island and the Juneau area and recent surveys suggest that its range is expanding (MacDonald 2003). Effects of this species are currently unknown but potentially include the displacement of the endemic boreal toad (*Bufo borealis*) and wood

frogs (*Rana sylvatica*) (MacDonald 2003). The Pacific chorus frog (*Pseudacris regilla*) has an established breeding population on Revillagigedo Island (MacDonald 2003). Currently, this population is thought to be having little effect on native amphibian species, as boreal toads and rough-skinned newts (*Taricha granulose*) have successfully reproduced in the same pond complex (Schrader and Hennon 2005).

Environmental Consequences

This section describes effects to wildlife resources in the planning area. The NFMA, as interpreted in the context of the Tongass Forest Plan Conservation Strategy, directs the Forest to manage wildlife habitat to maintain viable and well distributed populations to ensure continued existence in the planning area. Quantitative criteria for viability are not specified by the NFMA or associated regulations. For this analysis, the evaluation of viability includes considerations of the island archipelago environment as well as the best available science related to each species.

This section begins with an analysis of effects to the overall Tongass Conservation Strategy, which is addressed in detail in Appendix D to this EIS. The use of the word “wildlife” occurs frequently in this discussion without referencing a particular species because the intent is to consider each of the contributing elements of the conservation strategy and their ability to function as intended with respect to old-growth associated species under the alternatives. Following this discussion, impacts to individual species are addressed.

Direct and Indirect Effects

Old-growth Conservation Strategy

The Tongass Conservation Strategy was designed to maintain well-distributed, viable wildlife populations across the Forest in the context of past and anticipated old-growth timber harvest. Since 1997 timber harvest rates have been far below those assumed in the 1997 Forest Plan FEIS and 2008 Forest Plan Amendment FEIS (USDA Forest Service 1997a, 2008a). The transition from old-growth harvest to young-growth harvest under Alternatives 2, 3, 4, and 5 would further reduce old-growth harvest levels, with the greatest amounts of POG maintained under Alternative 2, followed by Alternatives 3, 5, 4, and 1. Tables 3.10-8 and 3.10-9 present the amount of POG forest and young-growth forest protected and scheduled for timber harvest under each of the alternatives. Ultimately, all of the action alternatives would enhance the Conservation Strategy as a whole over the long term compared to the current Forest Plan by reducing POG harvest and thus maintaining habitat for old growth-associated or -dependent wildlife species. The total area and spatial distribution of POG forest on the landscape in the planning area are the foundation of the conservation strategy.

Table 3.10-8
Productive Old-Growth Acreage in Reserves, Protected/Unscheduled in the Matrix, and Scheduled for Timber Harvest over 100 years (NFS lands only)

		POG in Matrix – Protected or Unscheduled			
Alternative	POG in Reserves	Protected by Beach Fringe, Riparian, & Other Standards and Guidelines	Suitable, But Not Scheduled for Harvest[1]	Total Protected POG	Total POG Scheduled for Harvest[2]
1	3,638,141	1,035,499	265,764	4,939,404	**62,851**
2	3,645,766	1,007,109	316,771	4,969,646	**32,609**
3	3,645,766	839,922	480,999	4,966,687	**35,568**
4	3,645,766	1,087,353	226,539	4,959,658	**42,597**
5	3,645,766	1,127,428	186,581	4,959,775	**42,479**

[1] Productive old growth (POG) that is suitable, but is not estimated to be needed to achieve the old-gro portion of PTSQ over the next 100 years.
[2] Represents the POG that would be harvested assuming harvest takes place at the full estimated rate 100 years.

Table 3.10-9
Young-Growth Acreage in Reserves, Protected/Unscheduled in the Matrix, and Scheduled for Timber Harvest over 100 Years (NFS Lands Only)

		YG in Matrix – Protected or Unscheduled			
Alternative	Protected YG in Reserves	Protected by Beach Fringe, Riparian, & Other Standards and Guidelines	Suitable, But Not Scheduled for Harvest[1]	Total Protected YG	Total YG Scheduled for Harvest[2]
1	103,091	94,129	54,022	251,242	**209,882**
2	53,515	32,895	39,370	125,780	**335,343**
3	56,557	54,695	36,656	147,908	**313,216**
4	104,586	92,828	28,825	226,239	**234,885**
5	69,049	53,102	54,829	176,980	**284,144**

[1] Young growth that is suitable, but is not estimated to be needed to achieve the young-growth portion c PTSQ over the next 100 years.
[2] Represents the young growth that would be harvested assuming harvest takes place at the full estima rate over 100 years.

However, the alternatives differ in terms of how aggressively they approach the transition, and thus their effects on wildlife, by allowing young-growth harvest in OGRs, non-development LUDs, the beach and estuary fringe, and/or RMAs, all of which are contributing elements of the Forest Plan Conservation Strategy (see Table 3.9-11 in the *Biodiversity* section for a summary). The consequences of the differences in approach are two-fold. They influence the total area of old-growth forest harvested in the future and they influence the extent of harvest of young-growth in OGRs, non-development LUDs, the beach and estuary fringe, and/or RMAs. Appendix F provides a detailed comparison of Forest Plan direction proposed under each alternative. These contributing elements of the

Conservation Strategy (the overall extent of old-growth and integrity of OGRs, non-development LUDs, the beach and estuary fringe, and/or RMAs) maintain wildlife habitat and provide connectivity across the landscape. Thus, young-growth timber harvest proposed in these areas has the potential to affect the integrity of the Conservation Strategy. The Conservation Strategy is addressed specifically in Appendix D.

Alternatives that would allow young-growth harvest in the Old-growth Habitat LUD (Alternatives 2, 3, and 5; Table 3.9-11) and other non-development LUDs (Alternatives 2 and 3) would delay the amount of young-growth allowed to mature to old-growth conditions by maintaining them in a managed state at least over the short term. Alternative 5 is intended to emulate the natural scale and distribution of disturbance patterns on the landscape, and over the long term would promote the development of old-growth characteristics in harvested young-growth stands in Old-growth Habitat LUD, RMA, and beach fringe. This is because Alternative 5 limits the size of created openings to 10 acres, includes stand retention limits (maximum removal of 35 percent of original harvest stand acres, and includes a one-time entry stipulation (i.e., young-growth stands would only be harvested once) in these areas. After harvest, young-growth stands would be allowed to return old-growth conditions. In contrast, under Alternatives 2 and 3 the size of created openings is limited only by Scenery standards and multiple entries into stands are allowed in all non-development LUDs. Some wildlife species would benefit in the short term from increased forage availability associated with growth of vegetation following young-growth timber harvest (e.g., deer and bears) under Alternatives 2 and 3; however, the nutritional value of forage in clearcuts may be reduced due to the greater amount of tannins compared to forage in old-growth which reduces the amount of digestible protein (Happe et al. 1990); however, harvested stands would not develop the characteristics of POG forest such as snags, downed logs, diverse tree canopy layers that most POG-associated species (e.g., marten, goshawks, flying squirrels) prefer if reentered multiple times. Alternative 2 would harvest the most young-growth in the Old-growth Habitat LUD and other non-development LUDs (45,684 acres), followed by Alternatives 3 (41,671 acres) and 5 (1,796 acres); no harvest, except potentially salvage and personal use and habitat restoration projects, would occur in any non-development LUDs under Alternatives 1 and 4.

Young-growth stands within the beach and estuary fringe and RMAs provide lower value to wildlife than old-growth stands; however, they can provide structural connectivity for movement and dispersal of some wildlife and serve as buffers between areas of suitable habitat and human activity. Alternatives 2, 3, 4, and 5 would allow young-growth harvest within the beach and estuary fringe; Alternatives 2 and 5 would also allow young-growth harvest within RMAs. Young-growth harvest may decrease buffer width in some places, potentially reducing the effectiveness for wildlife species that are negatively affected by edge. Additionally, alternatives that allow even-aged management in the beach and estuary fringe (Alternative 2 and 5) and RMAs (Alternative 5) may increase habitat perforation and limit movements of some wildlife if openings are too large to be crossed by species with limited dispersal capabilities and snow interception is decreased in the openings. Commercial thinning in these areas, which could occur under all of the action alternatives, have the potential to improve wildlife habitat quality over time by promoting the development of fewer, larger trees in thinned stands and increasing forage availability (Hanley et al. 2005). Although research has shown that the removal of commercial-sized trees can promote tree growth and understory vegetation development, there remains some uncertainty about the effectiveness of young-growth treatments in benefiting wildlife. Thus, the discussion of commercial thinning and its benefits here and below should be

interpreted in the context of the remaining uncertainty associated with its benefits to wildlife. Additionally, young-growth harvest in these areas has the potential to disturb species such as river otters, black bears, bald eagles and migratory bird that use riparian and estuarine areas.

Alternative 3 would harvest the most young growth in the beach and estuary fringe (41,489 acres), followed by Alternatives 2 (30,892 acres), 4 (14,865 acres), and 5 (3,546 acres); no harvest in the beach and estuary fringe would occur under Alternative 1 (Table 3.9-11). Alternatives 2 and 5 incorporate measures to maintain wildlife habitat and connectivity in the beach and estuary fringe through maintenance of a 1,000-foot-wide corridor adjacent to even-aged harvest units (i.e., effectively shifting the beach and estuary buffer inland; Alternative 2) and maintenance of a 200-foot-wide buffer from the shoreline (Alternative 5) which could provide some continued connectivity and reduce the impacts of commercial young growth harvest. Effects would be further reduced under Alternative 5, which limits clearcutting to the first 15 years after plan approval, limits the size of created openings to 10 acres, and includes a one-time entry stipulation (i.e., young-growth stands would only be harvested once). Alternative 2 is less conservative in that the size of created openings is limited only by Scenery standards and multiple entries into harvested young-growth stands would be allowed; however even-aged harvest would be limited to the first 15 years after plan approval (commercial thinning would be allowed thereafter). Commercial thinning would be allowed under Alternatives 3 and 4, but would occur through the life of the Forest Plan.

Alternative 2 would harvest the most young-growth in RMAs (36,092 acres), followed by Alternative 5 (882 acres); no harvest in RMAs would occur under Alternatives 1, 3, and 4 (Table 3.9-11). Effects to wildlife habitat and connectivity would be minimized under Alternative 5 by limiting timber harvest to the first 15 years after plan approval, limiting the size of created openings to 10 acres, and including a one-time entry stipulation (i.e., young-growth stands would only be harvested once). Commercial thinning would be allowed under Alternative 2, but would occur through the life of the Forest Plan.

Alternatives 2, 3, and 5 would also lower the Scenic Integrity Objective (SIO) standard for young-growth stands, which would allow the removal of more trees from these stands. This would reduce the amount of trees retained that could provide habitat for wildlife.

Under Alternatives 2, 3, 4, and 5, young-growth harvest in the beach and estuary fringe and RMAs, as well as the reduction in SIOs, would result in long-term, minor, localized reductions in habitat for wildlife. Effects would last for decades in association with even-aged harvest, as treatments would effectively restart the forest successional process in harvested units, taking decades to return to their current state, and likewise the potential beneficial effects of thinning would occur over decades as stand development toward old-growth conditions is promoted. Protective corridors and other limitations on harvest would maintain wildlife habitat and connectivity in these areas over the long term. Additionally, over the long term, young-growth management would accelerate the development of old-growth characteristics in these areas.

Although IRAs were not part of the original 1997 Conservation Strategy, they add value by providing large expanses of roadless refugia, which are important to wide-ranging wildlife species such as wolves, brown bears, marten, and less mobile species such as flying squirrels and amphibians. Under Alternative 2, no harvest would occur in IRAs that have not been roaded; however, the portions of IRAs that were roaded before the 2001 Roadless Rule and during the 2001

Roadless Rule exemption period for the Tongass would be available for young-growth and old-growth harvest after rulemaking. Alternative 3 would permit old-growth and young-growth harvest in 2001 Roadless Areas, but only if the Roadless Rule changed or the Tongass Roadless Rule Exemption were reinstated. No harvest in Roadless Areas would occur under Alternatives 1, 4, and 5 (Table 3.9-11). Timber harvest in these areas and associated road construction or reconstruction has the potential to decrease the value of these roadless areas to wildlife through increased habitat fragmentation and reduce landscape connectivity. Additionally, species that are vulnerable to overharvest (e.g., wolf, marten, and spruce grouse) would be affected by potential increased hunter access along new or reconstructed roads, whether for young-growth harvest or renewable energy projects. (Note that new roads would only occur in currently roaded areas where reconstruction is not feasible and that in unroaded areas helicopters would be used to extract logs; see the *Transportation* section of this EIS for additional discussion on roads.)

Alternatives 2, 3, 4, and 5 propose modifications to OGRs that compensate for effects associated with the Sealaska land conveyance. The land conveyance removed portions of OGRs, decreasing the amount of wildlife habitats (e.g., POG forest, streams, and low elevation forest) within the reserve system. An interagency team reviewed these affected OGRs and proposed modified locations to meet Appendix K criteria for OGRs (see the *Biodiversity* section and Appendix E for additional discussion of the Biologically Preferred OGR locations proposed by the Interagency Review Team). The proposed modifications to the existing (i.e., post-conveyance) OGRs would result in the following net changes within the reserve system:

- Net increase in 6,171 acres of OGR;
- Net increase of 7,148 acres of POG forest;
- Net increase of 31 stream miles;
- Net increase of 3,066 acres of rare/underrepresented features (large tree POG);
- Net increase of 3,648 acres of deep snow deer and marten habitat (high-volume POG below 800 feet elevation);
- Net increase of 4,466 acres of goshawk and murrelet nesting habitat (high-volume POG); and
- Net increase of 6,696 acres of low-elevation POG (indicative of important areas of landscape connectivity).

These OGR modifications would result in greater protection of wildlife habitats and connectivity under the Conservation Strategy, than would occur as a result of the land conveyance without these changes. These OGR modifications would also result in a net increase in road miles (9 miles) and early seral habitat (2,408 acres) included in the reserve system relative to post-conveyance OGRs, but these areas are distributed across the forest and were a tradeoff made in the interest of selecting the only available areas to add to the reserve system or increasing connectivity or inclusion of ecologically important features within the reserve system.

Species-specific Effects

The following sections describe impacts to threatened and endangered species, former MIS, Alaska Region sensitive species, migratory birds, endemic species, and invasive species.

Threatened, Endangered, and Candidate Species

Impacts from the Proposed Action to Threatened and Endangered species potentially occurring within the boundary of the Tongass are addressed in the BA, which is included in the planning record. All alternatives would require adherence to the MMPA, ESA, and NMFS guidelines for approaching sea lions and other marine mammals. The amount of human activity in the marine environment associated with Forest management activities is only a fraction of the total amount of human activity occurring in the marine environment. Some of the other activities include commercial fishing, sport fishing, hunting, subsistence, tourism, and mariculture. Many of these activities are not regulated by the Forest Service. The effect of such recreational activity on marine mammals would depend on many factors such as size of the bay, depth of the waters in the bay, number of boats, individual behavior responses to disturbance. At the present time, there is not a quantifiable way to estimate these possible effects. Forest-wide standards and guidelines that have been developed for application on all Forest Service permitted or approved activities to minimize or eliminate adverse impacts on marine mammals.

Humpback Whale, Fin Whale, Sperm Whale, and Steller Sea Lion Western DPS

These species could be exposed to disturbance and noise associated with LTF activity, potential collisions with vessels, and fuel or oil spills associated with vessel traffic particularly if these activities occur in the vicinity of nearshore areas used by whales and major haul-outs or rookeries used by sea lions. Harassment or displacement of whales and Steller sea lions from preferred habitats by human activities such as boating, recreation, aircraft, log transfer facilities, and log raft towing, was identified as a concern with regard to long-term conservation in the Biological Assessment conducted for the 2008 Forest Plan Amendment (USDA Forest Service 2008b). Exposure of whales and Steller sea lions to these impacts would be unchanged under all of the alternatives because a much greater volume of old-growth timber harvest was assumed to occur compared to the actual amount (see Appendix D); therefore, any of these nearshore activities associated with proposed young-growth timber harvest have been accounted for no increases in these uses are anticipated under this Amendment. All alternatives would require adherence to the MMPA, ESA, and NMFS guidelines for approaching sea lions and other marine mammals, as currently required under the Forest Plan. Young-growth timber harvest within the beach fringe, and potentially removal of timber for renewable energy development in these areas, has the potential to result in very localized, minor, temporary reductions in water quality to which whales and Steller sea lions could be exposed. For these reasons, the Forest Plan Amendment (all alternatives considered) may affect, but is not likely to adversely affect whales and Steller sea lions.

Short-tailed albatross

Short-tailed albatross occur in nearshore areas along the outer coast. Short-tailed albatross could be affected by reduced marine water quality due to activities in the nearshore environment, including LTF use, log raft towing, vessel traffic, and timber harvest within the beach fringe. However, vessel traffic, log raft towing, and LTF use are expected to remain comparable to that anticipated

under the current forest plan with use occurring periodically over the planning horizon. Moreover, the 2008 Forest Plan assumed a considerably greater amount of old-growth harvest than has actually occurred (see Appendix D) and therefore, any use associated with future young-growth harvest has been accounted for. Young-growth timber harvest, or removal of trees in association with renewable energy development, within the beach and estuary fringe also has the potential to reduce marine water quality (see the Fisheries section for additional discussion). However, effects would be minor and effects would likely be limited to nearshore areas. Therefore, the Forest Plan Amendment (all alternatives considered) may affect but is not likely to adversely affect the short-tailed albatross. Alaska Region Sensitive Species

In accordance with Forest Service Manual 2670, a BE covering federally listed threatened and endangered wildlife species and Region 10 sensitive species was prepared; this BE contains an evaluation and comparison of all alternatives on these species. The project record contains one BE for wildlife and fish, and a separate BE for plants.

Queen Charlotte Goshawk

Impacts to goshawks are assessed in terms of the reduction in total and high-volume POG, which provides potential high quality nesting and foraging habitat. High-volume POG represents optimal nesting habitat due to the presence of large-trees and snags. Reductions in forest cover, and the subsequent progression of forest succession in young-growth stands, also have the potential to affect the abundance and availability of prey. At a landscape level, reductions in the amount of POG and mature young-growth forest may result in portions of the landscape becoming marginal or unsuitable for goshawks. Therefore, alternatives under which harvest of the most POG is proposed would be expected to have the greatest effect on goshawks (Tables 3.10-8 and 3.10-9). The greatest amount of POG harvest would occur under Alternative 1 (62,851 acres total; 26,275 acres high-volume), followed by Alternative 4 (42,597 acres total; 18,031 high-volume), Alternative 5 (42,479 acres total; 18,173 high-volume), Alternative 3 (35,568 acres total; 13,134 high-volume) and Alternative 2 (32,609 acres total, 12,636 high-volume). Refer to the *Biodiversity* section for a discussion of effects to POG by biogeographic province (Tables 3.9-12 and 3.9-13).

Young-growth forest provides marginal goshawk habitat, but over the long term if unharvested or thinned with an objective of accelerating old growth conditions would return to old-growth conditions. Young-growth stands ready for commercial harvest may be reaching an age to provide some benefits to goshawk (foraging, occasional nesting, post-fledging areas) if adequate structure is developed (typically 45 to 100 years following harvest, depending on site productivity). The most young-growth harvest would occur under Alternative 2, followed by Alternatives 3, 5, 4, and 1 (Table 3.10-9). Impacts to goshawks would be greatest in the North Central Prince of Wales, Kupreanof/Mitkof Island, East Chichagof Island, and Revilla Island/Cleveland Peninsula biogeographic provinces where the most suitable young-growth forest is located (See Suitable Land maps in the Map Packet that accompanies this EIS). Of course, evaluation of the consequences of young-growth harvest must be considered in light of associated changes in harvest of old growth.

The beach and estuary fringe and RMAs provide connectivity for goshawks between reserve areas, and old-growth forest near beach, estuary, and riparian habitats generally support greater prey diversity and net prey productivity for goshawk foraging (USDA 1996). Thus, young-growth stands in these areas have the potential to develop into highly productive habitats for goshawks. Pre-commercial and commercial thinning of young-growth stands, which would occur

under all of the alternatives, would promote the development of stand conditions that provide foraging habitat for goshawks. However, even-aged harvest or group-selection of young-growth in the beach and estuary fringe (Alternatives 2, 3, 4, and 5), RMAs (Alternatives 2 and 5), and non-development LUDs (Alternatives 2, 3, and 5) would setback the stand development process (returning harvest units to the stand initiation stage). The creation of gaps several acres in size or more could result in localized reductions in goshawk foraging habitat quality, and would delay the development of old-growth habitat capable of providing higher quality foraging, nesting, and post-fledging habitat. Effects to connectivity for goshawks would be lessened under Alternatives 2 and 5, which maintain a 1,000 foot buffer immediately inland of the beach and estuary fringe young-growth units and a 200-foot buffer along the shoreline, respectively.

Despite these localized effects, the transition to young-growth proposed under the action alternatives is likely to benefit goshawks by reducing the amount of POG harvest that would occur over the planning horizon, thereby maintaining more old-growth forest that provides potential foraging, nesting, and post-fledging habitat, compared to the current forest plan. Given the localized nature and extent of young-growth harvest in the beach and estuary fringe, RMAs, and non-development LUDS (see Appendix D for a detailed discussion of effects to the Conservation Strategy), all of the action alternatives would be expected maintain the long-term viability of goshawks in the planning area and increase the probability of maintaining viability relative to Alternative 1.

Alternatives 1, 2, 3, 4, and 5 include the Legacy Forest Structure standard and guideline that protect habitat features that are important for goshawks on a stand level. The Legacy Forest Structure standard and guideline applies only to old-growth harvest, and is clarified under Alternatives 3 and 4 to indicate that in VCUs that have received concentrated past old-growth harvest the management approach would be to retain young-growth stand acres when implementing young-growth timber harvest projects greater than 20 acres to retain residual trees to diversity structural characteristics and promote future recruitment of snags. The proposed clarifications to the Legacy Forest Structure standard and guideline would continue to provide protection of forest structure in harvest units, maintaining foraging habitat and connectivity for goshawks (USDA Forest Service 2008b).

Alternatives 2, 3, 4, and 5 also propose a revision to the Goshawk standards and guidelines which address nesting habitat. These standards and guidelines expand the requirement to maintain 100 acres of POG forest surrounding a nest tree or nest site to include the largest diameter young-growth forest if POG alone is not sufficient. Therefore, the proposed modification would provide greater protection to goshawk nest sites.

Alternatives 2, 3, 4, and 5 propose modifications to OGRs that compensate for effects associated with the Sealaska land conveyance (see the *Biodiversity* section and Appendix E for additional discussion). The land conveyance removed portions of OGRs, decreasing the amount of goshawk habitat (total POG) within the reserve system. The proposed modifications to the existing (i.e., post-conveyance) OGRs would result in a net increase of 4,466 acres of goshawk nesting habitat included in the reserve system (Appendix E). These modifications would result in greater protection of goshawk habitat under the Conservation Strategy than would occur as a result of the land conveyance without these changes.

Renewable energy and transportation project development can affect goshawks directly during construction through disturbance and through habitat removal or

alteration. During operation, electrocution with powerlines and/or collisions with project structures is a potential risk. The proposed Forest-wide Renewable Energy and Transportation Systems Corridors standards and guidelines under Alternatives 2, 3, 4, and 5 do not directly address this species; however, they do specify consideration of the most current science, guidance (e.g., APLIC guidelines; EEI et al. 2006), and methodologies related to avoiding and minimizing wildlife impacts. These measures would minimize impacts to goshawks and their habitats during project construction and operation.

Collectively all of the action alternatives would reduce the amount of old-growth timber harvest that would occur over the planning horizon which would maintain more suitable habitat for the goshawk than anticipated under the 2008 Forest Plan. This would offset to some extent the potential for loss of high quality habitat associated with young-growth harvest within the beach and estuary fringe, RMAs, and old-growth reserves. Added measures under Alternatives 2 (the 1,000-foot inland buffer) and 5 (the 200-foot no-harvest shoreline buffer) would further reduce effects to goshawks. Individual projects would be required to conduct goshawk surveys and implement the goshawk standards and guidelines which would minimize impacts to this species at the project level. For these reasons, the Forest Plan Amendment (all alternatives considered) may impact individuals but would not result in loss of viability of this species or a trend toward federal listing.

Kittlitz's Murrelet

The Kittlitz's murrelet is associated with glacial habitat and occupies areas outside of where timber harvest and associated activities and renewable energy development have occurred or are likely to occur. Consequently, implementing any of the alternatives would not directly or indirectly affect the Kittlitz's murrelet. No changes are proposed to the 2008 Forest Plan standard and guideline to "provide for the protection and maintenance of known Kittlitz's murrelet nesting habitats." Moreover, none of the activities proposed under the Forest Plan Amendment would occur within the upland scree slope nesting habitat used by this species. If young-growth timber harvest within the beach fringe, or renewable energy development in these areas, were to occur with in the vicinity of tidewater glaciers on the Tongass where this species occurs (Yakutat District), foraging Kittlitz's murrelets could be exposed to very minor, localized, temporary reductions in water quality. Therefore, the Forest Plan Amendment (all alternatives considered) may impact individual Kittlitz's murrelets but would not result in loss of viability of this species or a trend toward federal listing.

Black Oystercatcher

The black oystercatcher is associated with rocky shorelines and tidal mudflats along the coast. They could be affected by oil or fuel spills associated with vessels in the vicinity of the LTFs and the transport of logs from harvested areas under all of the alternatives. They could also be affected by disturbance associated with management activities within the beach fringe. Effects would be greatest under the action alternatives that allow harvest within the beach and estuary fringe (Alternatives 2, 3, 4 and 5). Effects would be least under Alternative 5, which limits harvest in these areas to the first 15 years after plan approval and maintains a 200-foot-wide no harvest buffer along the shoreline. Alternative 5 is anticipated to have 3,546 acres of young-growth harvest within the beach fringe over a 100 year timeframe. Alternative 2 would allow even-aged harvest for the first 15 years, and then commercial thinning thereafter; it is anticipated to harvest 30,892 acres of young growth in the beach fringe. Alternatives 3 and 4 would allow commercial thinning only with no time limit. Alternative 3 estimates 41,489 acres while Alternative 4 estimates 14,865 acres of young-growth harvest in the beach fringe. Therefore, the alternatives would

differ slightly in the intensity and time frame of harvest allowed near areas used by black oystercatchers.

However, black oystercatchers occur at low densities across the Tongass and the habitats it uses (intertidal areas) do not typically coincide with management activities, although there is the potential for ongoing effects associated with recreation and tourism activities on the Tongass and disturbance associated with young-growth harvest in the each fringe under Alternatives 2, 3, 4, and 5. A Forest-wide standard was added to the Forest Plan to provide a minimum 330-foot buffer from human activities and concentration or nesting areas. Therefore, this species is unlikely to be affected by the activities proposed under the alternatives.

Renewable energy and transportation development would have the potential to affect this species directly through disturbance or through loss or removal of habitat if facilities are proposed along the shoreline. The proposed Forest-wide Renewable Energy and Transportation Systems Corridors standards and guidelines under Alternatives 2, 3, 4, and 5 do not directly address this species; however, they do specify consideration of the most current science, guidance, and methodologies related to avoiding and minimizing wildlife impacts and the new Forest-wide 330-foot buffer for nesting areas would also apply. These measures would minimize impacts to black oystercatchers and their habitats during project construction and operation.

Young-growth timber harvest and/or renewable energy development within the beach and estuary fringe and RMAs could impact nesting or foraging black oystercatchers due to disturbance or displacement or habitat degradation or loss within the intertidal areas used by this species. However, effects would be minor, localized, and temporary given the limited areas across the Tongass where black oyster catcher occur and where these proposed activities could occur, the mobile nature of the species, and the BMPs and other measures in place for maintain water quality. Therefore, the Forest Plan Amendment (all alternatives considered) may impact individual black oystercatchers but would not result in loss of viability of this species or a trend toward federal listing.

Aleutian Tern

Management activities proposed under all the alternatives would have the potential to affect this species through disturbance to nesting colonies or through water quality impacts to prey species. However, none of the alternatives propose young-growth or old-growth harvest or other management activities in the vicinity of Black Sand Spit, in the Yakutat Ranger District, where the largest known breeding colony occurs. Should renewable energy development be proposed in this area, adherence to the USFWS Land-based Wind Energy Guidelines (USFWS 2012d) and APLIC guidelines (EEI et al. 2006) would minimize impacts to this species.

It is unlikely that any of the areas identified as habitat will be impacted by the currently proposed activities; if impacts do occur which create noise and disturbance (e.g., helicopter) the potential resulting disturbance would likely be minor and temporary. Additionally, this species would be afforded protection by standards and guidelines for shorebird colonies. Therefore, the Forest Plan Amendment (all alternatives considered) may impact individual Aleutian terns but would not result in loss of viability of this species or a trend toward federal listing.

Steller Sea Lion Eastern DPS

Steller sea lions may occur in the nearshore and pelagic waters throughout the Tongass. Steller sea lions have the potential to be exposed to disturbance and noise associated with LTF activity, potential collisions with vessels, and fuel or oil spills associated with vessel traffic particularly if these activities occur in the

vicinity of major haul-outs or rookeries. All of the identified rookery sites occur in the outside waters of the Tongass and none are located near any proposed activities. One site, Forrester Island, is a designated National Wildlife Refuge and is under the jurisdiction of the USFWS. Most of the known haulouts (Biali Rock, Cape Cross, Biorka Island, Cape Ommaney, Coronation Island, Timbered Island, and Cape Addington) occur in the outside waters of the Tongass and will not likely be impacted by any proposed activities. Of the known haulout sites, only Gran Point, Benjamin Island, Sunset Island, and Lull Point occur in the inside waters of the Tongass. Gran Point is an area in Chilkoot Inlet near Haines; Benjamin Island is a small island in Lynn Canal north of Juneau; Sunset Island is a small island located in Stephens Passage between Hobart and Windham Bay; and Lull Point located on the south end of Catherine Island on the east side of Baranof Island. It is unlikely that any of the areas identified as critical habitat would be impacted by the currently proposed activities; if impacts do occur that create noise and disturbance (e.g., boating), the potential resulting disturbance would likely be minor and temporary.

The amount of human activity in the marine environment associated with Forest management activities is only a fraction of the total amount of human activity occurring in the marine environment. Some of the other activities include commercial fishing, sport fishing, hunting, subsistence, tourism, and mariculture. Most of these activities are not regulated by the Forest Service. Harassment or displacement of sea lions from preferred habitats by human activities such as boating, recreation, aircraft, LTFs, and log raft towing was identified as a concern with regard to long-term conservation in the BA conducted for the 2008 Forest Plan Amendment (USDA Forest Service 2008b). Exposure of Steller sea lions to these impacts would be unchanged under all of the alternatives because a much greater volume of old-growth timber harvest was assumed to occur compared to the actual amount (see Appendix D); therefore, any of these nearshore activities associated with proposed young-growth timber harvest have been accounted for no increases in these uses are anticipated under this Amendment. All alternatives would require adherence to the MMPA, ESA, and NMFS guidelines for approaching sea lions, as currently required under the Forest Plan. Young-growth timber harvest within the beach fringe, and potentially removal of timber for renewable energy development in these areas, has the potential to result in very localized, minor, temporary reductions in water quality to which Steller sea lions could be exposed. Therefore, the Forest Plan Amendment (all alternatives considered) may impact individual Steller sea lions but would not result in loss of viability of this species or a trend toward federal listing.

Sitka Black-Tailed Deer

Extensive analysis on deer was done for the 1997 Forest Plan and subsequent 2008 Forest Plan Amendment. Analyses included information on summer and winter forage and effects of roadbuilding. The expected ecological response of deer to old-growth and mature young-growth timber harvest , road building, and vegetation succession will be similar to those predicted in those analyses; however, the extent of future impacts would be expected to be reduced by the Forest Plan amendment because lower levels of old-growth harvest are proposed in all action alternatives.

All of the alternatives would reduce deer habitat capability (based on Interagency Deer Habitat Capability model output) from existing conditions due to the harvest of mature young-growth and POG forest (Table 3.10-10). Model output by WAA is available in the project record. Immediately following young-growth and old-growth timber harvest there is an increase in the amount of forage available to deer during the summer and mild winter months in response to increased understory growth responding to sunlight associated with opening the forest

canopy, although it is may be of lesser quality compared to the same species of plants grown in the shade (Person and Brinkman 2013; Happe et al. 1990). Therefore, reductions in deer habitat capability in summer and mild winters would not be realized immediately after timber harvest due to the short-term increase in forage, but would be greatest in heavy snow winters during years immediately following harvest and after about 25 years, as forest succession progresses and harvested stands reach the stem exclusion stage. Under all alternatives, this would occur to some extent due to natural succession of previously harvested stands. Over the long term, reductions in habitat capability would reduce carrying capacity, or the numbers of deer an area is capable of supporting given the available resources. This could lead to a decline in the deer population, particularly following severe winters, if the demand for resources (e.g., food or habitat) exceeds that which is available. Uneven-aged and two-aged harvest prescriptions (which would be determined at the project-level) would maintain both some overstory cover to capture snow and understory forage in harvested stands resulting in fewer negative effects than even-aged management. Potential declines in the deer population resulting from reduced habitat capability may decrease the availability of deer to wolves (Person 2001; Farmer et al. 2006; Brinkman et al. 2009). Likewise, reductions in deer habitat capability over the long term may reduce the access to and availability of deer to wolves (see discussion below) and subsistence hunters (see the *Subsistence* section).

The transition to young-growth harvest under Alternatives 2, 3, 4, and 5 would dampen the long-term decrease in deer habitat capability predicted for Alternative 1 because fewer acres of POG forest would be harvested over the planning horizon, thereby maintaining more quality winter habitat for deer (Table 3.10-10). This is illustrated in the Interagency Deer Habitat Capability model results at both the 25-year and 100-year time steps, where Alternatives 2, 3, 4, and 5 maintain approximately 1 to 4 percent more of the existing habitat capability than Alternative 1 (the current Forest Plan). At the forest scale, all alternatives would maintain 99 percent of the existing deer habitat capability over the long term.

Additionally, intermediate stand treatments (pre-commercial and commercial thinning) in young-growth forest would result in increased understory growth which would improve forage resources for deer over the first 15-25 years following harvest. These treatments are not reflected in the Interagency Deer Habitat Capability model results, which only assign one value to harvested stands (i.e., this model does not account for the benefit of young-growth harvest which would convert stands currently in the stem exclusion stage back into the stand initiation stage, or account for thinning treatments which open the forest canopy and promote the development of old-growth stand characteristics and understory plant growth). In contrast, the FRESH deer model (Table 3.10-11) accounts for, and assigns different biomass values (indicative of habitat quality) to, multiple young-growth forest age classes. Therefore, FRESH model results reflect the potential benefits to deer associated with young-growth management as well as the progression of older young-growth stands to POG forest. The results of the FRESH deer model indicate that all of the action alternatives would either maintain the level of habitat quality anticipated under the current Forest Plan (Alternative 1) or improve it by 1 to 2 percent at 25 years; 100 years after plan approval the action alternatives would maintain or result in an additional decline of 1 percent of the level of habitat quality anticipated under the current Forest Plan (Table 3.10-11). At the forest scale, all alternatives maintaining 100 percent of existing habitat quality in 25 years and 99 percent of the existing deer habitat quality in 100 years (Table 3.10-11). Details on model inputs are provided in the Deer subsection under Affected Environment and also included in the project record.

Table 3.10-10
Relative Changes in Deer Habitat Capability (DHC) by Biogeographic Province by Alternative in 25 years and 100 years based on the Interagency Deer Habitat Capability Model (NFS Lands Only)

	Biogeographic Province	Existing Deer Habitat Capability (Deer Habitat Capability Units)	Deer Habitat Capability By Alternative (% Existing Habitat Quality Remaining)									
			Alt 1		Alt 2		Alt 3		Alt 4		Alt 5	
			25 yrs	100 yrs	25 yrs	100 yrs	25 yrs	100 yrs	25 yrs	100 yrs	25 yrs	100 yrs
1	Yakutat Forelands	6,187	98	94	100	94	100	100	100	100	100	100
2	Yakutat Uplands	3,259	100	100	100	100	100	100	100	100	100	100
3	East Chichagof Island	18,919	99	98	100	99	100	99	100	98	99	98
4	West Chichagof Island	6,172	100	100	100	100	100	100	100	100	100	100
5	East Baranof Island	4,167	99	100	101	100	100	100	101	100	100	100
6	West Baranof Island	14,085	100	101	102	101	101	101	101	101	101	100
7	Admiralty Island	28,416	100	100	100	100	100	100	100	100	100	100
8	Lynn Canal	5,461	100	100	100	100	100	100	100	100	100	100
9	North Coast Range	9,520	100	100	100	100	100	100	100	100	100	100
10	Kupreanof/Mitkof Island	19,823	99	98	101	99	101	99	100	99	100	99
11	Kuiu Island	18,861	100	101	100	100	100	100	100	100	100	100
12	Central Coast Range	9,910	101	100	101	100	101	100	101	100	101	100
13	Etolin Island	11,968	99	97	100	99	100	98	99	97	99	97
14	North Central Prince of Wales	31,134	97	95	101	97	101	97	100	96	100	96
15	Revilla Island/ Cleveland Peninsula	23,700	99	99	100	99	100	99	99	99	100	98
16	Southern Outer Islands	9,043	99	98	101	100	101	100	101	98	101	99
17	Dall Island and Vicinity	5,272	100	100	101	100	101	100	100	100	100	100
18	South Prince of Wales	11,358	100	100	100	100	100	100	100	100	100	100
19	North Misty Fiords	5,562	100	100	100	100	100	100	100	100	100	100
20	South Misty Fiords	11,612	100	100	100	100	100	100	100	100	100	100
21	Ice Fields	3,401	100	100	100	100	100	100	100	100	100	100
	Forest-wide	257,830	99	99	101	99	100	99	100	99	100	99

[1] Deer habitat capability model output by WAA, including habitat capability units, is available in the project record.

Table 3.10-11
Habitat Conditions Resulting from Each Alternative Using the FRESH Deer Model in 25 years and 100 years (NFS Lands Only)

No.	Biogeographic Province	Existing Habitat Quality (Deer Days Per Hectare)	Percent of Existing Habitat Quality Remaining									
			Alt 1		Alt 2		Alt 3		Alt 4		Alt 5	
			25 yrs	100 yrs	25 yrs	100 yrs	25 yrs	100 yrs	25 yrs	100 yrs	25 yrs	100 yrs
1	Yakutat Forelands	0.0	--	--	--	--	--	--	--	--	--	--
2	Yakutat Uplands	0.0	--	--	--	--	--	--	--	--	--	--
3	East Chichagof Island	35.7	99	98	99	97	99	97	99	98	99	97
4	West Chichagof Island	89.1	100	100	100	100	100	100	100	100	100	100
5	East Baranof Island	30.6	99	99	100	100	100	99	100	99	100	99
6	West Baranof Island	56.9	100	100	101	100	101	100	100	100	100	100
7	Admiralty Island	50.6	100	100	100	100	100	100	100	100	100	100
8	Lynn Canal	24.4	100	100	102	100	100	100	100	100	100	100
9	North Coast Range	19.3	100	100	100	100	100	100	100	100	100	100
10	Kupreanof/Mitkof Island	96.8	99	99	100	99	100	99	99	99	99	99
11	Kuiu Island	64.8	99	99	99	98	99	98	99	98	99	98
12	Central Coast Range	31.8	101	100	102	100	102	100	101	100	101	100
13	Etolin Island	72.9	99	98	100	98	100	98	99	98	99	98
14	North Central Prince of Wales	79.1	99	98	101	98	101	98	100	98	100	97
15	Revilla Island/ Cleveland Peninsula	68.8	100	99	100	99	100	99	100	99	100	99
16	Southern Outer Islands	96.4	99	99	100	99	100	99	100	99	100	99
17	Dall Island and Vicinity	76.5	100	100	100	100	100	100	100	100	100	100
18	South Prince of Wales	95.1	100	100	100	100	100	100	100	100	100	100
19	North Misty Fiords	21.6	100	100	100	100	101	100	100	100	100	100
20	South Misty Fiords	56.3	100	100	100	100	100	100	100	100	100	100
21	Ice Fields	3.0	100	100	101	100	101	100	100	101	100	100
	Forest-wide	**40.9**	**100**	**99**	**100**	**99**	**100**	**99**	**100**	**99**	**100**	**99**

Note: No snow zone assigned to Biogeographic Province 1 and 2 due to very low use by deer; therefore, model not run.

Alternatives 2, 3, 4, and 5 propose modifications to OGRs that compensate for effects associated with the Sealaska land conveyance (see the *Biodiversity* section and Appendix E for additional discussion). The land conveyance removed portions of OGRs, decreasing the amount of deer winter habitat (high-volume POG less than 800 feet elevation) within the reserve system. The proposed modifications to the existing (i.e., post-conveyance) OGRs would result in a net increase of 3,648 acres of deep snow deer winter habitat included in the reserve system (Appendix E). These modifications would result in greater protection of deer habitat under the Conservation Strategy than would occur as a result of the land conveyance without these changes.

Alternatives 2, 3, 4, and 5 propose to eliminate the TUS LUD, and implement a new series of Forest-wide Renewable Energy and Transportation Systems Corridors standards and guidelines. Renewable energy and transportation project development can affect deer during construction through disturbance and through habitat removal or alteration. Operational impacts due to disturbance would expected to be minimal. The proposed standards and guidelines include consideration of the most current science, guidance, and methodologies related to avoiding and minimizing wildlife impacts. These measures would minimize impacts to deer and/or areas of important deer habitat during construction and operation.

Mountain Goat

Mountain goats are associated with old-growth forest and are susceptible to over-hunting if road access is increased or improved, though most roads are located a long distance (both vertically and horizontally) from mountain goat habitat. The greatest amount of POG harvest would occur under Alternative 1 (62,851 acres), followed by Alternatives 4 (42,597 acres), 5 (42,479 acres), 3 (35,568 acres) and 2 (32,609 acres; Table 3.10-8).

The amount of road access, quantified in terms of the amount of road construction and reconstruction proposed under each alternative, is representative of the potential for over-hunting. New road construction on NFS lands after full implementation of the Forest Plan (100 years) for each alternative ranges from 871 miles (Alternative 4) to 1,056 miles (Alternative 2) (See Table 3.12a-1 in the Transportation Section). The greatest amount of road to be constructed over decommissioned roadbeds or reconstruction would occur under Alternative 2 (1,191 miles), followed by Alternatives 3 (1, 129 miles), 5 (1,058 miles), 4 (900 miles), and 1 (887 miles). However, most of the roads, particularly accessing young-growth units, would be below 1,500 feet in elevation and outside of mountain goat habitat. Additionally, note that many new or reconstructed roads would be closed or decommissioned after use, further reducing effects on mountain goats. Risk of over-harvest due to human access along roads is mitigated to some extent by Transportation Forest-wide standards and guidelines that require travel access road objectives to be developed for all roads, and mountain goat standards and guidelines that would be implemented under all of the alternatives.

Mountain goats are also susceptible to disturbance and displacement from helicopter overflights and landings. There are Forest Plan standards and guidelines in place that address helicopter use at the project level that would be maintained under all of the alternatives.

Renewable energy and transportation projects could affect mountain goats through direct disturbance or through removal or modification of habitats. The proposed Forest-wide Renewable Energy and Transportation Systems Corridors standards and guidelines proposed under Alternatives 2, 3, 4, and 5 do not

directly address this species; however, they do specify consideration of the most current science, guidance, and methodologies related to avoiding and minimizing wildlife impacts. These measures would minimize impacts to mountain goats and their habitat during project construction and operation.

Black Bear

Preferred habitats for black bears, which include coastal, estuarine, and riparian areas, are protected by the Forest Plan Conservation Strategy. All of the alternatives maintain these measures, although Alternatives 2, 3, 4, and 5 propose guidelines for young-growth harvest that allow harvest in the beach and estuary fringe and RMAs (Alternatives 2 and 5 only; see discussion above under Tongass Conservation Strategy). Alternative 2 would result in the greatest amount of young-growth harvest in these black bear habitats (66,984 acres), followed by Alternatives 3 (41,489 acres), Alternative 4 (14,865 acres) and Alternative 5 (4,428 acres); no harvest in beach and estuary buffers or RMAs would occur under Alternative 1 (Table 3.9-11 in the *Biodiversity* section).

Harvest of mature young-growth and old-growth timber (both even aged as well as thinning) would increase forage availability (berries) for black bears over the short term in the resulting early-successional plant communities. However, this food source typically lasts only about 25 years post-logging and decreases over time in association with canopy closure. Over the long-term, old-growth harvest would decrease habitat suitability for black bears, due to the reduced understory forage in young-growth stands and loss of denning habitat in upland areas (e.g., large woody structures such as hollow logs and hollow living trees; Davis et al. 2012). This effect would be greatest under continued POG harvest (Alternative 1). The transition to young-growth harvest under Alternatives 2, 3, 4, and 5 would increase forage availability over the long term by reverting young-growth stand in the stem exclusion stage back to the stand initiation stage; however, development of old-growth stand characteristics used by bears for denning would be delayed. However, effects to the contributing elements of the Conservation Strategy would be localized, with the maximum proposed young-growth harvest affecting 2.4 percent, 3.3 percent, 1.2 percent, and 0.4 percent of forest land in the beach and estuary fringe under alternative 2, 3, 4, and 5, respectively; 6.7 percent and 0.3 percent of the forest land within RMAs under Alternatives 2 and 5, respectively; up to 3 percent of the forest land within old-growth reserves and other non-development LUDs (Alternatives 2, 3, and 5) within the planning area (see Appendix D for additional discussion of the Conservation Strategy). Therefore, these areas would continue to function as habitat for black bears.

Reductions in deer habitat capability resulting from timber harvest (both old-growth and young-growth) could reduce fawn productivity, and therefore the prey base for bears in the spring in some portions of the Tongass. However, as discussed above over the long term the transition to young-growth harvest is expected to maintain or increase deer habitat capability and habitat quality over the long term under Alternatives 2, 3, 4, and 5 minimizing this effect to black bears.

Timber harvest (both old-growth and young-growth) may also indirectly increase the susceptibility of black bears to over-harvest if road access is increased or improved. An increase in open roads, particularly in open habitats such as clearcuts and muskegs, where bears forage and are easier to see, can increase the potential for human-bear interactions. The amount of road access, quantified in terms of the amount of road construction and reconstruction proposed under each alternative, is representative of the potential for over-hunting (USDA Forest Service 2008b; see discussion above under Mountain Goat for a comparison of the alternatives). Average total road density on NFS lands (across all WAAs) in 100 years would be approximately 0.2 mile per square mile under all of the

alternatives, an increase of 0.03 to 0.04 mile per square mile above existing average road density; Table 3.10-12). Therefore, any potential increase in hunter access and risk of over harvest would be localized, and no measureable increase would be expected at the forest scale under any of the alternatives.

Alternatives 1, 2, 3, 4, and 5 would incorporate the Legacy Forest Structure standards and guidelines, which are intended to maintain old-growth structure in areas that are already highly developed, as well as areas that will experience increased harvest levels over the life of the Forest Plan. These components (large trees and snags) may provide potential den sites for black bears. Alternatives 2, 3, 4, and 5 include a proposed clarification that the list of VCUs where the Legacy Forest Structure standards and guidelines apply should be verified during project-specific planning and analysis. Alternatives 3 and 4 also include a new management approach for this standard and guideline to indicate that when implementing young-growth harvest projects larger than 20 acres in VCUs that have received concentrated past old-growth harvest it is intended that 30 percent of the young-growth stand acres should be left to retain residual trees to diversify structural characteristics and promote future recruitment of snags. Therefore, the proposed clarification would provide greater protection of black bear denning habitat.

Alternatives 2, 3, 4, and 5 propose modifications to OGRs that compensate for effects associated with the Sealaska land conveyance (see the *Biodiversity* section and Appendix E for additional discussion). The land conveyance removed portions of OGRs, decreasing the amount of shoreline and riparian habitats included in the reserve system. The proposed modifications to existing (i.e., post-conveyance) OGRs would help maintain connectivity to shoreline and protect riparian habitats preferred by black bears. Proposed OGR modifications would result in a net increase of 31 miles of Class I streams and 6,696 acres of low-elevation POG included in reserve system (Appendix E). These modifications would provide greater protection of black bear foraging habitat under the Conservation Strategy than would occur as a result of the land conveyance without these changes.

Renewable energy and transportation projects could affect black bears through direct disturbance or through removal or modification of habitats. The proposed Forest-wide Renewable Energy and Transportation Systems Corridors standards and guidelines under Alternatives 2, 3, 4, and 5 do not directly address this species; however, they do specify consideration of the most current science, guidance, and methodologies related to avoiding and minimizing wildlife impacts. These measures would minimize impacts to black bears and their habitats during project construction and operation.

Table 3.10-12
Estimated Average Road Density and Percent of WAAs in Road Density Categories on NFS Lands and All Lands Combined[1] for All Roads and for Open Roads Only within the Tongass National Forest Boundary by Alternative after 100 Years

	Percentage of WAAs											
	Existing		Alt 1		Alt 2		Alt 3		Alt 4		Alt 5	
Road Density Category (miles per sq. mi.)	NFS Lands Only	All Lands	NFS Lands Only	All Lands	NFS Lands Only	All Lands	NFS Lands Only	All Lands	NFS Lands Only	All Lands	NFS Lands Only	All Lands
All Roads												
0	47.6%	43.5%	35.1%	32.5%	33.5%	32.5%	35.6%	32.5%	43.5%	33.0%	39.3%	32.5%
0 to 0.7	37.7%	35.1%	47.6%	39.8%	49.2%	39.8%	47.1%	39.8%	40.3%	39.8%	43.5%	39.8%
0.7 to 1.0	6.3%	5.8%	6.3%	7.3%	5.2%	5.8%	5.2%	5.8%	5.2%	5.8%	5.2%	5.8%
1.0 to 2.0	7.9%	12.6%	7.9%	13.1%	8.9%	14.1%	8.9%	14.7%	7.9%	14.1%	8.9%	14.7%
2.0 to 3.0	0.5%	3.1%	3.1%	5.8%	3.1%	6.3%	3.1%	5.8%	3.1%	5.8%	3.1%	5.8%
>3.0	0.0%	0.0%	0.0%	1.6%	0.0%	1.6%	0.0%	1.6%	0.0%	1.6%	0.0%	1.6%
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
Average Total Road Density – All WAAs	0.195	0.334	0.231	0.450	0.235	0.454	0.233	0.453	0.228	0.448	0.232	0.452
Open Roads												
0	57.1%	49.7%	37.7%	33.5%	35.6%	33.5%	37.7%	33.5%	46.6%	34.0%	41.4%	33.5%
0 to 0.7	39.3%	37.7%	58.6%	51.3%	60.2%	51.3%	58.1%	51.3%	49.2%	50.8%	54.5%	51.3%
0.7 to 1.0	2.6%	4.7%	1.6%	5.8%	2.1%	5.2%	2.1%	5.2%	2.1%	5.8%	2.1%	5.8%
1.0 to 2.0	1.0%	6.3%	2.1%	8.9%	2.1%	9.4%	2.1%	9.4%	2.1%	8.9%	2.1%	8.9%
2.0 to 3.0	0.0%	1.6%	0.0%	0.5%	0.0%	0.5%	0.0%	0.5%	0.0%	0.5%	0.0%	0.5%
>3.0	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%
Total	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**	**100%**
Average Open Road Density – All WAAs	0.089	0.218	0.094	0.238	0.095	0.239	0.095	0.239	0.094	0.238	0.094	0.239

[1] Percentages are based on all 191 WAAs inside the Forest boundary, including Annette Island

River Otter

River otters prefer habitats, especially POG forest, immediately adjacent to coastal and fresh water aquatic environments, with most use occurring within 500 feet of the these areas. These old-growth habitats are protected by Forest Plan standards and guidelines for the beach and estuary fringe, riparian areas, and lakes which would be implemented under all alternatives. Alternatives that propose young-growth harvest within habitats used by river otters would be expected to have the greatest effects to these species. Young-growth harvest within beach and estuary fringe (Alternatives 2, 3, 4, and 5) and RMAs (Alternatives 2 and 5 only) are presented in Table 3.9-11 and discussed above under Black Bear. Alternative 2 would result in the greatest amount of young-growth harvest in these river otter habitats (66,984 acres), followed by Alternative 3 (41,489 acres), Alternative 4 (14,865 acres), and Alternative 5 (4,428 acres); no harvest in the beach and estuary fringe or RMAs would occur under Alternative 1 (Table 3.9-11 in the *Biodiversity* section).

Renewable energy and transportation projects could affect river otters through direct disturbance or through removal or modification of habitats, particularly if activities affect water bodies. The proposed Forest-wide Renewable Energy and Transportation Systems Corridors standards and guidelines under Alternatives 2, 3, 4, and 5 do not directly address this species; however, they do specify consideration of the most current science, guidance, and methodologies related to avoiding and minimizing wildlife impacts. These measures would minimize impacts to river otters and their habitats during project construction and operation.

American Marten

Through the removal of forest cover and old-growth ecosystem features such as decadent live trees and snags, timber harvest (POG harvest and young-growth harvest) would reduce the vertical and horizontal structural complexity important to marten in relation to prey access, denning and resting sites, escape from predation, and thermoregulation (Buskirk and Zielinski 1997; Hargis et al. 1999; Flynn and Schumacher 2001). Forest fragmentation resulting from timber harvest may also alter patterns of occupancy by marten (Thompson and Harestad 1994; Bissonette et al. 1997; Chapin et al. 1998). Although more recent research indicates that marten use all forested stands relative to their ability, including young-growth stands mixed conifer and deciduous stands less than 40 years of age (Goldstein 2013), alternatives that result in the greatest reduction in deep snow marten habitat (high-volume POG at or below 800 feet elevation) would be expected to have the greatest negative effects to marten. Reductions in deep snow marten habitat may result in localized reductions in the capability of the remaining habitat to support marten. The greatest amount of deep snow marten habitat is scheduled to be harvested in the next 100 years under Alternative 1 (16,116 acres), followed by Alternatives 4 (9,921 acres), 5 (9,844 acres), 2 (8,120 acres), and 3 (6,297 acres; Table 3.10-13).

Table 3.10-13
Estimated Harvest (acres) of High-Volume (SD5N, SD5S, and SD67) and Large-Tree (SD67) Productive Old-Growth by Elevation Category and Alternative after 100 years (NFS lands only)

Elevation Category	Alternative				
	1	2	3	4	5
High-Volume POG					
< 800 feet	16,116	8,120	6,297	9,921	9,844
> 800 feet	11,349	5,901	7,420	8,328	7,972
Total	**27,464**	**14,022**	**13,716**	**18,248**	**17,816**
Large-Tree POG					
< 800 feet	6,076	2,989	1,937	3,542	3,594
> 800 feet	3,227	1,640	1,748	2,478	2,211
Total	**9,303**	**4,629**	**3,685**	**6,021**	**5,805**

Alternatives 1, 2, 3, 4, and 5 would incorporate the Legacy Forest Structure standards and guidelines which are intended to maintain old-growth structure in areas that are already highly developed, as well as areas that will experience increased harvest levels over the life of the Forest Plan. These components (large trees and snags) may provide potential den sites and foraging habitat for marten. Alternatives 2, 3, 4, and 5 include a proposed clarification that the list of VCUs where the Legacy Forest Structure standards and guidelines apply should be verified during project-specific planning and analysis. Alternatives 3 and 4 also include a new management approach for these standards and guidelines to indicate that when implementing young-growth harvest projects larger than 20 acres in VCUs that have received concentrated past old-growth harvest it is intended that 30 percent of the young-growth stand acres should be left to retain residual trees to diversify structural characteristics and promote future recruitment of snags. Therefore, the proposed clarification would provide greater protection of marten habitat in managed forest stands.

Increased human access associated with new roads may result in increased marten vulnerability to harvest, particularly along open roads (Flynn et al. 2004). All alternatives would result in minor increased average total road densities; however, the proportion of WAAs within various road density categories would not change under any of the alternatives (see the discussion under Black Bear; Table 3.10-12). Increased road densities have the potential to indirectly increase hunter access and associated trapping pressure; however these effects would be minor and would not differ among alternatives.

Marten were chosen as one of the design species in the development of 1997 Forest Plan Conservation Strategy (USDA Forest Service 1997b) because they exhibit a consistent close association with mature forests throughout their distributional range (Sturtevant et al. 1996). Under the current Forest Plan, the marten populations are supported by the Conservation Strategy which works to maintain old-growth forest cover and coarse woody debris to provide structure important to marten for resting, denning, escape from predators, trapping refugia, and facilitate marten dispersal. The beach and estuary fringe and RMAs provide travel corridors for marten, and old-growth reserves and other non-development LUDs provide refugia from trapping. Pre-commercial and commercial thinning of young-growth stands in these areas, which would occur under all of the alternatives, would promote the development of stand conditions that provide habitat structure for marten. However, even-aged harvest or group-selection of young-growth in the beach and estuary fringe (Alternatives 2, 3, 4, and 5), RMAs (Alternatives 2 and 5), and non-development LUDs (Alternatives 2, 3, and 5) would setback the stand development process (returning harvest units to the

stand initiation stage). The creation of gaps several acres in size or more could result in localized reductions in marten movement, local reductions in prey availability, and would delay the development of old-growth habitat conditions in harvested stands. Effects to connectivity for marten would be lessened under Alternatives 2 and 5, which maintain a 1,000 foot buffer immediately inland of young-growth harvest units in the beach and estuary fringe and a 200-foot buffer along the shoreline, respectively. Additionally, Alternative 5 includes a one-time entry stipulation for young-growth harvest in each of these areas (See the discussion above under Conservation Strategy and the analysis of effects to the Conservation strategy in Appendix D for more detail).

Alternatives 2, 3, 4, and 5 propose modifications to OGRs that compensate for effects associated with the Sealaska land conveyance (see the *Biodiversity* section and Appendix E for additional discussion). The land conveyance removed portions of OGRs, decreasing the amount of marten habitat (high-volume POG below 800 feet elevation) within the reserve system. The proposed modifications to the existing (post-conveyance) OGRs would result in a net increase of 3,648 acres of deep snow marten habitat included in the reserve system. Overall, these modifications would increase the amount of marten habitat protected by the Conservation Strategy, compared to the amount of protection that would occur as a result of the land conveyance without these changes.

Renewable energy and transportation projects could affect marten through direct disturbance or through removal or modification of habitat. The proposed Forest-wide Renewable Energy and Transportation Systems Corridors standards and guidelines under Alternatives 2, 3, 4, and 5 do not directly address this species; however, they do specify consideration of the most current science, guidance, and methodologies related to avoiding and minimizing wildlife impacts. These measures would minimize impacts to marten and their habitats during project construction and operation.

Brown Bear

Brown bears are associated with low-elevation POG forests, particularly along Class I salmon streams. These habitats are protected to some extent by Forest-wide Standards and Guidelines for beach and estuary fringe and RMAs. However, young-growth harvest would occur in these areas under Alternatives 2, 3, and 5. It can be assumed that the alternatives with the greatest amount of young-growth harvest in the beach and estuary fringe and RMAs would have the greatest effect to brown bears. Young-growth harvest within beach and estuary fringe and RMAs are presented in Table 3.9-13 and discussed above under Black Bear. Alternative 2 would have the greatest effects to habitats used by brown bears, followed by Alternatives 3, 4, and 5; no harvest in the beach and estuary fringe or RMAs would occur under Alternative 1 (Table 3.9-11 in the *Biodiversity* section).

Road densities are another measure of the potential impact of the alternatives on brown bears. Primary concerns include increased hunting or poaching, and disturbance during critical life stages (e.g., late-summer feeding periods for bear). Habitat fragmentation, as well as habitat loss secondary to activities that are facilitated by vehicular access (e.g., timber harvest, mining, residential development, and renewable energy development) are other potential impacts. Open roads, which receive the highest and most consistent use, are likely to have the greatest effect on brown bears, although closed roads still facilitate access (e.g., off-highway vehicle, pedestrian) to roadless areas. There is no road density guideline for brown bears; however, it can be assumed that increased road density elevates the potential for human-bear interactions. All

alternatives would result in minor changes in total road density (see the discussion under Black Bear; Table 3.10-12). Increased road densities have the potential to indirectly increase human-bear interactions; however, these effects would be minor and would not differ among alternatives.

The reserve system serves as an important source of roadless refugia for brown bears, reducing the possibility of human-bear interactions. Alternatives 2, 3 and 5 allow young-growth harvest in old-growth reserves and other non-development LUDs (Alternatives 2 and 3 only). Under Alternatives 2, 3, and 5, maximum estimated young-growth harvest acres within these areas comprise less than 3 percent of Old-growth Habitat LUD acres Forest-wide and less than 1 percent of other non-development LUD acres Forest-wide (see Appendix D for an analysis of the Conservation Strategy). Suitable young-growth stands within OGRs and other non-development LUDS are typically located along the shoreline or inland under existing road systems. These easily accessible stands, particularly when located near other suitable young-growth stands in development LUDs, would be selected to avoid effects to intact, relatively undisturbed POG forest within OGRs and other non-development LUDs. Therefore, young-growth harvest within the reserve system under Alternatives 2, 3, and 5 would not be expected to reduce the functioning of these areas as refugia for brown bears.

Renewable energy and transportation projects could affect brown bears through direct disturbance or through removal or modification of habitat, particularly if developments affect Class I salmon streams. The proposed Forest-wide Renewable Energy and Transportation Systems Corridors standards and guidelines under Alternatives 2, 3, 4, and 5 do not directly address this species; however, they do specify consideration of the most current science, guidance, and methodologies related to avoiding and minimizing wildlife impacts. These measures would minimize impacts to brown bears and their habitats during project construction and operation.

Alexander Archipelago Wolf

The 1997 and 2008 Forest Plan analyses contain extensive information on wolf ecology building on the wolf assessment (Person et al. 1996). As outlined in the 1997 and 2008 plans and associated documents, scheduled harvest of POG forest has the potential to result in the reduction of the wolf prey base (deer through decreased deer habitat capability) and increased human access along project roads, which could reduce the wolf population through increased legal and illegal hunting and trapping. It is assumed that a decline in the deer population would likely result in a decline in the wolf population (USDA Forest Service 2008b). Resonating effects could include reductions in opportunities to hunt or trap wolves (see Subsistence section). These effects are of particular concern on Prince of Wales Island where the population has apparently undergone substantial declines over the last several decades; however, this population represents a small proportion (approximately 4 percent) of the overall Alexander Archipelago wolf population and this decline is not anticipated to affect the status of the population at large (USFWS 2015).

One approach to examining potential effects of alternatives on wolves is evaluating the reduction in modeled deer habitat capability (based on Interagency Deer Habitat Capability model outputs in terms of calculated deer density) in each biogeographic area and by WAA. Note that deer density expressed by the habitat capability model does not represent actual population numbers but represents a consensus at the time the model was developed regarding deer habitat capability at different structural / successional stages

which can be used to compare alternatives. Model assumptions, based on recent direction provided by the Forest Service include:

- For the direct and indirect effects analysis, deer habitat capability by WAA (including only NFS lands) was divided by the total square miles of NFS lands (all elevations included, but with acres above 1,500 feet elevation receiving a zero value) in the WAA.
- For the cumulative effects analysis, deer habitat capability from all land ownerships (NFS and non-NFS lands) was divided by the total square miles of all lands (all elevations included, but habitats on non-NFS land and land above 1,500 feet elevation receiving a zero value) in the WAA.

Evaluation of potential effects of timber harvest on wolves based on the Interagency Deer Habitat Capability Model relies on an understanding of the complex interactions between forest management and deer habitat, roads, snowpack, deer populations, deer hunters, wolves (as predators of deer), and wolf trappers/hunters. Particularly important is the idea that winter deer habitat (old growth forest, which intercepts snow and provides forage) is reduced through timber harvest to the point where a severe winter (or series of such winters) with deep snow results in high deer mortality.

Evaluation employing the Interagency Deer Carrying Capacity Model suggests that harvest of POG forest will decrease carrying capacity for deer over the long term because of reductions in the amount of available winter habitat due to the ultimate development of forest in stem-exclusion (Table 3.10-11; see also discussion of effects to deer). However, this long-term decline in carrying capacity is less under Alternatives 2, 3, 4, and 5 than Alternative 1 due to the transition to young growth,. Current deer habitat capability based on the interagency habitat capability model is below the Forest Plan guideline of 18 deer per square mile in many WAAs. This results from several factors and varies among landscapes. Contributing factors include lower inherent capability of some landscapes and habitats, reduced habitat capability from past timber harvest and associated succession, and the static nature of how the model expresses habitat capability during succession (such as one value for young growth from 25 to 150 years of age). Model results suggest that continued harvest of POG forest in some areas would result in higher risk that there will be insufficient deer to sustain predation by wolves and human deer harvest over the long-term (see existing modeled deer densities in Table 3.10-2). That concern exists despite the availability of alternative prey and current abundance of deer in some parts of the forest.

Alternative 1 would reduce the existing percentage of WAAs with deer habitat capability of at least 18 deer per square mile by 14 percent at stem exclusion in approximately 25 years; there would be no change in the percentage of WAAs with at least 18 deer per square mile habitat capability over this time period under Alternatives 2, 3, or 4, but the decrease in number of WAAs would be 11 percent under Alternative 5 (Table 3.10-14)., After 100 years of Forest Plan implementation all alternatives would reduce the percentage of WAAs with at least 18 deer per square mile by 14 percent. WAAs with the greatest potential impacts are located in South Prince of Wales, North Central Prince of Wales, Kupreanof/Mitkof Islands, Revillagigedo Island, and Chichagof Island biogeographic provinces (Table 3.10-14). Deer Habitat Capability model output by WAA is included in the project record. Reductions in habitat capability are due to both timber harvest as well as natural succession of stands harvested in the past.

Table 3.10-14
Comparison of Alternatives in terms of their Long-term Ability to Meet the Wolf Guideline of Providing Sufficient Habitat to Support 18 Deer per Square Mile after 25 and 100+ Years of Forest Plan Implementation 1 (NFS Lands Only)

No.	Biogeographic Province	Existing Habitat Capability 2015 (Deer per Square Mile)	Existing No. WAAs with Modeled Deer Density of at least 18 Deer per Square Mile[1/]	Model-generated Habitat Capability by Alternative (Deer Per Square Mile and Number of WAAs with Modeled Deer Density of at least 18 Deer per Square Mile)[2]									
				Alt 1		Alt 2		Alt 3		Alt 4		Alt 5	
				25 yrs	100 yrs	25 yrs	100 yrs	25 yrs	100 yrs	25 yrs	100 yrs	25 yrs	100 yrs
1	Yakutat Forelands	13.3	2	12.4(2)	11.9(2)	12.6(2)	11.9(2)	12.7(2)	12.7(2)	12.7(2)	12.7(2)	12.7(2)	12.7(2)
2	Yakutat Uplands	2.3	0	2.3(0)	2.3(0)	2.3(0)	2.3(0)	2.3(0)	2.3(0)	2.3(0)	2.3(0)	2.3(0)	2.3(0)
3	East Chichagof Island	11.7	1	11.4(1)	11.3(1)	11.6(1)	11.4(1)	11.5(1)	11.4(1)	11.5(1)	11.3(1)	11.5(1)	11.4(1)
4	West Chichagof Island	14.5	1	14.0(0)	14.0(0)	14.0(0)	14.0(0)	14.0(0)	14.0(0)	14.0(0)	14.0(0)	14.0(0)	14.0(0)
5	East Baranof Island	7.0	0	6.8(0)	6.8(0)	6.9(0)	6.8(0)	6.8(0)	6.8(0)	6.9(0)	6.8(0)	6.8(0)	6.8(0)
6	West Baranof Island	12.2	4	11.9(4)	11.9(4)	12.1(4)	12.0(4)	12.0(4)	11.9(4)	11.9(4)	11.9(4)	11.9(4)	11.9(4)
7	Admiralty Island	17.6	10	17.3(10)	17.3(10)	17.3(10)	17.3(10)	17.3(10)	17.3(10)	17.3(10)	17.3(10)	17.3(10)	17.3(10)
8	Lynn Canal	5.5	1	5.4(1)	5.4(1)	5.4(1)	5.4(1)	5.5(1)	5.4(1)	5.4(1)	5.4(1)	5.4(1)	5.4(1)
9	North Coast Range	6.2	0	6.1(0)	6.1(0)	6.1(0)	6.1(0)	6.1(0)	6.1(0)	6.1(0)	6.1(0)	6.1(10)	6.1(0)
10	Kupreanof/Mitkof Island	16.9	7	16.5(3)	16.4(3)	16.8(3)	16.6(3)	16.8(3)	16.6(3)	16.6(3)	16.5(3)	16.7(3)	16.4(3)
11	Kuiu Island	25.5	7	25.0(7)	25.1(7)	25.1(7)	25.1(7)	25.1(7)	25.1(7)	25.1(7)	25.1(7)	25.1(7)	25.0(7)
12	Central Coast Range	9.0	1	8.9(1)	8.8(1)	8.9(1)	8.8(1)	8.9(1)	8.8(1)	8.9(1)	8.8(1)	8.9(1)	8.8(1)
13	Etolin Island	15.7	3	15.2(2)	14.9(2)	15.5(1)	15.1(1)	15.5(1)	15.0(1)	15.4(2)	14.9(1)	15.3(2)	14.9(1)
14	North Central Prince of Wales	17.7	11	16.8(9)	16.5(9)	17.4(11)	16.7(10)	17.4(11)	16.7(10)	17.3(11)	16.6(10)	17.2(11)	16.6(10)
15	Revilla Island/ Cleveland Peninsula	13.5	7	12.9(6)	12.9(6)	13.1(6)	12.9(6)	13.1(6)	12.9(6)	13.0(6)	12.9(6)	13.0(6)	12.8(6)
16	Southern Outer Islands	28.1	9	27.4(9)	27.0(9)	27.8(9)	27.4(9)	27.8(9)	27.3(9)	27.9(9)	26.9(9)	27.9(9)	27.1(9)
17	Dall Island and Vicinity	30.4	3	29.5(3)	29.5(3)	29.5(3)	29.5(3)	29.5(3)	29.5(3)	29.5(3)	29.5(3)	29.5(3)	29.5(3)
18	South Prince of Wales	21.8	5	20.9(5)	20.8(5)	21.0(5)	20.9(5)	20.9(5)	20.9(5)	20.9(5)	20.8(5)	20.9(5)	20.8(5)
19	North Misty Fiords	3.7	2	3.7(1)	3.7(1)	3.7(1)	3.7(1)	3.7(1)	3.7(1)	3.7(1)	3.7(1)	3.7(1)	3.7(1)
20	South Misty Fiords	8.4	0	8.2(0)	8.2(0)	8.2(0)	8.2(0)	8.2(0)	8.2(0)	8.2(0)	8.2(0)	8.2(0)	8.2(0)
21	Ice Fields	0.7	0	0.7(0)	0.7(0)	0.7(0)	0.7(0)	0.7(0)	0.7(0)	0.7(0)	0.7(0)	0.7(0)	0.7(0)
	Forest-wide	**10.1**	**74**	**9.8(64)**	**9.7(64)**	**9.9(65)**	**9.8(64)**	**9.9(65)**	**9.8(64)**	**9.9(66)**	**9.8(64)**	**9.9(66)**	**9.8(64)**

1 For WAAs that overlap a biological province boundary only the overlapping portion counted toward the total.
2 Note that the model treats harvested stands in the stem exclusion stage (25 years old or older) the same value regardless of thinning treatments that are implemented.3 Note that wolves very rarely occur on Admiralty, Baranof, and Chichagof Islands.

The transition to young-growth harvest under the action alternatives is not fully reflected in the interagency deer model results because the model does not assign different values to stands that have been pre-commercially or commercially thinned (i.e., it still treats them as stands in the stem exclusion phase with limited value for deer), or young-growth stands beyond the stem exclusion phase which become more suitable for deer. Harvest of young-growth stands would increase summer and low-snow winter forage availability for deer over the short term, providing temporary increases in habitat capability during most years, but reduced winter habitat capability in high-snow years. Over the long term as young-growth stands re-enter the stem exclusion phase, habitat capability for deer (and thus potential prey availability for wolves) would be expected to decrease (due to reduced forage availability) until the next stand treatment.

The transition to young growth would revert stands in the stem exclusion stage back to the stand initiation stage, and therefore would extent the period of short-term benefits to deer (in summer and low-snow winters) associated with increased habitat capability and thus also benefiting wolves. Ultimately, the continued harvest of old-growth and young-growth forest under all the alternatives has the potential to result in localized reductions in deer habitat capability which may reduce prey availability for wolves in portions of the Tongass where deer are their primary prey (e.g., Prince of Wales Island and surrounding islands [GMU 2]).

All action alternatives involve the construction or reconstruction of roads. The roads associated with timber harvest (old-growth and young-growth) may also increase the risk of both legal and illegal hunting and trapping related wolf mortality by increasing human access. Estimated total road densities below 1,200 feet (representative of low elevation habitats used by wolves and deer) would increase by 0.07 to 0.08 miles per square mile (NFS lands only) under all of the alternatives. Estimated open road densities would increase by 0.01 miles per square mile under all action alternatives (Table 3.10-15). Therefore, at most, localized increases in hunter access would be expected under the action alternatives with no substantial increase across the Tongass. Relative to Alternative 1, the action alternatives would result in a minor increase in open road miles below 1,200 feet under Alternatives 2, 3, and 5 (an increase of 26 miles, 20 miles, and 14 miles, respectively) and a minor decrease under Alternative 4 (5 miles; Table 3.10-15). These effects would be lessened through road closures after use, through storage or decommissioning. The effectiveness of closure and storage, or decommissioning and ultimately the extent of mitigation will depend on both enforcement and the approach to closure. These decisions are made at the island, district, and project level through Access Travel Management Plans based on an evaluation of all resources.

The old-growth reserve system of the Conservation Strategy serves as an important source of roadless refugia for wolves. Alternatives 2, 3, 4, and 5 propose modifications to OGRs that compensate for effects associated with the Sealaska land conveyance (see the *Biodiversity* section and Appendix E for additional discussion). The land conveyance removed portions of OGRs, decreasing the amount of deer winter habitat and areas identified as being important for landscape connectivity (low-elevation POG) in the reserve system. The proposed modifications to the existing (i.e., post-conveyance) OGRs would result in a net increase in the of 3,6,48 acres of deep snow deer winter habitat and 6,696 acres of low-elevation POG the reserve system, thus indirectly benefiting wolves (see the discussion under Deer above and Appendix E).

Table 3.10-15
Estimated Road Miles and Average Road Density below 1,200 ft. in Elevation on NFS Lands and All Lands Combined for All Roads and for Open Roads by Alternative after 100 Years

	Existing		Alt 1		Alt 2		Alt 3		Alt 4		Alt 5	
Category	NFS Lands Only	All Lands	NFS Lands Only	All Lands	NFS Lands Only	All Lands	NFS Lands Only	All Lands	NFS Lands Only	All Lands	NFS Lands Only	All Lands
Road Miles												
All Roads	4,858	8,900	5,726	11,917	5,830	12,020	5,796	11,987	5,659	11,850	5,772	11,963
Open Roads	2,201	5,777	2,327	6,264	2,353	6,290	2,347	6,283	2,322	6,259	2,341	6,277
Road Density (mi/mi^2)												
All Roads	0.39	0.63	0.46	0.85	0.47	0.86	0.47	0.85	0.46	0.84	0.46	0.85
Open Roads	0.18	0.41	0.19	0.45	0.19	0.45	0.19	0.45	0.19	0.45	0.19	0.45

These modifications would result in greater protection of the wolf prey base and potential wolf travel corridors under the Conservation Strategy than would occur as a result of the land conveyance without these changes.

Renewable energy and transportation project development can affect wolves directly during construction through disturbance at den and rendezvous sites and indirectly through effects to deer habitat and increased vulnerability to harvest. The proposed Forest-wide Renewable Energy and Transportation Systems Corridors standards and guidelines under Alternatives 2, 3, 4, and 5 do not directly address this species; however, they do specify consideration of the most current science, guidance, and methodologies related to avoiding and minimizing wildlife impacts. These measures would minimize impacts to wolves, their habitats, and their prey base during project construction and operation. Additionally, it is assumed that all projects would implement existing Forest Plan standards and guidelines for wolves to further minimize impacts.

Bald Eagle

Timber harvest (both old-growth and young-growth) and associated activities which create noise and disturbance (e.g., blasting and helicopter logging) have the potential to result in minor, temporary disturbance to individual bald eagles. As required by the Forest Plan, all alternatives would be conducted implemented in accordance with the Bald and Golden Eagle Protection Act, including maintaining appropriate distances from active bald eagle nests. Riparian and beach and estuary standards and guidelines, as well as OGRs and other non-development LUDs, protect bald eagle habitat on the Tongass. Alternatives 2, 3, 4, and 5 propose young-growth harvest to varying extents in the beach and estuary fringe and/or RMAs (Alternatives 2 and 5 only). Management activities in these areas could disturb eagles and reduce the protection afforded to suitable bald eagle habitat. Alternative 5 allows commercial management of young growth (up to 10-acre openings) in the beach and estuary fringe and RMAs for the first 15 years after plan approval, so would delay development of future trees/snags suitable for eagle nesting, perching, and roosting; it includes a minimum 200-foot forested buffer along the shore (beach) that would continue to protect some eagle perching or roosting trees during that time. Alternatives 2, 3, and 4 allow commercial thinning of young growth in the beach buffer to continue into the future, beyond 15 years, so could have longer term effects on eagle habitat. In addition, Alternative 2 allows even-aged management for up to 15 years (harvest opening size limited by Scenery standards only) in the beach and estuary fringe and commercial thinning in RMAs (no time limit specified). Alternatives 3 and 4

would not allow even-aged management in the beach and estuary fringe and do not propose harvest in RMAs and would therefore have less impact on eagles than Alternatives 2 and 5. No harvesting in the beach and estuary fringe or RMAs would occur under Alternative 1.

Many of young growth trees harvested would be of insufficient size to be suitable for nesting or preferable for roosting. Harvest of young growth has potential to disturb eagles, especially if helicopter harvest methods are used. Timing restrictions would apply near active eagle nests in the vicinity of harvest activities to minimize disturbance to eagles or the abandonment of nests.

Renewable energy and transportation project development can affect bald eagles directly during construction through disturbance and through habitat removal or alteration. During operation, electrocution with powerlines and/or collisions with project structures are a potential risk. The proposed Forest-wide Renewable Energy and Transportation Systems Corridors standards and guidelines under Alternatives 2, 3, 4, and 5 do not directly address this species; however, they do specify consideration of the most current science, guidance, and methodologies related to avoiding and minimizing wildlife impacts. This would include adherence to the MBTA, Bald and Golden Eagle Protection Act, and guidelines such as APLIC standards for transmission lines (EEI et al. 2006). These measures would minimize impacts to bald eagles and their habitats during project construction and operation.

Red Squirrel, Red-breasted Sapsucker, Hairy Woodpecker, and Brown Creeper

These species are associated with old-growth forest and extensive quality habitat is protected through the conservation system, particularly old-growth reserves and non-development LUDs. In the matrix, these species rely on legacy components (e.g., large diameter trees, snags) of the old-growth forest ecosystem for nesting and foraging. All of the alternatives would result in the removal of nesting and foraging habitat (POG forest; Tables 3.9-12, 3.9-13, and 3.9-14). Red-breasted sapsuckers are most closely associated with low-volume old-growth; whereas hairy woodpeckers and brown creepers are associated with high-volume and large-tree, respectively. Red squirrels are more versatile and will use young-growth stands as young as 40 years of age. Indirect effects to these species would be associated with fragmentation and the reduction in POG patch sizes. Fragmentation reduces the amount and effectiveness of interior old-growth forest habitat by creating habitat edges along which there may be increased rates of nest predation by avian predators (Kissling and Garton 2008). It is assumed that alternatives that harvest more POG would have greater effects to these species. The greatest amount of POG harvest would occur under Alternative 1, followed by Alternatives 5, 4, 3, and 2 (Table 3.9-9). Harvest of young-growth stands would have minimal fragmentation-related effects to these species because old-growth interior forest conditions preferred by these species would not be affected. However, connectivity for red squirrels could be locally reduced because this species may use mature young-growth stands that are suitable for commercial harvest.

Alternatives 2, 3, 4, and 5 propose modifications to OGRs that compensate for effects associated with the Sealaska land conveyance (see the *Biodiversity* section and Appendix E for additional discussion). The land conveyance removed portions of OGRs, decreasing the amount of red squirrel, red-breasted sapsucker, hairy woodpecker, and brown creeper habitat (total POG) within the reserve system. The proposed modifications to the existing (i.e., post-conveyance) OGRs would result in a net increase of 7,148 acres of POG forest included in the reserve system (Appendix E). These modifications would result in

greater protection of habitats used by these species under the Conservation Strategy than would occur as a result of the land conveyance without these changes.

Alternatives 1, 2, 3, 4, and 5 would incorporate the Legacy Forest Structure standards and guidelines which are intended to maintain old-growth structure in areas that are already highly developed, as well as areas that will experience increased harvest levels over the life of the Forest Plan. These components (large trees and snags) may provide nesting and foraging habitat for the red-squirrels, red-breasted sapsuckers, hairy woodpeckers, and brown creepers. Alternatives 2, 3, 4, and 5 include a proposed clarification that the list of VCUs where the Legacy Forest Structure standards and guidelines apply should be verified during project-specific planning and analysis. Alternatives 3 and 4 also include a new management approach for these standards and guidelines to indicate that when implementing young-growth harvest projects larger than 20 acres in VCUs that have received concentrated past old-growth harvest it is intended that 30 percent of the young-growth stand acres should be left to retain residual trees to diversify structural characteristics and promote future recruitment of snags. Therefore, the proposed clarification would provide greater protection of habitats used by these species in managed forest stands

Renewable energy and transportation projects could affect red squirrels, red-breasted sapsuckers, hairy woodpeckers, and brown creepers during construction through direct disturbance or through removal or modification of habitats. During operation, the potential for collision with project structures is a risk. The proposed Forest-wide Renewable Energy and Transportation Systems Corridors standards and guidelines under Alternatives 2, 3, 4, and 5 do not directly address these species; however, they do specify consideration of the most current science, guidance (e.g., APLIC guidelines; EEI et al. 2006), and methodologies related to avoiding and minimizing wildlife impacts. These measures would minimize impacts to these species and their habitats during project construction and operation.

Vancouver Canada Goose

Vancouver Canada geese use wetlands (forested and non-forested) in the estuary, riparian, and uplands areas of the forest. Habitat needs for this subspecies are specifically provided for under the waterfowl standards and guidelines, which apply to specific sites, and a 100-foot buffer around lakes or streams. The beach, estuary, and riparian Forest-wide standards and guidelines provide additional protection to habitats used by Vancouver Canada geese. Alternatives that propose the most harvest of forested wetlands and that would allow young-growth harvest within the beach and estuary fringe and RMAs would result in the greatest loss of suitable habitat for this species. After full implementation of the Forest Plan (100 years), the greatest effects to forested wetlands would occur under Alternative 1 (28,923 acres), followed by Alternatives 2 (28,681 acres), 5 (28,265 acres), 3 (28,142 acres), and 4 (26,305 acres); see *Wetlands* section for additional discussion. Young-growth harvest within beach and estuary fringe and RMAs are presented in Table 3.9-13 and discussed above under Black Bear. Alternative 2 would have the greatest effects to habitats used by geese, followed by Alternatives 3, 4, and 5; no harvest in the beach and estuary fringe or RMAs would occur under Alternative 1.

Renewable energy and transportation projects could affect the Vancouver Canada goose during construction through direct disturbance or through removal or modification of habitats. During operation electrocution and collision with project structures is a risk. The proposed Forest-wide Renewable Energy and Transportation Systems Corridors standards and guidelines under Alternatives 2,

3, 4, and 5 do not directly address this species; however, they do specify consideration of the most current science, guidance (e.g., APLIC guidelines; EEI et al. 2006), and methodologies related to avoiding and minimizing wildlife impacts. This would include adherence to the MBTA. These measures would minimize impacts to Vancouver Canada geese and their habitats during project construction and operation.

Other Species

Migratory Birds

All of the alternatives would result in a reduction of perching, foraging, and potential nesting habitat and the increase in fragmentation associated with timber harvest and road building. After timber harvest, there would be a short-term increase in the habitat for species associated with early successional habitats and forest edges, which may result in short-term population growth for these species. However, extended local reductions in available habitat would be expected as forest succession progresses. Habitat removal would reduce the effectiveness of interior forest habitat, and increase the potential for nest predation and nest parasitism for some species, which can ultimately reduce reproductive success (Robinson et al. 1995). Migratory birds would be most susceptible to impacts from harvest activities occurring in suitable nesting habitat during the nesting/fledging period, which generally begins in mid-April and ends about mid-July, when young birds have fledged.

The migratory bird species most likely to be adversely affected by the harvest of POG forest under all of the alternatives are those that primarily nest in POG forests, including the Western screech-owl, rufous hummingbird, red-breasted sapsucker, Pacific-slope flycatcher, Steller's jay, northwestern crow, chestnut-backed chickadee, golden-crowned kinglet, varied thrush, Townsend's warbler, blackpoll warbler, northern goshawk and marbled murrelet. Alternatives that harvest more POG and result in greater increases in the number of POG patches on the landscape would be expected to have greater effects to these migratory bird species. The greatest amount of POG harvest would occur under Alternative 1, followed by Alternatives 4, 5, 3, and 2 (Tables 3.10-8, 3.9-12, 3.9-13, and 3.9-14). However, species associated with early successional or scrub habitats such as the MacGillivray's warbler, golden-crowned sparrow, and golden-crowned kinglet would benefit through increases in suitable habitat over the short- to mid-term from timber harvest. All migratory bird species would benefit from the transition to young-growth harvest proposed under the action alternatives due to the reduced long-term scheduling of POG harvest.

At the project level, effects to migratory birds can be minimized by altering the season of activity, retaining snags, maintaining the integrity of breeding sites, considering key winter and migration areas, and minimizing pollution or detrimental alteration of habitats (USDA Forest Service 2008c). Under all alternatives, migratory bird habitat would be maintained by the Forest Plan Conservation Strategy. Alternatives 1, 2, 3, 4, and 5 include the Legacy Forest Structure standard and guideline that protect habitat features that are important for migratory birds on a stand level. Alternatives 2, 3, 4, and 5 include a proposed clarification that the list of VCUs where the Legacy Forest Structure standards and guidelines apply should be verified during project-specific planning and analysis. Alternatives 3 and 4 also include a new management approach for these standards and guidelines to indicate that when implementing young-growth harvest projects larger than 20 acres in VCUs that have received concentrated past old-growth harvest it is intended that 30 percent of the young-growth stand acres should be left to retain residual trees to diversify structural characteristics and promote future recruitment of snags. These clarifications would benefit

migratory birds by maintaining forest structural components (dead trees and snags) in managed stands.

Alternatives 2, 3, 4, and 5 propose modifications to OGRs that compensate for effects associated with the Sealaska land conveyance (see the *Biodiversity* section and Appendix E for additional discussion). The land conveyance removed portions of OGRs, decreasing the amount of POG forest within the reserve system and used by many species of migratory bird species for nesting and foraging. The proposed modifications to the existing (i.e., post-conveyance) OGRs would result in a net increase of 7,148 acres of POG forest included in the reserve system (Appendix E). These modifications would result in greater protection of habitats used by migratory birds under the Conservation Strategy than would occur as a result of the land conveyance without these changes.

Renewable energy and transportation projects could affect migratory during construction through direct disturbance or through removal or modification of nesting habitats. During operation collision with project structures is a risk. The proposed Forest-wide Renewable Energy and Transportation Systems Corridors standards and guidelines under Alternatives 2, 3, 4, and 5 do not directly address migratory birds; however, they do specify consideration of the most current science, guidance (e.g., APLIC guidelines; EEI et al. 2006), and methodologies related to avoiding and minimizing wildlife impacts. This would include adherence to the MBTA. These measures would minimize impacts to migratory birds and their habitats during project construction and operation.

Marbled Murrelets

Marbled murrelets nest in structurally complex old-growth forest stands (Piatt et al. 2007). As a result, timber harvesting and road construction within POG forest stands (especially high-volume POG) can remove nest trees or disturb nesting birds. Indirectly, timber harvest and road building increase fragmentation, reducing the effectiveness of interior forest habitat and creating habitat edges along which there may be increased rates of nest predation by avian predators. Alternatives that harvest the most POG forest would be expected to have the greatest direct and indirect effects to marbled murrelets (Tables 3.9-12, 3.9-13, and 3.9-14). The greatest amount of POG harvest would occur under Alternative 1, followed by Alternatives 5, 4, 3, and 2 (Table 3.9-9). Under all alternatives, marbled murrelet nesting habitat would be protected by the Forest Plan conservation strategy.

The transition to young-growth harvest would benefit this species through the retention of a greater amount of POG forest on the landscape over the planning horizon. Moreover, many of young-growth trees harvested would be of insufficient size to be suitable for nesting. Additionally, harvest of young-growth stands would have minimal fragmentation-related effects to this species because old-growth interior forest conditions preferred by this species for nesting would not be affected.

Alternatives 2, 3, 4, and 5 propose modifications to OGRs that compensate for effects associated with the Sealaska land conveyance (see the Biodiversity section and Appendix E for additional discussion). The land conveyance removed portions of OGRs, decreasing the amount of marbled murrelet habitat (total POG) within the reserve system. The proposed modifications to the existing (i.e., post-conveyance) OGRs would result in a net increase of 7,148 acres of POG forest included in the reserve system (Appendix E). These modifications would result in greater protection of habitats used by marbled murrelets under

the Conservation Strategy than would occur as a result of the land conveyance without these changes.

Alternatives 1, 2, 3, 4, and 5 would incorporate the Legacy Forest Structure standards and guidelines which are intended to maintain old-growth structure in areas that are already highly developed, as well as areas that will experience increased harvest levels over the life of the Forest Plan. These components (large trees and snags) may provide nesting habitat for marbled murrelets. Alternatives 2, 3, 4, and 5 include a proposed clarification that the list of VCUs where the Legacy Forest Structure standards and guidelines apply should be verified during project-specific planning and analysis. The proposed clarification would provide greater protection of habitats used by marbled murrelets in managed forest stands

Renewable energy and transportation projects could affect marbled murrelets during construction through direct disturbance or through removal or modification of habitat. During operation, the potential for collision with project structures is a risk. The proposed Forest-wide Renewable Energy and Transportation Systems Corridors standards and guidelines under Alternatives 2, 3, 4, and 5 do not directly address this species; however, they do specify consideration of the most current science, guidance (e.g., APLIC guidelines; EEI et al. 2006), and methodologies related to avoiding and minimizing wildlife impacts. These measures would minimize impacts to marbled murrelets and their habitats during project construction and operation.

Bats

All bat species known to occur in southeast Alaska are associated with mature forested habitats which provide roosting, breeding, and foraging sites, and bat activity appears rare in young-growth forest (ACCS 2016). Old-growth timber harvest would remove POG, thereby reducing the number of potential day-roosts available to tree-roosting bats and foraging habitat. Indirectly, timber harvest may also reduce the suitability remaining roosting habitat through increased fragmentation (and decreased patch sizes) as day-roosts are more likely to be selected for some species (e.g., Keen's myotis and silver-haired bat) if they are located in stands with a higher number of trees in early to late decay stages (Boland et al. 2009).

Therefore, alternatives that harvest the most POG would be expected to have the greatest effect to the bats. The greatest amount of POG harvest would occur under Alternative 1, followed by Alternatives 4, 5, 3, and 2 (Tables 3.10-8, 3.9-12, 3.9-13, and 3.9-14). However, it should be noted tree-roosting species may choose a large-diameter tree for roosting regardless of whether or not it is located in an area with past timber harvest (Boland et al. 2009). Habitat and landscape connectivity would be provided for these species by the Forest Plan conservation strategy.

Amphibians

Amphibians require both aquatic and terrestrial habitats in order to complete their life-cycle. Ponds, streams, and wetlands used by amphibians for breeding are protected by Forest Plan Riparian and Wetland standards and guidelines. However, increased sedimentation and the entry of contaminated run-off from roads resulting from timber harvest (both young-growth and old-growth) can reduce the quality of these habitats. Under all alternatives, standard BMPs for water quality would be implemented to minimize these effects (see the Fisheries section for additional discussion).

Amphibians have very limited physiological mechanisms for preventing water loss, and therefore require relatively cool, moist forested habitats, in conjunction with underground refuges or coarse woody debris to maintain high moisture levels (Semlitsch et al 2009). Timber harvest (both old-growth and young-growth) has the potential to result in the loss and/or degradation of terrestrial habitats through changes in microclimates, soil compaction, and leaf litter disturbance. Tree canopy removal increases solar radiation to the forest floor, resulting in changes in moisture and soil temperatures which can make terrestrial habitats unsuitable for amphibians. Thinning or uneven-aged harvest techniques may reduce these effects.

Amphibians also possess small home ranges and relatively limited dispersal capabilities compared to other wildlife species. Therefore, timber harvest (both old-growth and young-growth) can affect the interchange between populations if harvest units do possess suitable microclimates or habitat features (e.g., course woody debris) for amphibians to cross. Likewise, road development can preclude amphibian movement and can also result in direct mortality to adults moving between breeding and upland terrestrial habitats.

The effects of specific harvest treatments on amphibians is complex. Some amphibians in the aquatic stage may be affected positively by even-aged harvest techniques (clearcutting), whereas effects of these treatments on juvenile and adult terrestrial stages are mostly negative (Semlitsch et al. 2009). Moreover, uneven-aged (partial) harvest treatments have been shown to produce both positive and weaker negative responses than even-aged treatments. Therefore, it is assumed here that alternatives that propose the most total POG harvest, regardless of treatment, would have the greatest potential for adverse effects to amphibians, as these forest stands provide optimal habitat conditions for amphibians. The greatest amount of POG harvest would occur under Alternative 1, followed by Alternatives 4, 5, 3, and 2 (Tables 3.10-8, 3.9-12, 3.9-13, and 3.9-14).

Renewable energy and transportation projects could affect amphibians through direct disturbance or through removal or modification of habitats, particular if activities affect water bodies. The proposed Forest-wide Renewable Energy and Transportation Systems Corridors standards and guidelines under Alternatives 2, 3, 4, and 5 do not directly address these species; however, they do specify consideration of the most current science, guidance, and methodologies related to avoiding and minimizing wildlife impacts. These measures would minimize impacts to amphibians and their habitats during project construction and operation.

Endemism

By definition, endemic species occur in isolated populations and many have limited mobility or specific habitat requirements. Thus, they are vulnerable to the effects of habitat loss and fragmentation, introduced non-natives, pathogens and disease, natural events (i.e., climate change), and overharvesting (Dawson et al. 2007). Therefore, the ability to disperse and recolonize is an important factor in how endemic species are able to respond to environmental changes.

Timber harvest and road construction/reconstruction proposed under all alternatives would directly affect endemic species through habitat loss (POG) and fragmentation (reduced patch size), and by altering the distribution of habitats across the landscape. This may inhibit the ability of individuals to move between patches of suitable habitat, and therefore may further limit the distribution of a population or reduce genetic interchange between subpopulations. These effects would occur to a less extent in association with young-growth harvest as these stands provide lower quality habitat to most

endemic species. Timber harvest by alternative is presented in Tables 3.10-8 and 3.10-9; landscape connectivity and fragmentation are discussed in detail in the *Biodiversity* section. Most endemic species would benefit from the transition to young-growth harvest proposed under the alternatives due to the reduced amount of scheduled POG harvest over the long term. Effects would be greatest under Alternative 1, followed by Alternatives 4, 5, 3, and 2 (ranging from most to least POG harvest over 100 years of Forest Plan implementation).

Alternatives 2, 3, 4, and 5 propose modifications to OGRs that compensate for effects associated with the Sealaska land conveyance (see the *Biodiversity* section and Appendix E for additional discussion). The land conveyance removed portions of OGRs, reducing connectivity between reserves and decreasing the amount of POG forest and other important habitat features (e.g., streams, low elevation POG forest, and large-tree POG stands) within the reserve system and used by endemic species (Appendix E). The proposed modifications to the existing (i.e., post-conveyance) OGRs would result in a net increase of 7,148 acres of total POG (including 6,696 acres of low-elevation POG and 3,066 acres of large-tree POG) and 31 Class I stream miles included in the reserve system (Appendix E). These modifications would result in greater protection of habitats used by endemic species, as well as greater connectivity between reserves and to the shoreline, under the Conservation Strategy than would occur as a result of the land conveyance without these changes.

Prince of Wales Flying Squirrel

A thorough analysis of this species occurred during the 1997 and 2008 Forest Plan efforts and results documented that the conservation strategy was functioning adequately to maintain the viability of this species in the planning area (USDA Forest Service 1997b, Appendix N; 2008b, Appendix D). Prince of Wales flying squirrels are closely associated with old-growth structural characteristics and are limited by their dispersal capabilities. Densities of flying squirrels are linked to structural features common in POG forests such as large-diameter downed woody debris, snags, and tall trees (Smith et al. 2004) and abundance has been shown to be reduced by forestry practices that influenced the structure or age of residual stands (Smith et al. 2011). Additionally, due to their gliding locomotion, forest openings resulting from timber harvest can act as dispersal barriers if flying squirrels are not able to traverse openings (Flaherty et al. 2008, 2010; Smith et al. 2011). This subspecies has a limited gliding range (approximately 250 feet), a distance substantially less than the average clearcut width (Flaherty et al. 2008). Fragmentation resulting from old-growth timber harvest has the potential to reduce the value of residual patches of old growth in the matrix if they become isolated from adjacent patches either by distance or habitat type (young growth). Old-growth timber harvest under all alternatives would reduce the quality and quantity of flying squirrel nesting, foraging, and denning habitat but effects would be expected to be greatest under alternatives that propose the most POG harvest (Table 3.10-8). Alternatives that harvest the most POG and result in the greatest increase in the fragmentation be expected to have the greatest effect to the Prince of Wales flying squirrel due to their limited dispersal capabilities. The greatest amount of POG harvest (and thus the greatest effects to this species) would occur under Alternative 1, followed by Alternatives 4, 5, 3, and 2. The Forest Plan Conservation Strategy would continue to maintain suitable old-growth habitat and provide landscape connectivity for flying squirrels.

Young-growth management proposed under Alternatives 2, 3, 4, and 5 (particularly commercial thinning) could benefit flying squirrels over the short-term by increasing canopy height and creating more open space in the midstory -

conditions which facilitate efficient gliding (Scheib et al. 2006). Over the long-term, commercial thinning would promote stand development toward conditions capable of supporting breeding flying squirrels and improve the functional connectivity between old-growth reserves (Smith et al. 2011).

Prince of Wales Spruce Grouse

Prince of Wales spruce grouse are associated with muskegs, high-volume POG, and mixed conifer (scrub) habitats but will also use young-growth forest (15-30 years following timber harvest) with a well-developed middle story. Because they are associated with microhabitats within POG forests, old-growth timber harvest would alter habitat availability for this species, though effects would change over time. Prince of Wales spruce grouse avoid young (less than 5 years) clearcuts presumably due to the presence of large amounts of debris that inhibit movement, increased exposure to predators, and lack of food. However, as the understory vegetation develops, peaking after 15 to 30 years, grouse likely benefit from increased berry production and cover for chicks (Russell 1999). After this, forest conditions become unfavorable to spruce grouse, characterized by canopy closure, high stem densities, and little understory vegetation due to reduced light which reduces the overall structural and horizontal diversity of the stand (USFWS 2010). These conditions can persist up to 150 years after even-aged timber harvest. Thus, old-growth timber harvest under all action alternatives would have a short-term benefit to grouse due to increased forage availability, followed by an extended period in which habitat conditions in harvested units would not be suitable. Young-growth harvest would provide similar short-term benefits to this species in the years following stand treatments. However, even-aged harvest of both old-growth and young-growth forest would initially (i.e., within the first 5 years after harvest) result in habitat patches unsuitable for spruce grouse, which may result in local impediments to movement. Due to their generally sedentary nature and preference for walking rather than flying, fragmentation due to old-growth and young-growth even-aged timber harvest can result in the isolation of local spruce grouse populations (i.e., if open areas are too large or forested patches are spread too far apart to enable spruce grouse to move between them). However, thinning and group selection treatments can promote the development of structural and horizontal diversity beneficial to grouse (Russell 1999).

Increased road densities associated with timber harvest (both young-growth and POG forest) could also adversely affect spruce grouse by increasing hunter access (USFWS 2010). None of the alternatives propose measurable increases in average WAA road densities and therefore would not be expected to result in increased harvest risk at the forest level. Localized increases in road densities would be managed through road closures and storage or decommissioning which would minimize the potential for increased harvest risk for spruce grouse over the long term.

Alternatives that harvest the most POG and result in the greatest increase in the fragmentation be expected to have the greatest effect to the Prince of Wales spruce grouse, due to their limited dispersal capabilities. The greatest amount of POG harvest, and thus the greatest effects to this species, would occur under Alternative 1, followed by Alternatives 4, 5, 3, and 2. The Forest Plan Conservation Strategy would continue to suitable habitat and provide landscape connectivity for spruce grouse.

Invasive Species

Although a number of non-native wildlife species have been accidentally introduced or deliberately transplanted in Southeast Alaska, the only species considered invasive (i.e., based on the definition that they cause harm to the

economy, environment, or humans) at the present time is the Norway rat. Elk in Southeast Alaska may be considered invasive in certain geographic areas due to their effects on habitat and competition with native species in areas where they were not intentionally introduced. None of the alternatives propose changes to the management of the Tongass in relation to invasive species and no invasive wildlife species are addressed under the Forest Plan Monitoring section or standards and guidelines. However, the Alaska Region of the Forest Service is currently developing an invasive species strategy that will apply the principles of prevention, early detection, control, and rehabilitation in cooperation with various agencies and partners.

Activities that create or enhance the habitats preferred by invasive species may facilitate range expansion. Timber harvest and associated management activities would occur under all alternatives, but would have no effect on the spread of Norway rats or elk.

Cumulative Effects

Activities that occur on other land ownerships within and adjacent to the Tongass have the potential to affect the overall context within which effects to wildlife are considered. Appendix C of this EIS provides a full list of all the projects considered in the cumulative effects analysis. Such reasonably foreseeable activities include, but are not limited to, timber harvest, residential development, mining, recreation and tourism, and road construction. Typically these activities have the potential to negatively impact wildlife populations through habitat conversion, fragmentation, and disturbance associated with road building, though some activities can have short-term or long-term beneficial impacts, depending on the species. Prediction of the future extent and intensity of such activities has a high degree of uncertainty associated with it on a Forest-wide basis over a broad time scale. This analysis is conservative in that it assumes harvest of all non-NFS lands over the planning horizon.

Many private lands in Southeast Alaska are already highly developed in terms of roading and timber harvest and are likely to experience a continuing decline in old-growth forest in the future. Therefore, the cumulative long-term trend within the Forest boundary under all alternatives is likely to be a decline in optimum habitat for most old-growth associated species, with non-NFS land contributing to this trend. Additionally, future land exchanges and conveyances (e.g., Mental Health Trust) have the potential to remove some lands from protection under the Conservation Strategy. The Forest Service would continue to evaluate opportunities to compensate for these losses by evaluating additional OGR modifications when these land exchanges or conveyances are implemented.

The transition to young-growth harvest on the Tongass would benefit wildlife species by reducing the overall amount of POG forest harvested over the planning horizon. Activities such as pre-commercial and commercial thinning would have both short-term (increased forage availability) and long-term (promotion of the development of old-growth forest stand characteristics) to wildlife species that use POG forests on the Tongass. The young-growth harvest proposed under Alternatives 2, 3, 4, and 5 would contribute to similar beneficial effects of ongoing young-growth management activities (e.g., restoration efforts and other forest thinning activities) on the Tongass, although effects under alternatives that allow commercial thinning would be delayed if stands are actively managed throughout the life of the Forest Plan. The following discussion addresses the effects of cumulative old-growth harvest resulting under the alternatives, with the transition to young-growth harvest proposed more aggressively under the action alternatives.

When combined with other management activities occurring on non-NFS lands, all alternatives would produce additional impacts (noted above) associated with

continued old-growth harvest to species for which this forest type is optimal habitat, such as goshawks, marten, mountain goats, red squirrel, red-breasted sapsucker, hairy woodpecker, brown creeper, marbled murrelets, and bat species. However, these declines in habitat (and associated effects such as fragmentation) would be lessened to some extent through the transition to young-growth harvest on NFS lands under Alternatives 2, 3, 4, and 5. Cumulative effects are anticipated to be the greatest under Alternative 1, which proposes the highest amount of POG timber harvest, followed by Alternatives 4, 5, 3, and 2 (i.e., cumulative effects would be least under the alternatives that propose the shortest transition from old-growth to young-growth harvest), and would be most evident in areas where timber harvest is concentrated. Tables 3.9-16, 3.9-17, and 3.9-18 in the *Biodiversity* section summarize the maximum long-term cumulative percent of the original total, high-volume, and large-tree POG that would be harvested in Southeast Alaska on all ownerships by biogeographic province by alternative. After 100 years of Forest Plan implementation, cumulative POG harvest levels on all lands of Southeast Alaska would maintain approximately 83 percent of the original (1954) total POG under Alternative 1. Cumulative harvest levels would be less under Alternatives 2, 3, 4, and 5 but would also maintain approximately 83 percent of the original total POG (Table 3.9-16).

Cumulative effects to modeled deer habitat capability under the alternatives would range from maintenance of 78 percent of the original level under Alternatives 1, 4, and 5 and slight increase to 79 percent of the original level under Alternatives 2 and 3 in 25 years; at 100 years, the current Forest Plan would maintain 77 percent of the original level whereas the alternatives would result in a slight increase, maintaining 78 percent of original levels (Table 3.10-16). WAAs with the greatest impacts under the alternatives are located in GMU 2 (Prince of Wales and surrounding island) where concentrated past timber harvest has occurred (see the Project Record for detailed information on interagency deer model analysis results by WAA). Thus each of the alternatives may result in local declines in the deer population, due to reduced habitat capability which could affect wolves and thus hunters and trappers, but less so than under the current Forest Plan due to the reduction in old-growth harvest. However, commercial thinning proposed under the action alternatives, in combination with ongoing and foreseeable thinning conducted various watershed restoration plans would mitigate these effects to some extent. The USFWS Alexander Archipelago wolf species status assessment concluded that assuming continuation of current land use trends, the GMU 2 wolf population is anticipated to decline by another roughly 8 to 14 percent of current levels over the next 30 years (USFWS 2015). Although this could result in gaps in wolf distribution within GMU 2, given that it comprises just 6 percent of the population range wide, impacts to the overall distribution in Southeast Alaska or to species viability are not expected (USFWS 2015).

Table 3.10-16
Relative Changes in Deer Habitat Capability (DHC) by Biogeographic Province by Alternative in 25 years and 100 years based on the Interagency Deer Habitat Capability Model (All Lands)

				Deer Habitat Capability By Alternative (% Original Habitat Quality Remaining)									
				Alt 1		Alt 2		Alt 3		Alt 4		Alt 5	
	Biogeographic Province	Original Deer Habitat Capability (Deer/mi^2)	Existing Deer Habitat Capability as % Original	25 yrs	100 yrs	25 yrs	100 yrs	25 yrs	100 yrs	25 yrs	100 yrs	25 yrs	100 yrs
1	Yakutat Forelands	13.6	84%	82%	79%	84%	79%	84%	84%	84%	84%	84%	84%
2	Yakutat Uplands	2.3	98%	97%	97%	98%	97%	98%	98%	98%	98%	98%	98%
3	East Chichagof Island	14.4	74%	73%	72%	74%	73%	74%	73%	74%	73%	73%	73%
4	West Chichagof Island	14.0	99%	99%	99%	99%	99%	99%	99%	99%	99%	99%	99%
5	East Baranof Island	8.3	81%	81%	81%	82%	81%	81%	81%	82%	81%	81%	81%
6	West Baranof Island	13.7	83%	83%	84%	84%	84%	84%	84%	83%	83%	84%	83%
7	Admiralty Island	18.3	92%	92%	92%	92%	92%	92%	92%	92%	92%	92%	92%
8	Lynn Canal	6.2	83%	83%	83%	83%	83%	83%	83%	83%	83%	83%	83%
9	North Coast Range	7.2	76%	76%	76%	76%	76%	76%	76%	76%	76%	76%	76%
10	Kupreanof/Mitkof Island	19.6	76%	76%	75%	77%	76%	77%	76%	76%	76%	76%	75%
11	Kuiu Island	27.7	88%	88%	89%	88%	88%	88%	88%	88%	88%	88%	88%
12	Central Coast Range	9.5	92%	92%	92%	93%	92%	93%	92%	92%	92%	92%	92%
13	Etolin Island	18.7	79%	77%	76%	79%	78%	79%	77%	78%	76%	78%	76%
14	North Central Prince of Wales	24.7	54%	53%	52%	55%	53%	55%	53%	54%	52%	54%	52%
15	Revilla Island/ Cleveland Peninsula	13.6	79%	79%	78%	79%	79%	79%	78%	79%	78%	79%	78%
16	Southern Outer Islands	31.8	81%	81%	80%	82%	81%	82%	81%	82%	80%	82%	80%
17	Dall Island and Vicinity	25.4	66%	66%	66%	66%	66%	66%	66%	66%	66%	66%	66%
18	South Prince of Wales	22.6	82%	82%	81%	82%	82%	82%	82%	82%	81%	82%	81%
19	North Misty Fiords	3.8	97%	97%	97%	97%	97%	97%	97%	97%	97%	97%	97%
20	South Misty Fiords	8.2	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%	100%
21	Ice Fields	0.8	93%	93%	93%	93%	93%	93%	93%	93%	93%	93%	93%
	Forest-wide	**11.8**	**78%**	**78%**	**77%**	**79%**	**78%**	**79%**	**78%**	**78%**	**78%**	**78%**	**78%**

Populations are threatened with extinction for a variety of reasons and habitat loss is recognized as an important threat (Pimm et al 1988; Wilcove et al. 1998). When habitat conditions represent the primary threat to persistence, the likelihood of a wildlife population persisting over time has been suggested to be related to some threshold level of habitat loss on the landscape (Fahrig 1997, 1999, 2003; Flather et al. 2002; Andren 1994). After reaching this threshold, the rate of population decline, and thus the likelihood of extinction, may increase (Haufler 2006). Reported threshold levels (percentage of habitat maintained on the landscape) range from 20 percent (Fahrig 1997) to 50 percent (Soule and Sanjayan 1998), depending in part on the dispersal capability of the species under consideration. No specific threshold has been determined for the Tongass; however, all of the biogeographic provinces on the Tongass would maintain at least 57 percent of the original (1954) POG after 100 years of Forest Plan implementation. Moreover, all of the action alternatives would maintain 80 percent or more of the original (1954) total POG forest in 18 of 21 biogeographic provinces over this period (Table 3.9-16).

However, there are portions of the Tongass where cumulative effects become more important due to the level of past harvest that has occurred. Specifically, the North Central Prince of Wales and Kupreanof/Mitkof Islands biogeographic provinces have experienced some of the highest reductions in original (1954) POG forest on the Tongass and are also where much of the young-growth suitable for commercial timber production is located (see the Suitable Land maps in the Map Packet that accompanies this EIS). Additional timber harvest (young-growth and POG forest), particularly when located adjacent to previously harvested areas, has a greater potential to result in localized reductions in landscape connectivity and gaps in species distributions in these more heavily harvested areas compared to portions of the Tongass that have less cumulative past timber harvest. These cumulative effects would be most likely to occur for species with very limited ranges (endemic species limited to individual islands or island groups such as the Prince of Wales flying squirrel, Prince of Wales spruce grouse) or with limited dispersal capabilities or dispersal capabilities that are dependent on certain mature forest structural characteristics (e.g., goshawks, amphibians, flying squirrels, spruce grouse).

Species with limited dispersal capabilities (i.e., flying squirrels and spruce grouse, which are also endemic species) are likely to be more sensitive to habitat loss and fragmentation than species with greater dispersal capabilities (i.e., goshawks, wolves, and brown bears; D'eon et al. 2002). Natural fragmentation of habitats can also affect the level of additional fragmentation that can be supported. The Forest Plan Conservation Strategy would continue to provide for extensive areas in reserves, distributed across the Forest. The Legacy Forest Structure and other standards and guidelines that retain POG forest in harvested areas (e.g., beach and estuary fringe, RMAs, and Scenic Integrity Objectives) would also ensure the maintenance of a functional and interconnected old-growth ecosystem on the Tongass. These features are important for species associated with shoreline and riparian habitats such as river otters, black bears, brown bears, bald eagles, and Vancouver Canada geese, These measures, particularly when implemented in areas that have experienced concentrated past harvest increase the likelihood that these landscapes will continue to provide the full range of matrix functions that support viable and well-distributed populations of wildlife species.

As discussed in detail in Appendix D, the alternatives that propose young-growth harvest in the beach and estuary fringes (Alternatives 2, 3, 4, and 5), RMAs (Alternatives 2 and 5), and old-growth reserves and/or other non-development LUDs (Alternatives 2, 3, and 5) all have the potential to affect the functioning of

these contributing elements of the Conservation Strategy. However, due to the scale and distribution of suitable young growth in these areas (see Appendix D and the Suitable Land maps in the Map Packet that accompanies this EIS) all of the alternatives have the potential to result in localized reductions in intactness and effectiveness of these areas in providing habitat and facilitating movement of wildlife across the landscape; however, all alternatives are expected to maintain the integrity of the conservation strategy as a whole and its ability to maintain viable and well-distributed wildlife populations across the Tongass. Viability associated with individual wildlife species is discussed in more detail below.

Additional effects, associated with the cumulative timber harvest described above, include road construction, which has the potential to impact wildlife species through habitat fragmentation especially migratory birds, amphibians, and other interior-forest associated species, and access-related disturbance (increased harvest risk especially for wolves, marten, and spruce grouse) and human-bear conflicts. Table 3.10-12 summarizes existing and proposed total (open and closed roads) cumulative road densities (all land ownerships included) by the proportion of WAAs within road density categories. Generally road densities on non-NFS lands are greater than those found on adjacent NFS lands. In addition, there are no road closure/access management restrictions in place on these lands to reduce effects to species sensitive to access provided by roads. Forest-wide cumulative total and open road densities (NFS and non-NFS lands) would increase by 0.11 to 0.12 miles per square mile above current conditions (Table 3.10-12). When taking only lands below 1,200 feet elevation into account, representative of low elevation habitats used be wolves and deer, Under the action alternatives Forest-wide cumulative total and open road densities (NFS and non-NFS lands) would increase by 0.04 miles per square mile, and between 0.21 and 0.23 miles per square mile above current conditions, respectively (Table 3.10-15).

All of the alternatives would result in vessel traffic and marine activity associated with LTF use and log transport, which would occur irregularly over the life of the Forest Plan (in association with individual old-growth and young-growth timber harvest projects as they are proposed). Therefore all of the alternatives would make a minor contribution to the existing potential for oil or fuel spills associated with existing vessel activity and bark accumulations near the LTFs to which marine and shoreline-associated species such as black oystercatchers, Aleutian terns, short-tailed albatrosses, humpback whales, and Steller's sea lions would be exposed. However, levels of marine activity are expected to remain within levels anticipated for the current Forest Plan (Alternative 1) under all of the action alternatives given that the 2008 Forest Plan assumed a level of old-growth timber harvest far greater than what has occurred (see Appendix D). Therefore, any marine activities associated with young-growth harvest have been accounted for. Furthermore, all activities at the project level would be conducted in accordance with Alaska Water Quality Standards under Section 401 of the Clean Water Act for log transfer facilities (ADEC 2011). These standards place restrictions on the types, quantities, and extent of discharges (including bark) to the marine environment and would limit the effects of the project on water quality. Therefore, very minor contributions to cumulative effects in the marine environment are anticipated under all of the alternatives.

Climate change may also contribute to cumulative effects. Warmer temperatures and decreased precipitation are anticipated to result in changes to vegetation and thus, the suitability of wildlife habitat, among other impacts (Haufler et al. 2010, Shanley et al. 2015; see *Climate and Air* section). Although many species may benefit (e.g., greater overwinter survival of deer, and thus a greater prey base for wolves, resulting from warmer winter temperatures during normal

years), habitat changes resulting from a longer growing season, wind, fires, insect infestations, and disease may have variable effects on others. The greatest concerns for wildlife populations in relation to climate change, however, are the weather extremes that can be expected to occur periodically (Haufler et al. 2010). Periodic severe winter snowfalls, which may seem counterintuitive given the general warming trend, are anticipated (SNAP 2010). These stochastic events would be of greatest concern for populations that are limited in number or distribution. The Forest Plan Conservation Strategy was designed to maintain a resilient old-growth forest ecosystem in the face of this uncertainty. The potential for contributions to climate change from continued old-growth timber harvest on the Tongass, which could indirectly affect wildlife species such as the Kittlitz's murrelet, is described in detail in Section 3.1 – *Climate and Air Quality*.

Wildlife Viability

A series of wildlife panel assessments were conducted to evaluate the likelihood that plan alternatives for the 1997 Forest Plan would maintain habitat sufficient to support viable and well-distributed populations of select wildlife species across the planning area over a 100-year horizon. Panel assessments were conducted for goshawks, wolves, marten, brown bears, marbled murrelets, and "other terrestrial mammals" (including endemic species such as the Prince of Wales flying squirrel). These species or species groups were selected because collectively their ecologies were thought to incorporate the breadth of forest habitat features and other attributes of environmental variation represented across the Forest (Shaw 1999). They were also thought to be representative of species that are sensitive to disturbance and potentially at risk of either becoming locally extirpated or jeopardizing cultural or subsistence uses.

The 1997 Forest Plan wildlife panel assessments were conducted under the 1982 Planning Rule. Federal regulations for implementing the National Forest Management Act (USDA Forest Service 1982 [36 CFR 219.19:43048]) state: "Fish and wildlife habitat shall be managed to maintain viable populations of existing native and desired non-native vertebrate species in the planning area." A viable population was defined for planning purposes as "one which has the estimated numbers and distribution of reproductive individuals to insure its continued existence is well distributed in the planning area." Furthermore, "habitat must be provided to support, at least, a minimum number of reproductive individuals and that habitat must be well distributed so that individuals can interact with others in the planning area (USDA Forest Service 1997b, Appendix N).

The panel assessment process was designed to provide the context for, and guide the development of, the Forest Plan Conservation Strategy. Through each panel's evaluation, habitat conditions and/or management components (e.g., reserves, beach buffers) emerged as being important to providing sufficient habitat to maintain well-distributed, viable populations of each species or species group. The results of the panel assessments are included in Appendix N to the 1997 Forest Plan FEIS (USDA Forest Service 1997b) and summarized (and supplemented with new information) in Appendix D of the 2008 Forest Plan FEIS (USDA Forest Service 2008b).

Although the panel assessments do not directly address the alternatives evaluated in this EIS, the ability of the proposed Forest Plan Amendment to continue to maintain viable, well-distributed wildlife populations can be assessed based on two related premises. First, it can be assumed that if the integrity of the Forest Plan Conservation Strategy is maintained, there is a high likelihood that the Forest Plan Amendment would continue to provide habitat sufficient to support viable well-distributed wildlife populations and therefore maintain the

diversity of plant and animal communities. Second, if the Forest Plan Amendment maintains the key habitat factors identified as important to maintaining viability by the panel assessments for each species or species group, then there is a high likelihood that the Forest Plan Amendment would be at least as likely as the current Forest Plan to maintain viable, well-distributed populations of these species or species groups in the planning area.

A detailed analysis of the Forest Plan Conservation Strategy, indicating that none of the alternatives would compromise its integrity, is included in Appendix D of this EIS. Therefore, this topic is not discussed further here. The following discussion focuses on the key factors that formed the basis for the conclusions drawn in the 1997 Forest Plan panel assessments in relation to the proposed Forest Plan Amendment.

The transition to young-growth harvest proposed in the action alternatives would have a beneficial effect to wildlife species associated with old-growth forest by reducing the amount of old-growth timber harvest that would occur over the planning horizon. When developed for the 1997 Forest Plan, the Conservation Strategy was based on an assumed initial old-growth timber harvest rate of about 83,400 acres per decade. Over a period of 100 years (1996 to 2095), approximately 474,000 acres would be harvested. In contrast, the actual area harvested from 1996 to 2015 plus the projected harvest of old-growth through 2095 under each of the alternatives would result in a total of 70,300 to 100,500 acres of old-growth harvest. Thus, the transition to young-growth harvest, together with other changes to Tongass forest management (especially the 2001 Roadless Rule), would result in between 373,500 and 403,700 acres of old-growth forest remaining in 2095 that was projected to have been harvested by the panels assessing viability for the 1997 plan (see Appendix D for additional discussion). Therefore, many OGRs and non-Development LUDs would be surrounded by additional unharvested areas of POG forest and matrix lands would contain a substantially greater amount of POG forest than the amounts assumed during the development of the Forest Plan Conservation Strategy. Thus, panel assessment conclusions were based on assumptions that the Tongass would support far less old-growth forest than will be realized under the no action or any of the action alternatives.

For goshawks, the following were highlighted as important factors in maintaining a viable well-distributed population on the Tongass (2008 Forest Plan FEIS Appendix D, p. D-55-58; Iverson 1996a, 1997a)

- the amount and distribution of old-growth forest resulting from the reserve system together with the matrix, that is retained under maximum assumed harvest levels, was determined to be important for maintaining the distribution, persistence and habitat suitability for goshawks than the reserve system by itself, due to the wide-ranging nature of the species;
- the implementation of longer harvest rotations (100-200 years) to maintain forest structure sufficient to support prey populations and goshawk foraging (this is replaced by the substantial amount of unharvested POG under the current plan and alternatives);
- the implementation of additional measures for retaining POG in VCUs where more than 33 percent of the original POG had been harvested and where goshawk habitat had been highly fragmented (e.g., currently the Legacy standard and guideline); and

- the maintenance of POG within the beach and estuary buffers and RMAs to provide foraging and nesting habitat in the matrix, to support well-distributed populations across the planning area.

As noted above, all of the alternatives would maintain more POG within the matrix than the 1997 Forest Plan. This would likely outweigh the effects of increasing the harvest rotation (less than 100 years) in commercial young-growth stands, particularly because the harvested land base under these alternatives would be much less than assumed during development of the Conservation Strategy. Additionally, commercial young-growth harvest within the beach and estuary fringe (Alternatives 2, 3, 4, and 5) and RMAs (Alternatives 2 and 5) would be minor and localized. Forest-wide approximately 2.4 percent, 3.3 percent, 1.2 percent, and 0.4 percent of the forest land within the beach fringe consists of young-growth that would be harvested, under Alternatives 2, 3, 4, and 5, respectively (Table 6 in Appendix D of this EIS). Likewise, Forest-wide 0.3 to 6.7 percent of forest land within RMAs consist of young-growth that would be harvested, under Alternatives 2 and 5, respectively (Table 8 in Appendix D of this EIS). Moreover, the retention of TTRA buffers along streams, the provision under Alternative 2 to maintain a 1,000-foot corridor inland adjacent to shoreline harvest units, and the provision under Alternative 5 to maintain a 200-foot buffer along the shoreline would provide alternate low-elevation forested corridors which would maintain goshawk foraging habitat and reduce the likelihood of creating gaps in goshawk population distribution. At the project level, the extent of localized effects to goshawk habitat would be minimized through the implementation of Goshawk, Landscape Connectivity, and Legacy standards and guidelines which would help ensure that habitat components important to goshawks are maintained. For these reasons, all of the action alternatives would be expected to be at least as likely as the current Forest Plan to maintain a viable, well-distributed goshawk population on the Tongass.

For wolves, the following were highlighted as important factors in maintaining a viable well-distributed population on the Tongass (2008 Forest Plan FEIS Appendix D, p. D-63-65 Iverson 1996b, 1997b):

- the presence of large reserves to maintain roadless refugia (as a means of providing deer habitat capability and minimizing mortality risk by managing human access);
- the maintenance of deer habitat capability, particularly during winter, given its close link to wolf persistence; and
- the maintenance of demographic interchange among wolf packs to avoid gaps in distribution.

Large reserves (Old-growth Habitat and other non-development LUDs) would continue to function as roadless refugia for wolves under all action alternatives. None of the alternatives propose changes in the size or spacing of the reserve system or POG forest management (thereby maintaining deer habitat capability) within these areas. Although some alternatives propose young-growth harvest in the Old-growth Habitat LUD (Alternatives 2, 3, and 5) or other non-development LUDs (alternatives 2 and 3), these suitable young-growth stands are typically located along the shoreline or adjacent to existing road systems. Therefore, little change in wolf mortality risk due to increased road access in non-development LUDs is anticipated. Additionally, road densities (all LUDs considered) would remain comparable under all alternatives (see Wolf discussion above); therefore, at most, localized increases in hunter access would be expected under the action alternatives with no substantial increase across the Tongass.

Another important factor is related to the road development that was projected under the 1997 Forest Plan vs. what is projected under the current no action and action alternatives (see Appendix D). Under any of the alternatives, total road development on NFS lands is expected to be more than 2,000 miles less than that was projected to have been developed by the panels assessing viability for the 1997 Plan.

Under the current Forest Plan there would be a continued decline in deer habitat capability in some biogeographic provinces as a result of future POG harvest. However, this decline would be reduced under Alternatives 2, 3, 4, and 5 due to the transition to young-growth harvest. Therefore, the action alternatives would not be expected to affect the likelihood of wolf population persistence in the planning area. In GMU 2 where past harvest has been concentrated and where there are already concerns about wolf viability, any decline in deer habitat capability could result in localized gaps in wolf distribution. However, the recent USFWS Alexander Archipelago Wolf Species Status Assessment notes that, even with the anticipated continued decline in the GMU 2 wolf population, a viable population is still expected to be maintained in Southeast Alaska (USFWS 2015). With the transition to young-growth harvest, the likelihood of creating gaps in the wolf population in GMU 2 under the action alternatives is less than under the current Forest Plan. Therefore, all of the Action Alternatives would be expected to be at least as likely as the 2008 Forest Plan to maintain a viable, well-distributed wolf population on the Tongass.

For marten, the following were highlighted as important factors in maintaining a viable, well-distributed population on the Tongass (2008 Forest Plan FEIS Appendix D, p. D-59-63; Iverson 1996c, DeGayner 1997):

- The maintenance of late-seral forest and POG within beach and riparian zones for connectivity and prey diversity;
- The presences of large and medium reserves to provide roadless refugia for marten; and
- The implementation of other management measures to maintain habitat for marten within the matrix.

As noted above, all of the Action Alternatives would maintain more POG forest on the landscape than the current Forest Plan. Although commercial young-growth harvest within the beach and estuary fringe (alternatives 2 through 5) and RMAs (Alternatives 2 and 5) has the potential to reduce prey diversity and landscape connectivity for marten, effects would be minor and localized and would not be expected to result in gaps in the marten distribution (see discussion above for goshawks). Provisions under the alternatives including the retention of TTRA buffers along streams, a 1,000-foot corridor inland adjacent to shoreline harvest units (Alternative 2 only), and a 200-foot buffer along the shoreline (Alternative 5 only) would provide alternate low-elevation forested corridors which would maintain marten prey diversity and facilitate connectivity between reserves. At the project level, the extent of localized effects to marten habitat would be minimized through the implementation of Landscape Connectivity and Legacy standards and guidelines which would help ensure that connectivity and habitat components important to marten are maintained.

The effects of young-growth harvest within the reserve system (Alternatives 2, 3, and/or 5) would also be minor and localized. Forest-wide under all alternatives less than 3 percent of Old-growth Habitat LUD acres consist of projected young-growth harvest under all action alternatives. Likewise, Forest-wide less than 1 percent of other non-development LUD acres consist of projected young-growth

harvest (Tables 3 and 4 in Appendix D of this EIS). Moreover, suitable young-growth stands within the reserve system are typically located along the shoreline or adjacent existing road systems. Therefore, no change in the ability of the reserve system to provide roadless refugia from trapping for marten is anticipated under any of the action alternatives. For these reasons, all of the action alternatives would be expected to be at least as likely as the current Forest Plan to maintain a viable, well-distributed marten population on the Tongass.

The Prince of Wales flying squirrel was identified by the panel assessment as the greatest viability concern among endemic species and is representative of species with limited ranges and dispersal capabilities. The following were highlighted as important factors in maintaining viable, well-distributed populations of Prince of Wales flying squirrels and other endemic species on the Tongass (2008 Forest Plan FEIS Appendix D, p. D-68-73; Julin 1995, Iverson 1997c):

- the overall level of old-growth timber harvest proposed,
- the presence of a reserve system (particularly medium and large reserves) to support individual populations of flying squirrels;
- the maintenance of POG within the beach and estuary fringe and RMAs to retain structural components used by flying squirrels (e.g., snags and logs) and facilitate dispersal through the matrix, allowing flying squirrel populations within reserves to function as a metapopulation; and
- the removal of islands less than 1,000 acres from the timber base and the requirement to conduct surveys for endemic species on islands less than 50,000 acres (or in areas with a high likelihood of species presence).

None of the alternatives propose changes in the size or spacing of the reserve system or the management of POG forest within these areas, and as noted above under goshawks, young-growth harvest within the Old-growth Habitat LUD (Alternatives 2, 3, and 5) and other non-development LUDs (Alternatives 2 and 3) would have minor, localized effects. However, research suggests that many reserves on Prince of Wales Island may be too small or spaced too far apart to support populations of Prince of Wales flying squirrels over the long term, or maintain functional connectivity to support a back-and-forth exchange between flying squirrel populations (Pyare and Smith 2005, Smith et al. 2011). These findings emphasize the importance of matrix management in maintaining viable, well-distributed Prince of Wales flying squirrel populations under all alternatives.

Prince of Wales flying squirrel movement capabilities can be limited by localized matrix conditions and harvested stands (both young-growth and old-growth) can preclude the movement of individuals across the landscape. The current Forest Plan and the action alternatives would continue to allow some level of POG harvest, although as noted above the amount projected over the planning horizon is far less than the amount anticipated during the development of the Conservation Strategy, retaining more POG forest adjacent to and connecting reserves. Projected POG harvest would be further reduced under the action alternatives through the transition to young-growth harvest. On Prince of Wales Island where past timber harvest has been concentrated, any additional old-growth and commercial young-growth harvest has the potential to result in localized gaps in distribution if clearings are too large or too dense for flying squirrels to cross. However, with the transition to young-growth harvest, the likelihood of creating such gaps in the Prince of Wales flying squirrel population is less than under the current Forest Plan due to the overall reduction in old-growth harvest. Therefore, all of the Action Alternatives would be expected to be

at least as likely as the current Forest Plan to maintain a viable, well-distributed Prince of Wales flying squirrel population on the Tongass.

For brown bears, the following were highlighted as important factors in maintaining a viable, well-distributed population on the Tongass (2008 Forest Plan FEIS Appendix D, p. D-65-67; Iverson 1996d, Meade 1997):

- the overall level of old-growth timber harvest proposed (due to the presence of clearcuts, road construction, and risks to salmon populations);
- the presence of large reserves for providing roadless refugia to brown bears (due to risks associated with hunting and defense of life and property mortality); and
- the maintenance of riparian habitat capable of sustaining salmon habitat and populations over time and providing sufficient forest cover to maintain important brown bear foraging and loafing areas.

As noted above, all of the Action Alternatives would maintain more POG forest on the landscape than the current Forest Plan, and none of the alternatives proposed changes in the size or distribution of reserves. As noted above under the discussion of marten, young-growth harvest within old-growth habitat reserves and other non-development LUDs would have minor, localized effects to habitat and would not preclude these areas from providing roadless refugia. Although commercial young-growth harvest in RMAs (Alternatives 2 and 5) would remove riparian habitats potentially used by brown bears, effects would be minor and localized (see the discussion under goshawks regarding the scale of effects) and the retention of TTRA buffers along streams would maintain salmon habitat as well as brown bear foraging and loafing sites. For these reasons all of the action alternatives would be expected to be at least as likely as the current Forest Plan to maintain a viable, well-distributed brown bear population on the Tongass.

For marbled murrelets, the following were highlighted as important factors in maintaining a viable, well-distributed population on the Tongass (2008 Forest Plan FEIS Appendix D, p. D-73-76; Smith 1996):

- the presence of large, contiguous blocks of high-volume, low-elevation old-growth forest to provide nesting habitat (interior forest habitat) and provide protection from predation (along forest edges); and
- the implementation of long forest rotations (more than 200 years) to allow the development of suitable marbled murrelets habitat.

As noted above, all of the action alternatives would maintain more high-volume old-growth forest within the matrix, and thus more interior forest nesting habitat suitable for marbled murrelets, than the current Forest Plan. This would likely outweigh the effects of increasing the harvest rotation (less than 100 years) in commercial young-growth stands which would delay the development of suitable marbled murrelets habitat, particularly because the harvested land base under these alternatives would be much less than assumed during development of the Conservation Strategy. Therefore, all of the action alternatives would be expected to be at least as likely as the current Forest Plan to maintain a viable, well-distributed marbled murrelet population on the Tongass.

Human Uses and Land Management

Lands Uses, Ownership, and Adjustments

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Affected Environment

This section addresses land ownership administration and adjustments and special uses of Tongass National Forest System (NFS) lands. Transportation and mineral uses are discussed in other sections. Adjustment of land ownership within the Tongass boundaries can occur through congressionally mandated conveyances, exchanges, and acquisitions, or through Forest Service administrative activities. Authorized non-recreation special uses on the Tongass include industrial and commercial uses, such as commercial fishing camps, powerlines, communications sites, and a variety of other uses. The *Recreation* section of this Final Environmental Impact Statement (FEIS) addresses recreation special uses. Appendix E in the Tongass Land and Resource Management Plan (Forest Plan) lists approved communications sites on the Tongass.

The exterior boundary of the Tongass National Forest established by Congress includes varied land ownership patterns of non-federal ownership. Table 3.11-1 shows the acreage by ownership type within the exterior boundary.

Table 3.11-1
Land Ownership Distribution, Tongass National Forest[1]

Ownership Type	Acres	Percent of Total
Federal/Forest Service administered[2]	16,720,000	93.4
State of Alaska[3]	296,000	1.7
Local Governments	45,000	0.3
Native Regional Corporation (Sealaska)	363,000	2.0
Native Village Corporations	292,000	1.6
Private Owners and Unknown	190,000	1.1
Total	17,906,000	100

[1] Table indicates calculated ownership of total acreage within the exterior boundary of the Tongass National Forest. Acreages have changed since 2008 due to land adjustments, refinement of GIS mapping, the Sealaska land conveyance, and other transfers.
[2] Figure includes 296 acres administered by other federal agencies. Figure includes lakes surrounded by NFS lands.
[3] Figure does not include lakes surrounded by NFS lands.
Source: USDA Forest Service 2015 GIS data.

Land Ownership Adjustment

A number of land adjustments have occurred since the 2008 Forest Plan. Some lands have been conveyed from federal to other ownership, and these adjustments are documented on the Forest Plan Land Use Designation (LUD) map. Some lands have been acquired and become National Forest System lands during this period.

Most of these land adjustments were conveyances to the State of Alaska and Native corporations as authorized by the Statehood Act and the Alaska Native Claims Settlement Act of 1971 (ANCSA), as amended, and conveyances of Alaska Native Allotments as authorized by the Alaska Native Allotment Act of May 17, 1906 (43 Code of Federal Regulations [CFR] 1634, 34 Stat. 197, as amended). Parcels conveyed through land exchanges, a Small Tracts Act sale, and the disposal of two lighthouse reserves have also modified the Forest. Through land exchanges, purchases, and donations, the United States also acquired new lands for inclusion within the Tongass.

Legislated Alaska Conveyances

Land ownership status within the Tongass is complicated by ongoing land conveyances created under various federal legislation.

The Alaska Native Allotment Act of May 17, 1906, provided for Native individuals who had occupied lands prior to their designation as national forest to apply for conveyance of up to 160 acres, under conditions prescribed by the Act and federal regulations. As of August 2015, approximately 45 Native allotment cases on the Forest are pending adjudication by the Bureau of Land Management (BLM). This number could change by unknown circumstances by either quite title action, re-instatement applications, or new legislation proposals.

The Alaska Statehood Act of July 7, 1958 (Public Law 85–508, 72 Stat. 339, as amended) authorized the State of Alaska to select 400,000 acres of vacant and unappropriated land from within the Tongass and Chugach National Forests in Alaska, to further the development and expansion of Alaskan communities. To date, under this provision of the Statehood Act, the state has received title to approximately 256,150 acres located in the Tongass National Forest. Approximately 12,000 acres remain to be conveyed to the state on the Tongass National Forest.

The Alaska Native Claims Settlement Act of December 18, 1971 (ANCSA), (Public Law 92-203, 43 United State Code [USC] 1601, et seq.) as amended, was legislated, in part, to extinguish aboriginal land claims in Alaska in exchange for monetary compensation and conveyance of specified land entitlements to eligible Native Corporations and individuals. Thirteen (13) Regional Corporations were created and two hundred thirteen (213) Village Corporations. Section 16 of ANCSA, as amended, also known as the “Tlingit-Haida Settlement,” identified ten (10) villages entitled to select land entitlements of 23,040 acres each in Southeast Alaska across the Tongass National Forest. As of 2015, only four village corporations have not yet received land entitlements under Section 16 of ANCSA.

As of the current day, only four ANCSA Village Corporations on the Tongass have remaining entitlements under ANCSA, pending adjudication by the BLM. Those village entitlements are:

- Kake Tribal Corporation (Kake, AK) – Approximately 100 acres
- Kootznoowoo (Angoon, AK) – Approximately 20 acres under Section 506(a) of the Alaska National Interest Lands Conservation Act of 1980 (ANILCA) and 54 acres under Section 506(a)(5) of ANILCA
- Cape Fox (Saxman) – Approximately 180 acres
- Yak-Tat Kwaan (Yakutat, AK) – Approximately 40 acres

ANCSA also provided that the subsurface estate for any village or urban entitlement would be conveyed to the regional corporation.

In addition to the remaining village land entitlements depicted above, Section 14(h)(1) of ANCSA allows regional corporations fee title to existing cemetery, cultural, and historic sites. There are three remaining original 14(h)(1) applications pending adjudication by BLM on the Tongass under ANCSA. Title XXX, subtitle A, sec. 3002 of the Carl Levin and Howard P 'Buck' McKeon National Defense Authorization Act for Fiscal Year 2015 (Public Law 113-291) (hereafter referred to as the National Defense Authorization Act for Fiscal Year 2015), will allow Sealaska Regional Corporation an additional land entitlement of not more than 490 acres for cemetery sites and historical places under Section 14(h)(1) of ANCSA.

Section 14(h)(3) of ANCSA established four urban corporations, including Sitka and Juneau on the Tongass. Section 14(h)(8) of ANCSA established land entitlements and allocations to the regional Corporations. Only Sealaska Regional Corporation had a Section 14(h)(8) land entitlement in Southeast Alaska. Sealaska Regional Corporations' final land entitlement under Section 14(h)(8) of ANCSA was fulfilled in 2014; with the passage of the National Defense Authorization Act for Fiscal Year 2015.

The National Defense Authorization Act for Fiscal Year 2015 , amended ANCSA and provided Sealaska Regional Corporation final land entitlement under Section 14(h)(8) ANCSA entitlement. On March 9, 2015, Sealaska Corporation received its final ANCSA entitlement and conveyance of 69,585 acres. This law also amended Section 508 of ANILCA by adding eight LUD II areas, containing 152,000 acres. Additional actions to be finalized under the National Defense Authorization Act for Fiscal Year 2015 include negotiations with Sealaska Regional Corporation regarding reservations for public access under section 17(b) of ANCSA and road use agreements.

Potential Future Conveyances

In recent years there have been other formal and informal proposals that, if authorized, might result in the transfer of Tongass National Forest System (NFS) lands out of federal ownership. Several of these conveyance proposals are summarized below:

- **Unrecognized Southeast Alaska Native Communities Recognition and Compensation Act.** In March 2015, United States Senator Lisa Murkowski re-introduced a bill for the "Unrecognized Southeast Alaska Native Communities Recognition and Compensation Act." An Identical bill was introduced by House Representative Don Young in May 2015. This proposed legislation would amend ANCSA to permit the Native residents of each of the Native Villages of Haines, Ketchikan, Petersburg, Tenakee, and Wrangell to organize as Urban Corporations and to receive certain settlement land pursuant to this Act. The entitlement would consist of one township of land (23,040 acres) for each Alaska Native community (115,000 total acres), and require the conveyance of all roads, trails, log transfer facilities, leases, and appurtenances on or related to the land conveyed to the new urban corporations.

- **Alaska Natives Veterans Land Allotment Equity Act.** In May 2015, House Representative Don Young introduced the "Alaska Veteran Native Allotment Land Equity Act." An Identical bill was introduced in the Senate by Senator Dan Sullivan in August 2015. The proposed legislation includes a clause regarding approval of formerly rejected Native Allotment Cases (*Shields v. USA*, 698 F.2d 987, United States Court of Appeals, Ninth Circuit, 1983). If this were to become law, approximately 200 closed Native allotment cases

applied for under the 1906 Native Allotment Act could be approved, including many allotments on the Tongass. Native Allotment applications are 160 acres each. These allotments would become the private property of the original applicants or their heirs.

- **Alaska State Forest Proposal.** State officials or interests have at times advocated the establishment of an additional Alaska State Forest to be managed to provide income for state government programs. To date, no federal legislation to implement such a proposal has been introduced in Congress.

Land Disposal

Federal agencies responsible for administering public lands sometimes dispose of lands to other governments or private parties. Such disposals typically involve relatively small land parcels that have been determined to be "surplus" or "excess" property under federal property regulations.

The Forest Service Facility Realignment and Enhancement Act of 2005 (Public Law 109-54), as amended, authorizes a program for the conveyance of a limited number of excess Forest Service structures and associated administrative lands. The Tongass has used this program to excess and dispose of facilities and lands to reduce administration costs.

Additional real property disposal authorities include those under the Small Tracts Act and Townsite Act, and other special authorities.

Land Exchanges

Administrative land exchanges, in which NFS lands can be conveyed to another entity in exchange for lands of equal value, are another form of land ownership adjustment. Complex land exchanges are sometimes authorized by Congress through special legislation. In addition to the conveyances discussed above, the Forest Service has completed several land exchanges involving Tongass NFS lands. These adjustments are summarized below:

- Under the Kake Tribal Corporation Land Transfer Act of October 6, 2000, (Public Law 106-283), amended ANSCA directing the Forest Service to convey 1,389 acres of Tongass NFS lands (which had previously been selected by the State of Alaska) in the Jenny Creek area near Kake to the Kake Tribal Corporation. Public Law 106-283 also provided for transfer of 1,430 acres of land owned by the Kake Tribal Corporation and Sealaska Regional Corporation to the City of Kake, an exchange of the subsurface estate (mineral rights) for two areas (each of over 1,100 acres) between the Forest Service and Sealaska. Public Law 106-283 was enacted to provide protection and management of the Kake municipal watershed.

- Under the Hood Bay Land Exchange, the Forest Service received a 54-acre parcel that had formerly been a private inholding within Admiralty Island National Monument and the Kootznoowoo Wilderness (USDA Forest Service 2006b). The United States conveyed and relinquished all reversionary interests on 144 acres of land at Sitka to the Alaska Pulp Corporation.

- Through an exchange with the Kennecott Greens Creek Mining Company, Inc., the Forest Service received one 50-acre parcel within the Misty Fiords National Monument Wilderness and two parcels totaling approximately 139 acres within Admiralty Island National Monument Kootznoowoo Wilderness

(USDA Forest Service 2006b). The United States conveyed the subsurface mineral estate on 7,301 acres at Hawk Inlet/Young Bay on Admiralty Island.

In 2007, the Alaska Mental Health Trust Authority proposed an equal value land exchange with the Forest Service. The proposal included approximately 18,000 acres of non-federal lands in scenic backdrops surrounding the communities of Juneau, Sitka, Petersburg, Wrangell, Meyers Chuck, and Ketchikan in exchange for NFS lands on Prince of Wales Island near Naukati and Hollis, and Shelter Cove near Ketchikan, Alaska. In April 2015, a Feasibility Analysis and Study was completed by Forest Service. On June 30, 2015, an Agreement to Initiate was signed by both parties. The agreement provides a roadmap to exchange land and is one of the first steps in a multi-year process.

Alaska's unique land laws and land patterns continually change the landscape, and stimulate discussions regarding potential future land exchanges between the Forest Service, Tribal and Native corporations, and other local entities on the Tongass.

Land Acquisition

Land ownership adjustments can also occur through the outright purchase of lands or the acceptance of land donations for inclusion in the Forest. Purchases typically involve small inholdings, always involve a willing seller, and usually involve parcels surrounded by designated wilderness or other sensitive resource lands.

In 2012, the Secretary of Agriculture announced that the Forest Service will dedicate funds from the Land and Water Conservation Fund to acquire the surface estate at Cube Cove, which is almost entirely surrounded by Admiralty National Monument and Kootznoowoo Wilderness. The 22,890-acre surface estate within the Admiralty Island National Monument and Kootznoowoo Wilderness would be purchased from Shee Atiká, Incorporated. The purpose of this acquisition is to conserve and enhance significant scenic, recreation, cultural, wildlife, and plant resources within National Monument and Wilderness and to protect wilderness values from development.

In addition to the acquisition of the surface estate at Cube Cove between the Forest Service and Shee Atiká Incorporated, the subsurface estate owner, Sealaska Regional Corporation, has expressed interest in exchanging the underlying subsurface estate at Cube Cove for other surface estate on the Tongass National Forest.

Withdrawals/Encumbered Areas

Withdrawals and encumbrances are other key aspects of land ownership administration. Withdrawal is the withholding of an area of federal land from settlement, sale, mineral location, or entry under some or all of the general land laws for the purpose of limiting activities under those laws in order to maintain public values in the area. In general, an encumbrance is a claim, lien, charge, or liability attached to and binding real property (Black 1979, as cited in USDA Forest Service 2003b). In the context of the Tongass, an encumbrance is a land claim of some type that removes NFS lands from the full range of Forest Service administrative functions.

The largest withdrawal action applies to the more than 5.7 million acres in designated wilderness areas, which are withdrawn from entry under the mining laws. Many of the administrative withdrawals date back several decades and

include withdrawals around lighthouse and light station sites, and a large number of power site withdrawals intended to preserve options for hydroelectric development.

The land conveyance processes established by ANCSA delineated areas of federal lands within which Native village corporation land selections were to be located. These areas, totaling an estimated 1.8 million acres (on the Tongass, were withdrawn and will likely remain encumbered in the land status records until all lands to which the Native corporations are entitled have been conveyed The BLM is still processing several thousand acres of NFS lands that were over-selected by Sealaska Regional Corporation, and Southeast village corporations.

Approximately 1,000 additional acres of NFS lands will be conveyed to non-federal parties under the Native Allotment Act, ANCSA, and ANILCA. The adjudication process and conveyances are initiated by the BLM, Alaska State Office.

Land Use Authorizations

Uses of NFS lands by individuals or entities other than the Forest Service can be authorized under a special use authorization, subject to applicable regulations found in 36 CFR 251. Generally, permits are issued for 10 years or less. Complex authorizations for uses such as hydroelectric projects may be issued for up to 50 years.

The demand for uses of NFS land within the planning area has grown since 2008 and is expected to continue to grow over the life of the approved Plan. The challenge for the Forest Service would be to accommodate lands and realty needs for community development, rights-of-way, easements, leases, and other permitted uses while minimizing adverse effects on, or conflicts with, other resources.

The number of permits fluctuates between 700 and 750. In August 2015, there were about 720 special use authorizations issued on the Forest. About 380 of these are land uses such as, but not limited to, communications sites, roads, certain cabins, aquatic farming activities, research, military training areas, and fish camps. About 235 of these are outfitting and guiding permits, and about 105 are other recreational uses, such as organizational camps, isolated cabins, and recreation events.

Communications and Other Electronic Sites

A communications or electronic site is an area of National Forest System land designated for telecommunication uses. These sites are characterized by antennas, electronic transmitters, equipment shelters, passive microwave reflectors, and a wide variety of electronic communication support equipment such as those listed in Forest Service Handbook 2709.11, Chapter 90. These uses of federal land are authorized by the Federal Land Policy and Management Act of 1976 (FLPMA) and the Telecommunications Act of 1996.

As of May 2015, there were 75 approved communications sites on the Tongass (see Appendix E of the Forest Plan). Most of the sites are authorized to private and public entities (such as Alaska Power & Telephone, and the City of Wrangell). Some sites are operated by other federal agencies, such as the United States Coast Guard, the Federal Aviation Administration, and the Forest Service.

The majority of sites are occupied by a single user but some sites have multiple users. All sites are currently open to more than one user if the need arises. Applicants for new communications uses will be encouraged to co-locate their

facilities at approved sites. This approach to communication site development could reduce the impacts associated with the proliferation of sites by reducing the number of sites.

Roads, Trails, and Rights-of-Way

Landowners are allowed reasonable access across NFS lands to their land under provisions of ANILCA and other federal laws. Easements are issued to the State of Alaska, Department of Transportation & Public Facilities (ADOT&PF) for state-managed highways. The Forest Service administered about 40 road, trail, and rights-of-way authorizations in 2015. The types include one railroad right-of-way, one ADOT&PF easement, 14 Forest Road and Trail Act easements, three FLPMA easements, and 21 FLPMA right-of-way permits.

In August 2005, Congress enacted Section 4407 of the Safe, Accountable, Flexible, Efficient Transportation Equity Act – A Legacy for Users (SAFETEA-LU) (Public Law 109-59), which states: "Notwithstanding any other provision of law, the reciprocal rights-of-way and easements identified on the map numbered 92337 and dated June 15, 2005, are hereby enacted into law." Public Law 109-59 is presented in the *Transportation* section.

In December 2015, the President signed a transportation bill (Fixing America's Surface Transportation Act, or "FAST Act") that amended Section 4407 of SAFETEA-LU to now read:

> "Notwithstanding any other provision of law, the reciprocal rights-of-way and easements identified on the map numbered 92337 and dated June 15, 2005, are hereby granted."

Hydroelectric Projects

There are 22 operating hydropower projects on or adjacent to the Tongass (Table 3.12b-1). Fifteen of those are under license from the Federal Energy Regulatory Commission (FERC), with most of those also under special use permit from the Forest Service and authorized under the FLPMA. As of September 2015, there are an additional 11 proposed renewable energy projects (Table 3.12b-3). Six of the 11 projects are FERC hydroelectric projects. The remaining five projects consist of three non-FERC projects (Angoon Hydroelectric, Tenakee Springs/Indian River, and Little Port Walter), one wave project (Yakutat Wave), and one geothermal project (Bell Island Geothermal). See the *Renewable Energy* section for additional information.

Recreation Permits

As of August 2015, the Forest Service administers 341 special use permits for recreation uses. These include 234 outfitter/guide permits, 63 isolated cabins, and 14 recreation residences. Isolated cabins and recreation residences, although similar in many ways, are managed differently because of the different authorities used to grant use and occupancy. Construction of new cabins is regulated by ANILCA. New cabins can only be permitted for administration of the unit or continuing an authorized use. Over time, national policy, in combination with the provisions of ANILCA (section 1303), will result in a decrease in the number of privately owned cabins on the public lands in Alaska.

Environmental Consequences

Direct and Indirect Effects

No significant environmental consequences within the Lands category are anticipated for any of the alternatives. The NFS land base is the same for all five alternatives, at just over 16.7 million acres. The five alternatives would not change the Forest boundary or how the Forest Service acquires or disposes of land. Changes to the land base may occur as a result of ongoing conveyance processes, or from future land exchange, disposal, and acquisition actions. If future changes to the land base are not legislated (i.e., legislated land conveyances or exchanges) and are deemed major federal actions, they would require preparation of an environmental impact statement. None of the alternatives incorporate any specific land adjustment that is unique to the alternative.

The Forest Service would continue land use and land adjustment activities under the Forest-wide standards and guidelines presented in Chapter 4 of the Forest Plan. Only administrative changes were made to Chapter 4 direction to correct clerical errors, to address conformance of the Forest Plan to new statutory or regulatory requirements, or to delete repeated direction where standards and guidelines referenced directives (Forest Service Handbook or Manual) and repeated the existing direction. .

The only material change in the standards and guidelines as they relate to lands is the removal of the Transportation and Utility System LUD under the action alternatives and creation of the new direction for Renewable Energy and Transportation Systems Corridors to be applied to existing LUDs. See the *Renewable Energy* and *Transportation* sections in this chapter. As presented in Chapter 2, lands suitable for timber production vary by alternative and new young-growth direction has been developed. While these changes and variations between the alternatives would affect how the land is managed, the boundaries of the Forest would not be affected.

Administration of special use authorizations would continue under all alternatives. The number of communications and other electronic sites on NFS lands under special use authorization has increased in recent years, and additional sites may be authorized. Increases in land uses for recreation purposes, rights-of-way, and other special uses are possible.

Each request for a special use authorization receives individual consideration and evaluation. Special use authorizations may be granted in the future, and the environmental impacts of those actions would be evaluated through site-specific project analyses. The Forest Service can assign terms and conditions to an authorization to address impacts. Special use authorizations generally apply to small, specific areas and activities that have limited impacts. Impacts from permitted activities cannot be predicted at a Forest wide level, would not vary among the alternatives, and are not likely to be significant. The addition of communication sites could help improve electronic signal coverage Forest-wide improving health and safety for all forest users.

Cumulative Effects

Appendix C in this FEIS describes the existing, proposed, and reasonably foreseeable future land adjustments considered in the cumulative effects analysis. Forest Service land use and land adjustment activities under the Forest Plan do not have the potential to create or contribute to significant cumulative effects. To the extent that special use authorizations increase in number and affected acreage, environmental effects from future authorizations would add to those of use and occupancies already in effect. As noted above, however, those effects are not likely to be significant.

In general, land ownership adjustments executed by the Forest Service are made in response to direction from others, primarily Congress through legislated land conveyances or exchanges. There have been transfers of federal lands in Southeast Alaska to other ownership since statehood (Public Law 85–508, 72 Stat. 339, enacted July 7, 1958). Most recently are the 70,075 acres transferred to Sealaska under Public Law 113-291.

No land ownership adjustments are proposed under any of the Forest Plan alternatives. The proposed Alaska Mental Health Trust land exchange, the Cube Cove land acquisition, and possible land exchange of the underlying subsurface estate at Cube Cove for other surface estate with the Sealaska Regional Corporation are considered reasonably foreseeable actions (see Appendix C for a complete list of past, present, and reasonably foreseeable actions considered.) Each of these actions would have a cumulative effect on the NFS land base within the Tongass if they were to occur.

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Transportation

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Affected Environment

There are three principal types of travel in Southeast Alaska: air, water, and ground. Historically, marine transportation has been the major method of moving freight and passengers; however, during the last several decades, air services have developed to serve the growing demand for rapid transportation between communities within Alaska and to the contiguous United States. Residents of the region are dependent on air and water transportation for travel between most communities, rather than roads or rail. A roaded transportation system has developed on National Forest System (NFS) lands, largely in support of timber harvesting but for the most part does not connect communities except on Prince of Wales Island.

Currently, air carriers are the primary transporter of long distance passenger traffic in the Southeast. Commercial jet service connects the communities of Juneau, Ketchikan, Sitka, Petersburg, Wrangell, and Yakutat (and Gustavus in the summer) and provides service outside of Southeast Alaska. Other communities are connected by air through air taxis, scheduled commuter flights and chartered flights. Angoon is the largest community in the state without a land airport (Alaska Department of Transportation & Public Facilities [ADOT&PF] 2014). A Draft Environmental Impact Statement (DEIS) evaluating development of an airport in Angoon was published in January 2015, and the Federal Aviation Administration is working internally through comments received from the public and agencies.

Regional Transportation System

Southeast Alaska relies on a “marine highway system” to augment its limited roads and highways. The ADOT&PF issued the Final Southeast Alaska Transportation Plan (SATP) in 2004 (ADOT&PF 2004). The 2004 SATP called for transitioning away from the long line ferries to a system of expanded roads and shuttle ferries to fill the gaps in the road network. The 2004 SATP also identifies 34 essential highway and utility corridors and requested they be reserved and incorporated into the Tongass Land and Resource Management Plan (Forest Plan). These corridors were incorporated into the Forest Plan in 2008.

A Draft SATP was published in June 2014 (ADOT&PF 2014). The Draft SATP includes the same 34 essential corridors and identifies two priority highway transportation projects which could be developed within the next 20 years: East Lynn Canal Highway (Juneau Access Project) and a road (with ferry segment) between Kake and Petersburg. The Draft SATP also identifies a road between Sitka and Warm Spring Bay on the east side of Baranof Island as a priority, but not likely to be developed within the next 20 years.

Three cities in Southeast Alaska are connected to the continental road system: Haines, Skagway, and Hyder. Several cities in Southeast Alaska are linked to Bellingham, Washington, via the Alaska Marine Highway and the Canadian community of Prince Rupert, British Columbia. In addition, several ferries connect communities on a daily, weekly or twice-weekly basis. Prince of Wales Island has the only road system in Southeast Alaska that interconnects island communities. Several possibilities exist for state highways that could connect some communities of Southeast Alaska to the continental road system. Several new internal corridors are also possible.

Because the ADOT&PF's Southeast Region lies largely within the Tongass National Forest's boundaries, many of the proposed road projects cross National Forest System (NFS) lands and require Forest Service easements. The proposed linkages for the East Lynn Canal Highway (Juneau Access Improvement Project), the Kake to Petersburg road, and the Sitka to Warm Spring Bay road cross NFS land.

In August 2005, Congress enacted Section 4407 of the Safe, Accountable, Flexible, Efficient Transportation Equity Act - A Legacy for Users (SAFETEA-LU; Public Law 109-59), which states: "Notwithstanding any other provision of law, the reciprocal rights-of-way and easements identified on the map numbered 92337 and dated June 15, 2005, are hereby enacted into law."

The ADOT&PF and Alaska Department of Natural Resources entered into a Memorandum of Understanding (MOU) with the Forest Service that established a framework and process for granting the reciprocal rights-of-way and easements.

The MOU provides for two types of easements to be granted by the Forest Service to the State. The first is an easement for highway and utility planning purposes (the D-1 easement). Attachment D of the MOU identifies 19 transportation and utility corridors, all but one of which is also in the 2004 SATP. The Whale Pass to Exchange Cove corridor on Prince of Wales Island is not included in the 2004 SATP. The Forest Service has granted the State's D-1 planning easements, with one exception, the Lynn Canal East easement involved in the Juneau Access Improvement Project litigation. The second easement is for the actual construction, operation, and maintenance of a highway and utility system (the D-2 easement) to be issued once the planning and permitting is complete.

On December 4, 2015, the President signed into law Public Law 114-94, Fixing America's Surface Transportation Act, or the FAST Act. This law amended Section 4407 of SAFETEA-LU by striking "hereby enacted into law" and inserting "granted". The Forest Service and the State of Alaska are in discussions as to how this may affect the MOU.

The State grants to the United States tideland easements for the 126 log transfer facilities identified in the MOU. These easements are necessary to ensure appropriate infrastructure and access exists to support the Forest Service timber program in Southeast Alaska. The Forest Service has received 66 out of 126 easements from the State thus far.

In the MOU, the State agreed that the United States, as an upland landowner, may, without written authorization from the State, construct, operate, and maintain 231 marine access points identified through the map numbered 92337. These marine access points allow the Forest Service and its permittees to provide public access to NFS lands and facilities without obtaining a permit or written authorization from the State. Marine access points may include facilities

such as docks, boat ramps, floats, buoys, anchors, breakwaters, boat haulouts, and similar improvements and facilities.

The Federal Highway Administration (FHWA) issued a Record of Decision (ROD) in 2006 approving a road on the east side of Lynn Canal from the current terminus of State Highway 7 to the Katzehin River. From there, shuttle ferries would continue to Haines and Skagway. Following legal challenges, the District Court found that the Environmental Impact Statement (EIS) was not valid and this decision was upheld by the Court of Appeals. In September 2014, the FHWA published a Draft Supplemental Environmental Impact Statement (SEIS) for the Juneau Access Improvement Project and is currently reviewing the comments received on the draft.

Other transportation facilities within Southeast Alaska include more than 300 marine facilities (docks, small boat harbors, refuge floats, and boat launch ramps), 12 major airports, approximately 35 seaplane bases or floats, and numerous heliports and airstrips (ADOT&PF 2004).

National Forest System Roads

NFS roads are constructed to provide access to NFS lands and are included in the Forest Development Transportation Plan (see Transportation Standards and Guidelines in Chapter 4 of the Forest Plan [USDA Forest Service 2008a]). They are NFS roads, as are other roads that are wholly or partially on NFS lands and are intended to be maintained for the long term. They are functionally classified as arterial (serving large land areas and usually connecting to public highways), collector (serving smaller areas, usually connecting to arterials or public highways), and local (terminal roads, may connect to any other type).

NFS roads are also managed by a system of maintenance levels, depending on their intended use and suitability for various types of vehicles. These levels range between level 1 (closed), level 2 (suitable for high-clearance vehicles), level 3 (suitable for passenger vehicles, rough surface), level 4 (suitable for passenger vehicles, smooth surface), and level 5 (suitable for passenger cars, dust free, possibly paved). Maintenance can include reconditioning the original road grading the road surface, cleaning roadside ditches, and removing vegetation that may encroach upon the road or block vision. Grading and other maintenance would generally take place more often on a maintenance level 4 road than on a level 3 road, and would be expected to occur less often on a level 2 road. Level 1 roads are left to a self-maintaining condition that requires little or no maintenance.

With the exception of a few administrative sites and campgrounds, most NFS roads are single lane, constructed with blasted quarry rock, and designed for off-highway loads. Typical collector and local roads are 14 feet wide with a rough gravel surface. Higher standard arterial roads are normally 16 feet wide, may have a smooth gravel surface, and are designed for speeds of up to 30 miles per hour. Travel speed on lower standard roads is often controlled more by surface roughness than by horizontal alignment or road gradient.

On the Tongass, the demand for roads has primarily been for access to timber resources. The maintenance and reconstruction requirements of the existing system depend mainly on the volume of timber hauled and, to a lesser extent, on recreational use. Future construction is anticipated to continue to be largely determined by the need to access timber resources. Currently, there are approximately 5,000 miles of roads on NFS lands, approximately 3,100 miles of which are not maintained for highway vehicles (maintenance level 1 and 2). There are another 3,660 miles of roads that are on non-NFS lands. Over half of the roads suitable for highway vehicles are connected to communities.

The steep, densely vegetated terrain of Southeast Alaska limits the use of typical off-highway vehicles (OHVs) such as four-wheelers and all-terrain vehicles to beaches, communities, road systems, braided river channels, and frozen or snow-covered areas. Most trails in Southeast Alaska do not lend themselves well to the use of such vehicles because of wet ground conditions that often necessitate the use of boardwalks. With the exception of a few specific areas, the Tongass has not experienced the kinds of resource damage typically associated with OHVs elsewhere.

In 2001, the Forest Service adopted a road management policy that requires the agency to maintain a safe, environmentally sound road network that is responsive to public needs and affordable to manage. The policy includes a science-based roads analysis process designed to help managers make better decisions on roads. The Forest completed a Forest-wide roads analysis for maintenance level 3, 4, and 5 roads in 2003.

Prior to 2005, the Forest was designated open to OHVs except for Wilderness, National Monuments, and Research Natural Areas. Site-specific closures were considered in specific locations where conflicts with other uses, public safety problems, or damage to resources could occur. The goal of OHV management is to ensure resource protection and public safety, minimize user conflicts, and provide diverse opportunities for Forest users.

In November 2005, the Forest Service adopted a final rule for managing motor vehicle use, including OHV use, on national forests throughout the United States (36 Code of Federal Regulations 212). Under this rule, the travel management plans designate a system of roads and trails for OHV use, and identify areas for cross country travel that are appropriate and do not cause resource damage. Annually, each unit prepares an updated Motor Vehicle Use Map (MVUM). The MVUM displays NFS routes (roads and trails) or areas designated as open to motorized travel. The MVUM also displays allowed uses by vehicle class (ex. highway-legal vehicles, vehicles less than 50 inches wide and motorcycles), seasonal allowances, and distance allowances, and provides information on other travel rules and regulations. Routes not shown on the MVUM are not open to public motor vehicle travel. Driving off of routes designated on the current MVUMs is prohibited with limited exceptions. District and Monument Access and Travel Management Plans were completed between November 2007 and September 2009. These Plans determined which unauthorized roads were incorporated into the Forest transportation system and which would be closed as funding became available.

Log Transfer Facilities

The transport of harvested timber from isolated islands in Southeast Alaska requires both land and water routes to reach processing facilities. Log transfer facilities (LTFs) are used to transfer logs to barges or rafts for towing. Over 100 LTFs exist on the Tongass. The MOU discussed above grants the Forest Service easements to use the 126 LTFs on state lands listed on Map 92337. Currently, there are 55 LTFs with active permits.

Transportation and Utility Systems in the Current Forest Plan

The 2008 Forest Plan applies the Transportation and Utility Systems (TUS) Land Use Designation (LUD) to the potential right-of-way corridors and associated uses for selected potential and existing transportation systems and utility corridors. These systems include state and federal highways, power lines of 66 kilovolt capacity or greater, and pipelines 10 inches or more in diameter, if they are a public utility. This LUD was intended to minimize potential conflicts, such as over-determining the appropriate visual quality objective, should development of any of these projects occur. With minimal exceptions, transportation and utility systems are allowed throughout the Tongass.

The 2008 Forest Plan identifies three types of areas related to TUS on the Tongass based on the existing LUDs: windows, which represent areas potentially available for energy development; avoidance areas; and exclusion areas. Avoidance areas are those LUDs in which development of energy projects is allowed when there is no feasible alternative. Exclusion areas preclude TUS. There are no exclusion areas on the Forest due to special authorities provided in Alaska National Interest Lands Conservation Act, Title XI.

Environmental Consequences

Direct, Indirect, Effects

The following discussions address the direct, indirect, and cumulative effects of the alternatives on the transportation infrastructure of Southeast Alaska. Analyses examine both the existing system and reasonably foreseeable changes.

Effects on the National Forest Transportation Road System

The total number of existing roads on NFS lands tend to overestimate total road miles because they include unauthorized roads, most of which are either decommissioned or are likely to be decommissioned. New road construction estimates are directly related to proposed timber harvesting; they are based on the maximum harvest levels projected for each alternative. These estimates are primarily based on the logging system and transportation analysis (LSTA) completed in 2007 for the majority of the mapped suitable lands on the Tongass (refer to the *Timber* section). Where suitable lands were not covered by the LSTA (primarily in portions of Alternatives 2, 3, and 4 where harvest would occur in LUDs that are currently considered not suitable), they were estimated using the ratio of road miles to suitable acres based on the LSTA by Value Comparison Unit. As shown in Table 3.12a-1, which displays the existing road miles and maximum anticipated road construction by alternative over the next 100 or more years, new road construction on NFS lands for each alternative ranges from 871 miles (Alternative 4) to 1,056 miles (Alternative 2).

Table 3.12a-1
Estimated Number of Road Miles (includes Decommissioned Roads) on All Lands within the Tongass Forest Boundary for Each Alternative after Full Implementation of the Forest Plan for 100 Years[1]

	Alternative					
Road Categories	**Existing**	**1**	**2**	**3**	**4**	**5**
Total New Miles on NFS Lands	0	944	1,056	1,020	871	994
Total Miles on NFS Lands	5,093	6,036	6,148	6,113	5,964	6,086
Total Miles on Non-NFS Lands[2]	4,258	6,593	6,593	6,593	6,593	6,593
Total Miles on All Lands	**9,351**	**12,629**	**12,741**	**12,705**	**12,556**	**12,679**

[1] Assumes full implementation of Forest Plan plus future non-NFS harvest.
[2] Assumes an increase of 2,335 road miles on non-NFS lands by state, private, and municipality interests, over 100 years. Annette Island is included because it is surrounded by areas within the Forest boundary.

Roads have the potential to affect fish habitat, soils, and water quality by increasing erosion and landslide potential, changing recreation settings and

opportunities, altering scenery, and increasing wildlife harvest. These types of effects are discussed in the subject resource sections of this chapter, as applicable. Under all alternatives, Best Management Practices would be implemented to protect water quality (see USDA Forest Service 2012b and 2006a).

Based on current practices, most new roads would be closed to motorized traffic once their initial use is over. These roads are built for silvicultural purposes under exemptions granted under Section 404(f)(1) of the Clean Water Act. The construction or maintenance of forest roads used for established silvicultural activities is exempt from regulation under Section 404 of the Clean Water Act. Roads constructed and maintained specifically for recreation or other uses do not qualify under this exemption (USACE 2004). Roads built under the Section 404 exemption should be closed following completion of silvicultural activities. The roads would either be decommissioned or placed in storage. Bridges and culverts may be removed (or culverts may be bypassed), erosion control measures would be applied as needed, and the roadbeds would be allowed to revegetate naturally.

In addition to typical maintenance that would accompany all alternatives, each alternative would result in reconstruction of a portion of the existing road system in each decade, primarily roads that have been placed in storage (maintenance level 1) or reconstructed roads. Estimates range from 1,315 miles under Alternative 1 to 1,790 miles under Alternative 2 (Table 3.12a-2). Reconstruction of a road maintains the original investment and makes the road suitable and safe for intended use. Reconstruction involves the rehabilitation of the original roadbed, and can include cleaning ditches, replacing drainage structures, re-installing bridges, and grading and shaping.

Table 3.12a-2
Estimated Miles of Road Construction and Reconstruction by Alternative after 100 Years[1]

	Alternative				
	1	**2**	**3**	**4**	**5**
New Road Construction	944	1,056	1,020	871	994
Roads Constructed over Decom. Roadbeds	428	600	566	445	527
Road Reconstruction[2]	887	1,191	1,129	900	1,058
Total Road Work (includes reconstruction)	**2,259**	**2,846**	**2,716**	**2,216**	**2,579**

[1] Assumes full implementation of Forest Plan at PTSQ levels. Includes adjusted road miles estimated to needed to harvest all scheduled timber in the alternative
[2] Estimated existing road miles that would need to be reconstructed.

Effects on Log Transfer Facilities

The effects of operation at LTFs are likely to be similar under all alternatives. Generally, effects would be somewhat proportional to the amount of harvest under each alternative, with Alternative 2 having the greatest volume of harvest over the next 25 years followed by Alternatives 3, 5, 4, and 1 with the least volume of harvest during this period. Guidelines for LTF siting, construction and operation, and monitoring are provided in Appendix G of the Forest Plan.

See the *Fish* section for a discussion of the effects of LTFs.

Effects on Off-Highway Vehicle Access

Access and travel management plans designate roads and trails for OHV use, and identify if any areas for cross country travel are appropriate and do not cause resource damage. The proposed alternatives would not affect this process. Alternatives 1, 2, 4, and 5 include only the roaded land base. Where young growth would be harvested in roadless areas under Alternative 3, access would be by helicopter or from the beach; no new roads would be developed in these roadless areas that would affect OHV access, unless the Tongass exemption to the Roadless Rule is reinstated.

Effects on Regional Transportation Opportunities

None of the alternatives would affect other regional transportation opportunities. No new Wilderness or LUD II areas are proposed under any of the alternatives. None of the alternatives proposes changing any of the currently roaded areas to LUDs that would not allow road construction, or road expansion.

Alternative 1

The existing TUS LUD included in the current Forest Plan would be maintained. This includes the transportation corridors covered by Public Law 109-59 and the subsequent MOU with the State. There would be no difference in how these corridors are currently managed. Under Alternative 1, the TUS LUD would be given priority over all underlying LUDs, including LUDs that do not typically allow road construction.

Wilderness, Non-wilderness National Monument, Research Natural Areas, Special Interest Area, Remote Recreation, Municipal Watershed, Old-Growth Habitat, Wild River, Scenic River, Recreational River, Experimental Forest, Minerals, and LUD II lands are identified in the current Forest Plan as TUS "Avoidance Areas."

Alternatives 2, 3, 4, and 5

Under Alternatives 2, 3, 4, and 5, the existing TUS LUD would be removed from the Forest Plan. Proposed new plan components for Transportation Systems Corridors (TSC) would replace the direction currently found in the Transportation and Utility System LUD. TSC plan components apply only to major road systems such as state and federal highways, railroads, and those identified by the State of Alaska in the current version of the SATP and applicable laws (for example, Section 4407 of Public Law 109-59, Title XI of the Alaska National Interest Lands Conservation Act, Public Law 96-487).

The purpose of the plan direction for TSC is to facilitate the availability of NFS land for the development of existing and future transportation systems. These components would apply to existing and proposed major transportation developments. When planning future transportation projects, these plan components would apply. Prior to this, all other applicable Forest Plan LUD direction would remain in effect. Proposed new plan direction includes goals, objectives, standards, guidelines, and management approaches for the protection of forest resources. With this amendment, the existing transportation and utility LUD and avoidance areas would be removed from the Forest Plan. TSC plan components (e.g., standards and guidelines to the Forest Plan) would take precedence over other Forest-wide and LUD-specific standards and guidelines (subject to applicable laws) where TSC are proposed or exist.

Cumulative Effects

Cumulative road miles projected for the next 100 years for each alternative are displayed in Table 3.12a-1, which includes roads on state land, lands owned by Native corporations, and other lands (including towns and cities) within the Forest boundary; and Table 3.12a-2, which includes roads that would be constructed over decommissioned roadbeds and reconstructed roads over the same period. The total road miles are likely to be an over-estimate because these numbers include existing unauthorized roads on NFS lands, most of which are expected to be decommissioned.

The road construction projected for non-NFS lands primarily includes roads needed for timber harvest, but also includes roads likely built to serve communities, such as the road on the east side of Lynn Canal from the current terminus of State Highway 7 to the Katzehin River. This road and other road corridors covered by Public Law 109-59 would, if developed, connect additional areas in Southeast Alaska to the continental highway system and improve transportation between communities.

There is considerable uncertainty concerning the future development of Southeast Alaska's road system. As stated above, the ADOT&PF has prepared a Draft SATP, and a Draft SEIS has been prepared for the Juneau Access Improvement Project. New roads linking communities and linking Southeast Alaska to the continental highway system would be expensive to build and maintain, and funds have yet to be approved for their construction. The 2004 SATP estimated in 2004 that the cost would be $1.8 billion over 20 years. Most of the funding was anticipated to come from the federal government. To date, there has been no commitment for this level of funding from either the state or federal governments.

Roads associated with timber harvest are based on the projected harvest for each alternative; therefore, they represent a maximum estimate. If new wood processing facilities and markets are not developed, especially for young-growth products, these levels of harvest are unlikely to occur and new road construction would be less than projected in Table 3.12a-1. There is also uncertainty concerning the funds to maintain the existing forest road network, to place existing roads into storage status, and to decommission roads that are no longer needed. Risks associated with inadequate funding include adverse effects to fish, water quality, and wildlife and increased safety hazards as older roads and stream crossings deteriorate.

Appendix C in this EIS describes of all the past, present, and reasonably foreseeable future actions considered in the cumulative effects analysis.

Renewable Energy

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Affected Environment

Water is everywhere in the Tongass National Forest, originating as rainfall and melting snow and ice. Increasingly, it is this plentiful water that is the focus of communities, utility companies, and developers. The water resources of the Tongass are a potential source of reliable and relatively inexpensive renewable energy.

Twenty-two operating hydroelectric projects are located either on National Forest System (NFS) lands or on adjacent state or private land. These projects have a total installed capacity of 216.9 megawatts (MW) and range in size from less than 1 MW to 78 MW in size (Table 3.12b-1).

Project proponents have filed permit applications with the Federal Energy Regulatory Commission (FERC) for about seven new or amended hydroelectric projects on the Forest, such as Sweetheart Lake, Soule River, Crooked Creek/Jim's Lake, and Swan Lake. Each of these new hydroelectric projects is within inventoried roadless areas (IRAs), with one located in Wilderness. Three additional projects (Little Port Walter, Tenakee Springs/Indian River, and Angoon Hydroelectric) are not under FERC jurisdiction. The Forest Service special use permit will be the authorizing document for these three proposed projects.

Other active proposed renewable projects on the Forest consist of a wave energy project (Yakutat Wave) and one geothermal project (Bell Island Geothermal).

In addition to proposals for new energy projects, there is ongoing work associated with existing hydroelectric projects. Forest Service involvement continues throughout the life of these projects with the implementation and monitoring of license terms and conditions and annual coordination meetings. Examples of existing operating projects on NFS lands include the Black Bear Lake, Blue Lake, and Goat Lake projects.

Table 3.12b-1
Existing Renewable Energy Projects

No. 1	Name	Type	Capacity (MW)	Date Online	Community Served
1	Goat Lake	Hydropower (Storage)	4.0	1997	Skagway and Haines
2	Dewey Lakes	Hydropower (Run-of-the-River)	0.9	1902	Skagway
3	Kasidaya Creek	Hydropower (Run-of-the-River)	3.0	2008	Upper Lynn Canal
4	Salmon Creek	Hydropower (Storage)	6.7	1913	Juneau
5	Gold Creek	Hydropower (Run-of-the-River)	1.6	1914	Juneau
6	Annex Creek	Hydropower (Dam/Reservoir)	3.6	1915	Juneau
7	Lake Dorothy	Hydropower (Dam/Reservoir)	14.3	2009	Juneau
8	Snettisham	Hydropower (Dam/Reservoir)	78.0	1979	Juneau and Douglas
9	Falls Creek	Hydropower (Run-of-the-River)	0.8	2009	Gustavus
10	Pelican	Hydropower (Run-of-the-River)	0.7	1941	Pelican
11	Blue Lake	Hydropower (Dam/Reservoir)	16.9	1961	Sitka
12	Green Lake	Hydropower (Dam/Reservoir)	18.6	1979	Sitka
13	Crystal Lake	Hydropower (Dam/Reservoir)	2.0	1920s	Petersburg
14	Tyee Lake	Hydropower (Lake tap)	20.0	1984	Wrangell, Petersburg, Ketchikan
15	Black Bear Lake	Hydropower (Lake tap)	4.5	1995	Prince of Wales Island
16	South Fork Black Bear	Hydropower (Run-of-the-River)	2.0	2005	Prince of Wales Island
17	Ketchikan Lakes	Hydropower (Dam/Reservoir)	4.3	2000	Ketchikan
18	Beaver Falls	Hydropower (Dam/Reservoir)	5.4	1947	Ketchikan
19	Silvis Lake	Hydropower (Dam/Reservoir)	2.1	1968	Ketchikan
20	Swan Lake	Hydropower (Dam/Reservoir)	22.4	1983	Ketchikan, Wrangell, Petersburg
21	Whitman Lake	Hydropower (Dam/Reservoir)	4.6	2014	Ketchikan, Wrangell, Petersburg
22	Gartina Falls	Hydropower (Run-of-the-River)	0.5	2015	Hoonah
		Total Installed Capacity	**216.9**		

[1] Four other hydropower projects – Hidden Falls Hatchery, Jetty Lake, Betty Lake, and Burnett Inlet Hatchery – on NFS lands supply power to fish hatcheries and are not included.
Notes: Prince of Wales Island includes the communities of Craig, Klawock, Hydaburg, Hollis, Kasaan, and Thorne Bay
Upper Lynn Canal includes the communities of Haines, Skagway, Klukwan, and Chilkat Valley
Sources: USDA Forest Service 2010; AEA and REAP 2013; AEA 2014; AEL&P 2014; AP&T 2014; Leavitt et al. 2008; SEAPA 2014

The existing transmission system in Southeast Alaska is limited. The electric systems in a few communities are currently interconnected. These may be summarized by region, as follows:

- Southeast Alaska Power Agency (SEAPA) Region—The SEAPA system connects Ketchikan, Petersburg, and Wrangell.
- Juneau Area—The Alaska Electric Light & Power (AEL&P) system connects Juneau, Douglas Island, Auke Bay, and Greens Creek.
- Prince of Wales Island—The Alaska Power & Telephone (AP&T) system connects the communities of Coffman Cove, Craig, Hollis, Hydaburg, Kasaan, Klawock, and Thorne Bay.
- Upper Lynn Canal Region—A separate AP&T system connects Haines and Skagway in the Upper Lynn Canal Region and is connected via an intertie to the existing Inside Passage Electrical Cooperative (IPEC) system that serves Klukwan and Chilkat Valley.

Many of the proposed projects include transmission lines that cross NFS lands. These include the Swan Lake-Lake Tyee Intertie Project, completed in 2009, and the Kake to Petersburg Transmission Line Intertie Project, which is undergoing National Environmental Policy Act (NEPA) review; the Draft Environmental Impact Statement (DEIS) was released in December 2014 and a Final EIS (FEIS) and Draft Record of Decision (ROD) are anticipated in June 2016.

Others are still in the early conceptual planning stage and applications have not been submitted to the Forest Service.

Tongass National Forest Land and Resource Management Plan

The 2008 Forest Plan includes a Transportation and Utility System (TUS) Land Use Designation that "provide(s) for, and/or facilitate(s) the development of existing and future major public Transportation and Utility Systems" (USDA Forest Service 2008a). Major systems are defined as "state and federal highways, railroads, public hydroelectric power projects and associated facilities, powerlines 66 kV or greater, and pipelines 10 inches or greater in diameter." Four types of transportation and utility corridors are identified on the 2008 Forest Plan LUD map. These corridors are: Existing Power Transmission Corridor, Potential Power Transmission Corridor, Existing State Road Corridor, and Proposed State Road Corridor. The TUS LUD applies to existing or new transportation and utility systems once a project is approved and construction is initiated. Prior to construction, the management prescriptions of the underlying LUDs remain applicable.

The Forest-wide Standards and Guidelines for Lands address special use administration for right-of-way grants, including those related to the TUS LUD. Three types of Transportation and Utility System areas are identified based on the LUD's emphasis: TUS "windows," TUS "avoidance areas," and TUS "exclusion areas." These areas are defined in the 2008 Forest Plan in Chapter 4 (USDA Forest Service 2008a, pp. 32-33) as follows:

1. TUS "window" is an area potentially available for the location of transportation or utility corridors and sites. Windows represent areas of future opportunity where the applied management direction will not conflict with future designation of a TUS. A site-specific analysis is still required during project-level planning, to identify resource protection needs within these areas.

2. A TUS "avoidance area" is an area where the establishment and use of transportation or utility corridors and sites is not desirable given the LUD emphasis. A search for "windows" should be exhausted before TUS facilities are considered in avoidance areas. When feasible, these areas should be avoided through site-specific analysis during project-level planning. Avoidance areas often include congressionally and administratively designated areas. Although special environmental or procedural considerations may be required for these areas, they do not preclude consideration and use as a TUS. Avoidance areas are designated through the allocation of lands to LUDs specifically identified as TUS avoidance areas in their standards and guidelines. In cases where proposed or potential corridors are allocated to the TUS LUD that traverse other LUDs identified as TUS "avoidance areas," treat the corridors within such LUDs the same as TUS "windows" (subject to applicable laws).

3. A TUS "exclusion area" is a large area (large enough to cause significant barriers) that legislatively precludes TUS. There will be no exclusion areas on the Tongass National Forest due to special authorities provided in the Alaska National Interest Lands Conservation Act (ANILCA), Title XI (USDA Forest Service 2008a, p. 4-32 to 4-33).

The 19 LUDs on the Tongass include two overlay LUDs: the Transportation and Utility LUD and the Minerals LUD. The remaining 17 LUDs are either designated TUS windows or TUS avoidance areas. Four of the 17 non-overlay LUDs are TUS windows and together account for 6,342,405 acres, approximately 38 percent of the Forest. The remaining 13 non-overlay LUDs, which comprise

10,413,279 acres or 62 percent of the Forest, are TUS avoidance areas. The distribution of the TUS windows and TUS avoidance areas are shown in Table 3-12b-2. The assignment of TUS windows and TUS avoidance areas is discussed further in this section, and additional information, including map figures, is provided in the Energy Resource Report (Tetra Tech 2016).

Table 3.12b-2
Transportation and Utility System Window and Avoidance Areas by LUD (acres)

TUS "Window"	Acres	TUS "Avoidance Areas"	Acres
Natural Setting LUD Group		**Wilderness LUD**	
Semi-Remote Recreation	3,010,933	Wilderness	2,641,042
Development LUD Group		Wilderness National Monument	3,113,807
Modified Landscape	726,224	Non-Wilderness National Monument	167,282
Scenic Viewshed	308,950	**Natural Setting LUD Group**	
Timber Production	2,296,298	LUD II	878,694
Total Window Areas	**6,342,405**	Remote Recreation	2,005,891
		Old Growth Habitat	1,194,080
		Municipal Watershed	45,208
		Research Natural Area	21,682
		Special Interest Area	206,370
		Wild River, Scenic & Rec. River	102,130
		Development LUD Group	
		Experimental Forest	36,264
		Unmapped areas GIS Slivers	829
		Total Avoidance Areas	**10,413,279**

Inventoried Roadless Areas

As noted earlier, project proponents have filed permit applications with the Federal Energy Regulatory Commission (FERC) for seven new or amended hydroelectric projects on the Tongass National Forest that require Forest Service review and/or responses during various stages in the permitting and FERC licensing process. Forest Service involvement includes the permitting of investigative studies, reviewing and commenting on project documents, reviewing study plans and results, participating in project development and resource mitigation, developing Federal Power Act section 4(e) terms and conditions, and issuing an authorization after the project is licensed by FERC. Three additional proposed projects (Little Port Walter, Tenakee Springs/Indian River, and Angoon Hydroelectric) are not under FERC jurisdiction. The Forest Service special use permit will be the authorizing document for these three projects. Of the 11 new or unconstructed projects proposed for development, 8 are in inventoried roadless areas (see Table 3.12b-3 in the Proposed Renewable Energy Projects section below).

In addition, proposed transmission lines serving as power interties among Southeast Alaska communities also cross inventoried roadless areas.

The Federal Power Act (FPA) grants FERC the authority to issue and administer licenses for hydropower projects. For projects located on National Forest System lands, Section 4(e) of the FPA requires FERC to determine whether the project is consistent with National Forest purposes and the land management plan. Section 4(e) also gives the Forest Service authority to impose mandatory conditions in the FERC license to ensure the adequate protection and use of NFS land and resources.

Prohibitions on road construction and timber removal in inventoried roadless areas are considered conditions necessary for the protection and use of NFS land and resources.

If sited and designed properly, hydroelectric projects provide an environmentally and economically preferred source of power due to the near elimination of hydrocarbon emissions from diesel fuels and reduce the risk of catastrophic diesel fuel spills associated with shipping, handling, and storing activities.

Section 4(e) can be used to mitigate the impacts of any project including the location and size of a dam, associated project works (pipelines, roads, and facilities), reasonable access, and mitigation measures. The Forest Service may develop conditions necessary to protect NFS lands and resources, such as limiting or prohibiting certain roads, preserving remote characteristics, defining the size of facilities, project operations (run-of-river vs. large storage reservoirs, etc.) so long as the conditions do not constitute a veto and thereby usurp FERC's role in deciding to license a hydropower facility.

Current Trends

Viewed from an electric generation and transmission perspective, Southeast Alaska consists mainly of multiple, small load centers, separated from one another by mountainous terrain and marine waters. Regional planning efforts have included development of the 2012 Southeast Alaska Integrated Resource Plan (IRP). Developed in response to direction from the Alaska Legislature, the Alaska Energy Authority (AEA) was the lead agency for this plan, which explored the current status of energy resources in the region, as well as options for minimizing future power supply and space heating costs, while maintaining or improving power supply reliability (Black & Veatch 2012). The 2012 IRP describes the region's electric transmission grid as limited in terms of the number of communities connected and notes that the grid is very different from the integrated, interconnected, and redundant grids that are in place throughout the lower 48 states (Black & Veatch 2012).

Southeast Alaska has a wet, relatively temperate climate, and the combination of high precipitation rates and mountainous terrain provides considerable opportunity for hydroelectric generation. Although hydroelectric generation accounts for most of the region's net power generation, hydroelectric power is not evenly distributed among the region's communities. As communities moved toward electrification, hydropower projects were developed in locations near the region's main load centers (i.e., the larger communities). Diesel generation was developed to supplement and backup hydroelectric generation, where it existed, and for communities that could not economically access hydroelectric power. Diesel generation is the main alternate source of energy because of the availability of diesel fuel, the ease of installing diesel generators in a wide range of capacities, and relatively low initial costs. However, in the period leading up to the 2012 Southeast Alaska IRP, the Southeast region saw a large increase in the number of conversions from fuel oil to electric space heating in those communities where hydroelectric power is available. This trend has led to unplanned growth in electric loads and reductions in the excess generation available from existing hydroelectric facilities (See Energy Resource Report [Tetra Tech 2016] for additional discussion).

Municipal governments, Alaska Native organizations, corporations, and regional planning and development groups are all involved in energy planning in Southeast Alaska. The City of Wrangell is a strong advocate for the proposed Alaska-British Columbia Intertie (AK-BC Intertie) that would facilitate the export of surplus power from Southeast Alaska to Canada and the lower 48. Tlingit Haida Central Council, Grand Camp of the Alaska Native Brotherhood, and Sealaska

Corporation have all publicly supported hydroelectric power generation and intertie projects in the region. Southeast Conference has funded several energy development plans and worked closely with AEA to secure funding for specific projects (USDA Forest Service 2010).

According to the Southeast Alaska IRP, the Southeast region is currently at a crossroads regarding the mix of generation, demand-side management/energy efficiency, and transmission resources that it will rely on to meet future electric and heating needs. The Southeast Alaska IRP identified four trends influencing energy demand and development in Southeast Alaska: 1) uneven distribution of relatively low cost hydroelectric generation, 2) volatility in diesel prices (especially the unprecedented increase prior to 2010), 3) current shortage of hydroelectric storage projects, and 4) the continued increase in homes converting from fuel oil to electric space heating in those communities where hydroelectric power is available which has let to unplanned growth in electric loads. Additional detail can be found in the Energy Resource Report (Tetra Tech 2016).

Social and Economic Context

Today, the power requirements of the region's larger communities, including Juneau, Ketchikan, Sitka, Petersburg, Wrangell, Skagway, and Haines, as well as some smaller communities, are met by relatively low cost hydroelectric generation, with diesel generation used only as a back-up. Other communities do not have this benefit and are instead entirely dependent on diesel generation. While considerable hydroelectric power is available in some locations, the lack of power transmission facilities prevents its distribution to the region as a whole (Black & Veatch 2012).

Fourteen of the 32 communities within or adjacent to the Tongass National Forest are either completely dependent upon diesel-generated electricity or are partially served by small hydroelectric projects (e.g., Gartina Falls [455 kilowatts]). Nine of these communities (Angoon, Coffman Cove, Elfin Cove, Hoonah, Kake, Naukati Bay, Tenakee Springs, Whale Pass, and Yakutat), ranging in population in 2014 from 16 to 787, have central electric utility systems that rely on diesel generation for all or the majority of their electricity needs. The other five communities that are dependent on diesel generation (Edna Bay, Meyers Chuck, Point Baker, Port Alexander, and Port Protection) with 2014 populations ranging from 13 to 56 have no central utility system and residents rely upon individual generators (USDA Forest Service 2010; Alaska DOL 2015a).

Although relatively easy and inexpensive to install, high fuel costs and the operations and maintenance expenses associated with diesel generators make them expensive to operate. As a result, in communities where hydroelectric power is not available, the reliance upon diesel generation has contributed to very high electric rates. According to the 2012 Southeast Alaska IRP, this has "created a gap or chasm between communities, where stable and "well-to-do" communities exist near struggling communities and a notable absence of private sector economic activity are the norm" (Black & Veatch 2012, p. 1-4). Alexander et al. (2010, p. 8) found that "the high cost of energy in the communities that rely on diesel generation impedes economic development, as decisions to locate new commercial and industrial developments are influenced by the availability of reliable low-cost power. Residents in communities in Southeast Alaska that rely primarily on hydroelectric power to generate electricity have the lowest residential rates in the State, with rates as low as 10 cents/kilowatt hour (kWh) in 2011. Residents of Anchorage and other places in Southcentral Alaska that rely mostly on natural gas for generation also have low rates, paying around 13 cents/kWh in 2011. Rates are much higher in smaller, more remote communities that rely on

diesel, with rates ranging from about 50 cents to more than $1.50/kWh. The State helps to lower the price of electricity for residential customers and community facilities in most of these communities through the Power Cost Equalization (PCE) program. However, residents in these communities still pay higher rates even after the receipt of PCE payments (Fay et al. 2013).

The average residential rate in the U.S. was about 12 cents/kWh in 2011. In Southeast Alaska in 2011, electric rates for residential customers ranged from 9 cents to 73 cents/kWh. The lowest rates were in Metlakatla and Sitka (9 cents/kWh), Petersburg and Ketchikan (10 cents/kWh), Wrangell (11 cents/kWh), and Juneau (12 cents/kWh). The highest rates were in Pelican (69 cents/kWh), Tenakee Springs (69 cents/kWh), and Elfin Cove (73 cents/kWh). Rates for commercial and other users in each community are generally the same or very similar to residential rates (See Table 3 in the Energy Resource Report [Tetra Tech 2016]).

As noted above, the effective rate to residential customers in qualifying communities is lowered by the State of Alaska's PCE program. In Southeast Alaska, PCE reimbursement rates in 2011 ranged from 7 cents/kWh in Haines and Skagway to 40 cents/kWh in the communities served by the IPEC (Chilkat Valley, Kake, Hoonah, Klukwan, and Angoon). Commercial and other customers (community and governmental facilities and industrial customers) are not eligible to participate in the PCE program and there is no comparable program for these customers. See the Energy Resource Report for additional detail (Tetra Tech 2016).

Renewable Energy Resources

Hydropower is the main source of power generation in Southeast Alaska, accounting for 96 percent of net generation in 2011 (Fay et al. 2013). Other renewable resources exist and are being explored in the region. The following section provides a brief overview of hydropower and other renewable energy resources in Southeast Alaska.

Hydropower: As part of the Southeast Alaska IRP, AEA contractors developed a comprehensive list of potential hydroelectric projects in the region, with projects identified from numerous sources. One of the main sources was a 1947 report prepared by the Federal Power Commission that identified 200 projects. In total, the Southeast Alaska IRP identified almost 300 projects, but cautioned there is likely some duplication as some project names changed over time making it difficult to track individual projects. These projects are listed in Appendix C to the IRP (Black & Veatch 2012).

The Southeast Alaska IRP subsequently identifies five proposed hydroelectric facilities as "committed resources" (projects assumed to exist for the purposes of their analysis): Blue Lake Expansion, Gartina Falls, Reynolds Creek, Thayer Creek, and Whitman Lake, and uses a refined screening analysis to identify a total of 24 other potential hydroelectric projects that have the potential to be suitable to serve Southeast Alaska utility systems and communities. These projects are identified in Table 10-4 in the IRP (Black & Veatch 2012).

Wind: According to the Southeast Alaska IRP, there are small areas distributed throughout the region that may possess wind resources, but most utility-scale resources are in areas that are inaccessible due to terrain, are located in Inventoried Roadless Areas, or are too far from population centers (Black & Veatch 2012).

Geothermal: According to the Renewable Energy Atlas of Alaska, most of Southeast Alaska has low to moderate temperature geothermal systems with surface expressions as hot springs. Use of geothermal resources can involve

direct use, such as district heating, greenhouses, and swimming pool heating, or electricity production (AEA and REAP 2013). Three applications for geothermal projects on the Tongass have been submitted to the Forest Service: Bell Island Geothermal, Neka Geothermal, and Tenakee Geothermal. Bell Island is the only remaining active application on file and carried forward in Table 3.12b-3. The issuance of the 2012 Supplemental Final EIS and Record of Decision (USDA Forest Service 2012c) allows geothermal exploration activities across three leases through 2017.

Biomass: Alaska's primary biomass fuels are wood, sawmill waste, fish byproducts, and municipal waste (AEA and REAP 2013; Lowell et al. 2015). Current biomass projects are mainly geared toward heating facilities (Black & Veatch 2012) and several dozen projects have been funded in some part by the Alaska Energy Authority (AEA) Renewable Energy Fund and USDA Forest Service grants over the past several years. Examples include the Sealaska Corporation which installed the state's first large-scale pellet boiler at its headquarters in Juneau in 2010, followed by the Ketchikan Federal Building in 2012 and the Tlingit-Haida Regional Housing Authority maintenance headquarters located in Juneau in 2013. Wood-fired boilers have been installed in some communities in Southeast Alaska, including Sitka, Craig, Thorne Bay, and Coffman Cove (AEA and REAP 2013; Lowell et al. 2015). According to the Renewable Energy Atlas of Alaska, interest in manufacturing wood pellets continues to increase (AEA and REAP 2013; Lowell et al. 2015). Overall, successfully launched projects provide useful learning opportunities as case studies, but future projects will need to continue analyze overall cost savings based on choosing the right technology for the local biomass fuel supply (USDA Forest Service 2015k).

Tidal: Tidal and river in-stream energy generation involves the use of hydrokinetic devices placed directly into a river or tidal current to capture the kinetic energy of moving water. AEA has granted partial funding for two tidal power reconnaissance and feasibility studies in Southeast Alaska. The Port Frederick Project and Kootznahoo Tidal Energy Project (Kootznahoo Project, formerly known as the Angoon Tidal Power Project) have been surrendered and dismissed by FERC, respectively. A third project—the Gastineau Channel Tidal—identified in the Southeast Alaska IRP (Black & Veatch 2012) was granted a preliminary permit by the FERC in 2010; this permit expired in 2013.

Wave: Alaska has one of the strongest wave resources in the world, but much of this energy is dissipated on remote, undeveloped shorelines. The Renewable Energy Atlas of Alaska identified the Yakutat Wave project as perhaps the best prospect for wave energy development in Alaska (AEA and REAP 2013).

Proposed Renewable Energy Projects

Proposed projects include hydropower, geothermal, and tidal energy. In June 2015, the Forest Service reviewed the list of projects from 2014 (USDA Forest Service 2014c) and identified 11 currently active proposed renewable energy projects in Southeast Alaska. All of these projects are either on or considered likely to affect NFS lands (Table 3.12b-3). Additional summary information is provided for these projects in Appendix A of the Energy Resource Report (Tetra Tech 2016).

Table 3.12b-3
Active Proposed and Unconstructed Renewable Energy Projects on or likely to affect National Forest System Lands

No.	Name	Ranger District	On or Likely to Affect NFS Lands	Applicant	Power Destination	LUD(s)	TUS Identifi-cation	Roadless Area
1	Yakutat Wave	Yakutat	Yes	Resolute Marine Energy	Yakutat	Scenic Viewshed	Window	na
2	Annex Creek	Juneau	Yes	AEL&P	Juneau	Semi-Remote Recreation	Window	302
3	Sweetheart Lake	Juneau	Yes	Juneau Hydropower, Inc.	Juneau	Semi-Remote Recreation	Window	302
4	Angoon Hydroelectric[1]	Admiralty	Yes	Kootznoowoo, Inc.	Angoon	Wilderness	Legislated	na
5	Crooked Creek/Jim's Lake	Hoonah	Yes	Community of Elfin Cove	Elfin Cove	Semi-Remote Recreation	Window	311
6	Tenakee Springs/Indian River[1]	Sitka	Yes	City of Tenakee Springs	Tenakee Springs	na		na
7	Little Port Walter[1]	Sitka	Yes	NOAA/NMFS	Little Port Walter Marine Station	Remote Recreation	Avoidance	334
8	Swan Lake Expansion	KMF	Yes	SEAPA	Ketchikan, Swan-Tyee Intertie	Semi-Remote Recreation	Window	526
9	Bell Island Geothermal[1]	KMF	Yes	B. Wilson	Swan-Tyee Intertie	Semi-Remote Recreation	Window	529
10	Mahoney Lake[2]	KMF	Yes	City of Saxman, AP&T et al.	Swan-Tyee Intertie	Semi-Remote Recreation	Window	524
11	Soule River	KMF	Yes	AP&T	BC and Lower 48	Remote Recreation	Avoidance	530

Notes:
Summary: 11 total: 7 window --- 2 avoidance – 1 legislated – 1 on non-NFS lands.
11 total: 8 in IRA -- 1 in Wilderness
na – not applicable
KMF – Ketchikan-Misty Fiords
[1] Non-Federal Energy Regulatory Commission
[2] FERC licensed in 1998, unconstructed
Source: USDA Forest Service 2014a, 2014b

Six of the 11 of the projects identified in Table 3.12b-3 are FERC hydroelectric projects. The remaining five projects consist of three non-FERC projects (Angoon Hydroelectric, Tenakee Springs/Indian River, and Little Port Walter), one wave project (Yakutat Wave), and one geothermal project (Bell Island Geothermal).

Based on the existing LUDs, 2 of the 11 projects on or likely to affect NFS lands are located in TUS "avoidance areas." Eight of the 11 proposed projects are located in IRAs, with one located in Wilderness (Table 3.12b-3).

Kootznoowoo, Inc., the village corporation of Angoon, is proposing to develop a run-of-river hydroelectric facility and associated features (including a transmission line, access road, and auxiliary buildings) within the Kootznoowoo Wilderness. ANILCA section 506(a)(3)(B) granted Kootznoowoo, Inc., ''the right to develop hydroelectric resources on Admiralty Island within Township 49 South, Range 67 East, and Township 50 South, Range 67 East, Cooper River Base and Meridian, subject to such conditions as the Secretary of Agriculture shall prescribe for the protection of water, fishery, wildlife, recreational, and scenic values of Admiralty Island.'' ANILCA also recognized the economic and cultural needs and expectations associated with Kootznoowoo, Inc. (ANILCA Sec. 506(a)(3)(B)). FERC determined that it does not have jurisdiction over the project because Admiralty Island is a Congressionally designated National Monument on NFS lands. As directed by ANILCA, the Forest Service will issue special use authorizations, with specified conditions and in accordance with other federal and state permits and/or permissions, to allow construction and operation of the project under the terms of the May 2009 project Record of Decision.

Renewable Energy

The Forest Plan amendment would address renewable energy through the addition of Renewable Energy plan components, e.g., desired condition, objectives, standards and guidelines, to the Forest Plan. The Renewable Energy plan components would address each energy project including all related facilities, access roads, utility lines for the transmission and distribution of electric energy, ancillary equipment sites and areas required for construction and long-term maintenance of the project. As proposed, should there be a conflict in direction, the proposed plan components in Chapter 5 would take priority over forest-wide and LUD-specific standards and guidelines (subject to applicable laws).

Environmental Consequences

Direct and Indirect Effects

The NFS land base is the same for all action alternatives, approximately 16.7 million acres, and no changes are proposed to the 17 existing non-overlay LUD allocations (see Table 3.12b-2) or the Minerals LUD (which is an overlay LUD). The primary difference between the No Action and the Action Alternatives is that the amendment would remove the windows/avoidance language under the TUS LUD .

Under Alternative 1, renewable energy projects would continue to be managed in accordance with the 2008 Forest Plan. Current direction consists of the Transportation and Utility System LUD and the Forest-wide Standards and Guidelines for Lands that address special use administration for right-of-way grants, including those related to transportation and utility systems. There are three TUS areas on the Tongass based on the LUD's emphasis: TUS "windows," TUS "avoidance areas," and TUS "exclusion areas."

Thirteen of the 17 non-overlay LUDs are identified as TUS avoidance areas in the 2008 Forest Plan. Together, lands allocated to these LUDs comprise approximately 10,413,279 acres or 62 percent of the Forest (Table 3.12b-2). These areas are described in the Forest Plan as areas where the "establishment and use of transportation or utility corridors and sites is not desirable given the LUD emphasis"

(USDA Forest Service 2008a, p. 4-32). The Forest Plan directs that: a “search for "windows" should be exhausted before TUS facilities are considered in avoidance areas” and, when feasible, avoidance areas, as their name suggests, should “be avoided through site-specific analysis during project-level planning.”

Based on the existing LUDs, 2 of the 12 proposed renewable energy projects on or likely to affect NFS lands are entirely or partially located in TUS “avoidance areas” (Soule River and Little Port Walter). Including the above projects, 8 of the 12 proposed projects are located in IRAs, with one (Angoon Hydroelectric) located in Wilderness (Table 3.12b-3).

Consistent with the 2008 Forest Plan, renewable energy projects need to be consistent with the standards and guidelines for the respective LUDs affected by energy development. All potential impacts to IRAs would be addressed during the permitting and licensing of these projects, with most requiring NEPA analysis. Potential impacts would be mitigated, but some impacts, like the presence of a road in a roadless area, may be unavoidable.

Under the Action Alternatives 2, 3, 4, and 5, the TUS LUD would be removed and replaced with Forest-wide plan components for Renewable Energy. No significant environmental consequences within the Lands category are anticipated for any of the action alternatives. The proposed plan content for Renewable Energy would provide greater flexibility, in meeting project planning, goals, and objectives (subject to applicable laws) across the Forest (see Chapter 5). Implementation of the Renewable Energy Plan Components under Alternatives 2 through 5 would simplify the process for projects, but would not necessarily result in an increase in the number of projects developed. The greatest effect may be in making the permitting process for developers less burdensome, resulting in more rapid development of sites rather than a substantial increase in the number of sites developed.

The Forest Service would continue land administration activities under the respective Forest-wide standards and guidelines presented in Chapter 4 of the 2008 Forest Plan. Proposed plan components developed under the 2012 Planning Rule are reflected in Chapter 5. The primary change is the removal of the Transportation and Utility System LUD (e.g., TUS “windows” and TUS “avoidance areas” approach) described in Chapter 4 (USDA Forest Service 2008a, pp 32-33). Although the 2008 Forest Plan does allow renewable energy projects to be proposed in any LUD, the process to allow such activities was limited, particularly LUDs identified as “avoidance areas”.

The proposed Renewable Energy plan components (desired conditions, objectives, standards and guideline, etc.) would allow renewable energy sites to be proposed regardless of LUD type or emphasis. In other respects, administration of special use authorizations would continue under all alternatives. Proposed renewable energy projects (Table 3.12b-3) would be managed under the Renewable Energy Plan Components in Chapter 5 of the Forest Plan.

These Plan Components could affect other resources and are discussed in each respective resource. The proposed amendment would address each renewable energy site including all related facilities, access roads, utility lines for the transmission and distribution of electric energy, ancillary equipment sites and areas required for construction and long-term maintenance of the project. Site-specific locations and mitigation measures for proposed/unconstructed projects would still be determined by project-level planning and environmental analysis at the time a specific project is proposed.

As noted above, 8 of the 11 proposed projects listed in Table 3.12b-3 are located in IRAs. Two of these eight projects are located in “avoidance areas” with the remaining six in areas identified as “windows” and therefore, overall effects are consistent with current direction. Effects on IRA characteristics under all Action

Alternatives would need to be consistent with the new plan components for Renewable Energy (Forest Plan Chapter 5). Current existing and proposed renewable energy projects are widely distributed across the Forest, with 11 identified proposed renewable energy projects across six ranger districts. This would reduce the cumulative effects of these activities on any specific IRA. Overall, Alternatives 2 through 5 would likely have little additional adverse effects to IRAs relative to current conditions (Alternative 1).

Management and administration would remain the same regardless of the action alternative. For projects located on NFS lands, Section 4(e) of the FPA requires FERC to determine whether the project is consistent with National Forest purposes and the land management plan. The Forest Service will continue to use Section 4(e) to impose mandatory conditions in the FERC license to ensure the adequate protection and use of NFS land and resources. Non-FERC projects would continue to be administered through issuance of a special use authorization, with specified conditions and in accordance with other federal and state permits and/or permissions, to allow construction and operation of projects.

Cumulative Effects

Forest Service land use activities under the proposed amendment to the Forest Plan are not considered to have the potential to create or contribute to significant cumulative effects. Incremental effects to the Scenic Integrity Objectives could occur for energy-related projects that may be sited within beach and estuary fringe areas. The addition of the Renewable Energy plan components do not change the need to ensure that resource protection measures are incorporated throughout project-level planning, construction, and operation of renewable energy sites including those projects located in IRAs. The effects of past and present actions on roadless areas are discussed in more detail in the *Inventoried Roadless Areas* section. All proposed projects would continue to be subject to the Forest Plan and the NEPA, as well as FERC regulations in some cases. The energy projects listed in Table 3.12b-3 are considered reasonably foreseeable, including those located in IRAs, and are expected to have low potential for cumulative effects given that over 90 percent of the Tongass is currently roadless or wilderness. Regardless of the alternative chosen, approximately 97 percent of all existing IRAs would remain roadless after 100+ years (See the *Inventoried Roadless Areas* section for additional detail).

Appendix C in this EIS describes of all the past, present, and reasonably foreseeable future actions considered in the cumulative effects analysis.

Timber

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Affected Environment

Introduction

The forests of Southeast Alaska are primarily the western hemlock-Sitka spruce forest type. This forest type is part of the temperate rain forest that occupies a coastal strip 2,000 miles long from northern California to Southcentral Alaska. The most extensive occurrence of the western hemlock-Sitka spruce type is in Southeast Alaska. Within the Tongass, western hemlock-Sitka spruce stands cover 98 percent of the forest lands. Western hemlock and Sitka spruce comprise the majority of the stocking in this forest type, associated species include, depending on location, yellow-cedar, western redcedar, mountain hemlock, and silver fir (Harris and Johnson 1983). The remaining 2 percent of forest lands support relatively small stands dominated by yellow-cedar, lodgepole pine (shore pine), red alder, or black cottonwood. Western hemlock is used for pilings, poles, railway ties, windowsills, doors, and construction lumber, and has been an important fiber source for pulp. Sitka spruce is used for lumber and commodity products, as well as specialty products, such as piano sounding boards, guitar faces, oars, planking, masts, and spars for custom-made or traditional boats, and ladders. For centuries Alaska Natives have used cedar species for canoes and paddles, housing (along with Sitka spruce), and totem poles. Today, redcedar is primarily used as a roofing material and yellow-cedar has many uses, including boats, utility poles, heavy flooring, framing, and marine decking and piling.

The forests of Southeast Alaska are the main source of raw materials for the region's wood products industry. From 1980 through 2005, the Tongass National Forest accounted for between 18 and 49 percent of the total annual Southeast Alaska timber harvest, averaging approximately 42 percent. During this period, timber harvest on all ownerships in Southeast Alaska ranged from peak levels of just under 1,000 million board feet (MMBF) in 1989 and 1990 to a low of 169 MMBF in 2004. Timber harvested on National Forest System (NFS) lands is available for processing by the local wood products industry but most timber harvested on non-NFS lands is exported. The wood products industry and associated regional employment is discussed in more detail in the *Economic and Social Environment* section of this document.

Current Condition of the Forest Land Base

The timber inventory on the Tongass, including the forest type composition, age class distribution, and volume classes, is described in Chapter 3 of the 1997 Tongass Land and Resource Management Plan (Forest Plan) Revision Final Environmental Impact Statement (FEIS) (USDA Forest Service 1997a). This

information was updated with inventory data published in 2001 (van Hees 2001). Since 2008, extensive updating and inventorying of young growth stands has been conducted and incorporated into this analysis (S. Spores, Tongass Forest Silviculturist, personal communication, September 2015).

Approximately 55 percent of the forest land on the Tongass National Forest (approximately 5.5 million acres) is classified as productive forest land; these lands are considered biologically capable of producing industrial wood products. Approximately 0.5 million acres of the productive forest lands on the Tongass have been converted to young-growth forest due to harvest or other disturbances such as fire or wind. This is approximately 3 percent of the total Tongass land base and 9 percent of the productive forest lands and represents approximately 15 billion board feet of harvested timber.

In addition to productive forest lands, the Tongass includes approximately 4.6 million acres of unproductive forest. These are lands that are not capable of producing industrial forest products, but are important for watershed protection, wildlife habitat, recreation, and other uses. Unproductive forest is land incapable of yielding crops of industrial wood, usually because of adverse site conditions. These conditions may include sterile or poorly drained soil, subalpine conditions, and steep rocky areas where landslides or avalanches curtail timber development.

An analysis of timber resource land suitability on the Tongass in accordance to the 1982 planning rule was completed by the Forest Service for the 1997 Forest Plan Revision FEIS and updated for the 2008 Forest Plan, Appendix A. This was updated to comply with the 2012 planning rule for Alternative 5, the preferred alternative, and is included in the Forest Plan, Appendix A. Modifications to this appendix would be needed for Alternatives 2,3, and 4

Currently, the suitable forest land covers approximately 0.6 million mapped acres. Following field verification, the suitable acreage is expected to amount to approximately 0.5 million acres. A general summary of the derivation of suitable lands is presented in Table 3.13-1 for the 2008 Forest Plan.

Table 3.13-1
Land Classification of Suitable Lands

Classification	Acres[1]
Total National Forest System lands within the plan area	16,755,685
Lands not suited for timber production due to legal or technical reasons	15,794,004
Lands that may be suited for timber production	961,681
Lands not suited for timber production because timber production is not compatible with the desired conditions and objectives established by the plan	369,161
Total lands not suited for timber production	16,163,165
Total lands suited for timber production (mapped suitable) because timber production is compatible with the desired conditions and objectives established by the plan	592,520

[1] Sums and differences may not appear exact due to rounding. Differences between these numbers and those in the 2008 Forest Plan FEIS are due to changes in shoreline mapping, land adjustments (especially the Sealaska adjustment), and updates to the vegetation and other GIS layers.
Source: Forest Service GIS database.

Current Condition of the Timber Resource

Age Class Distribution. The Tongass is a mix of old-growth stands and naturally regenerated young-growth forest, which consists of both wind-created and harvest-created young growth. Harvest-created young growth amounts approximately 5 percent of the total forest land area. Suitable forest lands are classified into five stand conditions: 1) old-growth sawtimber, 2) young-growth sawtimber, 3) pole timber, 4) seedling and sapling, and 5) non-stocked. For timber inventory purposes, stands of trees 150 years old or older are designated as old growth. More than 85 percent of forest lands meet the criteria for old-growth sawtimber (Table 3.13-2).

To help define tree ages on the Tongass, Farr and McClellan (unpublished manuscript) measured and analyzed age data from 67 plots located throughout the Tongass (excluding the Yakutat Area). They found that 90 percent of all overstory trees were more than 180 years old; 84 percent were more than 200 years; 47 percent were more than 300 years; 15 percent were more than 400 years; and 5 percent were more than 500 years old.

Forests less than 150 years cover approximately 0.5 million acres; forests that are 150 years of age or greater cover over 5 million acres. Table 3.13-2 lists the total acres of productive forest land and the acres that are suitable for timber production within two broad age classes.

Table 3.13-2
Estimated Age Class Distribution of All Productive Forest Land and Suitable Productive Forest Land (acres)

Age (Years)	All Productive Forest Lands[1]	Suitable Forest Lands[1,2]
0 to 149	544,000[3,4]	264,000[3]
150+	5,002,000[4]	329,000
Total	**5,546,000**	**593,000**

[1] Numbers may not appear to add correctly due to rounding.
[2] Mapped suitable acres not adjusted (reduced) for falldown (MIRF).
[3] Includes 83,000 acres of natural young growth and 461,000 acres of harvested stands including about 40,000 acres of partial harvested stands.
[4] Differences between these numbers and those in the 2008 Forest Plan FEIS are due to changes in shoreline mapping, land adjustments (especially the Sealaska adjustment), and updates to the vegetation and other GIS layers.
Source: Tongass National Forest GIS database

Table 3.13-3 displays the acres of harvested even-aged young-growth forest by age class. Approximately 46 percent of the area harvested over the past century is no longer suitable, due to Congressional designations such as Wilderness, State and Native land selections, or Forest Plan LUD allocations. For example, areas designated as Wilderness or LUD II by Congress are no longer suitable.

Table 3.13-3
Estimated Age Class Distribution of Even-aged Young-Growth Stands (acres)[1,2]

Age Class (Years)	Development LUDs	Wilderness, National Monument, LUD IIs[3]	Other Non-Development LUDs
0 to 55	326,768	8,484	49,532
56 to 65	16,289	2,420	8,795
66 to 75	2,400	641	534
76 to 85	987	176	307
>85-149	1,160	760	2,363
Total	**347,605**	**12,482**	**61,529**

[1] Numbers may not appear to add correctly due to rounding.
[2] Acres differ from Table 3.13-2 that includes natural young-growth and uneven-aged stands.
[3] Withdrawn Non-Development LUDs include Wilderness, LUD II, and other withdrawn acres.
Source: Tongass National Forest GIS database

Species Mix and Log Types

Timber harvest on the Tongass generally results in a mix of species and log types. The majority of the logs cut in most sales are western hemlock; Sitka spruce is the second most common species. Yellow-cedar and western redcedar account for most of the remaining volume. Cedar, especially yellow-cedar, often commands high prices on the export market and is generally exported (refer to the *Economic and Social Environment* section for discussion of utilization).

Trees harvested from old-growth stands on the Tongass often contain three types of logs: sawlogs, utility logs, and cull logs. Sawlogs are logs that come from that portion of the tree that is of suitable size and quality to be cut into dimension lumber. Sawlogs usually come from the lower portion of the tree, the part of the tree with larger diameter logs. Higher quality sawlogs come from that portion of the tree with fewer branches, which can result in lumber with fewer knots, while lower quality sawlogs often come from that portion of the tree that still retains a live crown. Utility logs are logs that cannot be used to produce lumber but are suitable for chips. They contain at least 50 percent sound wood. Utility wood is also produced from portions of sawlogs that cannot be cut into lumber (refer to Figure 3.13-2). The third type of logs, referred to as cull logs, are logs that do not have enough sound wood to be merchantable, even for chips. These logs are usually left in the woods and contribute to large woody debris (LWD) component and structure left on the forest floor.

Trees harvested from young-growth stands have much lower rates of insects, disease and defect than in the old-growth stands. While productive young-growth stands can carry much higher volumes per acre, it is recognized that the wood quality is lower than from the larger, slower growing old-growth trees. For example, the smaller, younger trees will have more knots and wider-spaced growth rings; in one study, Christensen et al. (2002) showed that recovery of high-grade material (clear and select structural grades) from 90-year old young-growth trees from Prince of Wales Island was considerably lower than the typical old-growth yields of higher grade products.

Timber Inventory

The Timber section in the 2008 Forest Plan Amendment FEIS (USDA Forest Service 2008b) includes a discussion on the history of the timber inventory methodology on the forest through about 2005. Since that time, extensive work

has been conducted relative to the inventory of young-growth. A summary of this work is provided below:

- In 2005, approximately 25,000 acres of young-growth stands were inventoried using Common Stand Exam protocols. Approximately 22,000 acres were inventoried on Prince of Wales Island with the remaining acres inventoried on Ketchikan-Misty Fiords Ranger District.
- In 2011, another effort was initiated that inventoried an additional 33,000 acres of young growth.
- In 2009, the Forest contracted with the Forest Biometrics Research Institute to develop a version of the Forest Planning and Projection System (FPS) growth and yield model for both young growth and old growth forests. This model is spatially explicit and has been used to expand existing data into currently uninventoried stands.
- In July 2015, the Forest Service and State of Alaska entered into a cost share agreement to collect an additional $2.5 million dollars of inventory across young-growth stands to help determine feasibility of future harvest treatments and to develop a projected harvest schedule.

Volume Classes and Strata

The Forest established volume classes of commercial timber in the 1979 Forest Plan (amended 1985), also known as TimTyp or TIM86. Using net inventory volumes per acre, these classes are:

<u>Young Growth</u>

Class 3: 0 to 8,000 board feet

<u>Old Growth and Young Growth</u>

Class 4: 8,000 to 20,000 board feet

Class 5: 20,001 to 30,000 board feet

Class 6: 30,001 to 50,000 board feet

Class 7: 50,001 board feet or greater

There were a number of concerns from within and outside the agency regarding the reliability of this information (usually referred to as the volume class map). Therefore, a study addressing concerns about the volume class map reliability was commissioned in 1989. It concluded that there was no statistical difference among volume classes 5, 6, and 7 with respect to mean board feet per acre and that the existing volume class map should not be used to determine volume per acre (Brickell 1989).

The volume class map had been used by the Alaska Region to calculate long-term timber sale contract timber volume proportionality, as required by Section 301 of the Tongass Timber Reform Act (TTRA). However, this procedure was successfully challenged in court by The Wildlife Society, Alaska Chapter. The court disputes over the TTRA Section 301 proportional harvest methodology were settled, with issuance of an updated Forest Service Handbook Supplement (Region 10, FSH 2409.18 Supplement No. 2409.18-96-1), and alternative methods of assigning timber volume (or the capability to produce different timber volumes) to lands currently supporting old-growth forests were considered for the 1997 Forest Plan Revision. Five different options were studied and evaluated (Julin and Caouette 1997). Statistical analysis indicated that three volume strata can be distinguished for the available timberlands (lands not legislatively or administratively withdrawn) using the existing inventory and additional information

on soils and slope. The polygon characteristics of the three-strata approach are displayed in Table 3.13-4. In the development of the size-density model (SDM) (see *Biodiversity* section), these strata were redefined from the 1997 volume strata criteria of hydric soils and slope percent by using information on hydric soils and aspect, See Figure 3.9-2. Table 3.13-4 is based on these redefined strata. These volume strata were used to model timber outputs for this analysis (refer to Appendix B for a discussion of the Woodstock model).

Table 3.13-4
Tongass National Forest Strata Characteristics–Productive Old-Growth Forest

Geographic Area	Trees/ Acre	Gross Volume (MBF/ Acre)	Net Sawlog Volume (MBF/Acre)	Net Utility Volume (MBF/Acre)	Total Net Sawlog and Utility Volume (MBF/Acre)
North Islands[1]					
Low	102	17.8	11.1	1.8	12.9
Medium	89	27.8	17.7	3.0	20.7
High	89	39.8	25.6	4.8	30.4
North Mainland[1]					
Low	137	12.3	7.6	0.9	8.5
Medium	148	35.0	19.6	4.5	24.1
High	89	39.8	24.6	4.7	29.3
South Islands[1]					
Low	151	20.9	13.7	2.0	15.7
Medium	100	30.3	20.7	2.9	23.6
High	97	41.7	29.3	5.1	34.4
South Mainland[1]					
Low	97	22.9	15.1	2.0	17.1
Medium	100	30.3	21.0	3.0	24.0
High	111	41.3	30.2	5.4	35.6
Yakutat					
Low	21	6.5	4.7	0.5	5.2
Medium	187	40.4	27.7	5.0	32.7
High	196	45.2	32.7	4.1	36.8

[1] North Islands: Chichagof, Baranoff, Admiralty, and associated islands; North Mainland: mainland north of the Sti River; South Islands: Kupreanof, Mitkof, Kuiu, Prince of Wales, Wrangell, Zarembo, Etolin and Revillagigedo and associated islands; South Mainland: mainland south of the Stikine River.
Source: Refer to USDA Forest Service 2006, SDM Data for documentation on why forests were grouped in these geographic areas. Numbers not exact due to rounding.

While the three-strata approach is useful for estimating timber volume for forest planning purposes, it is not a good tool for identifying other important forest elements, including forest structure, ecosystem diversity, and wildlife habitat. For example, two stands may have the same volume, but one may be a dense stand of medium-sized trees with a single canopy layer, while the other stand may be a combination of widely- spaced large overstory trees and two or three lower canopy layers containing small- and medium-sized trees. To help account for these differences, the Size Density Model (SDM), which is based on a combination of tree sizes and tree densities (Caouette et al. 2001), has proven to be a better tool for representing these other forest elements. Using tree sizes and densities provides a more comprehensive forest measuring system for describing habitat than timber volume (Spies and Franklin 1991). The SDM (Caouette and DeGayner 2005) is described and used in the *Biodiversity* and other sections.

Non-National Forest System Lands

The State of Alaska, Native village corporations, Sealaska (the Native regional corporation) and individuals own over 1,186,000 acres of land in Southeast Alaska, inside the Forest boundary. Approximately 364,000 acres of this land currently consists of productive old-growth forest and 422,000 acres consists of young growth. This means that approximately 54 percent of the original productive old growth on non-NFS lands has been harvested (based on GIS analysis and information provided by the landowners). Most timber harvested from Department of Natural Resources state lands in recent years has been processed locally, while timber harvested from University Trust and Mental Health Trust lands has been exported.

Current Practices

Young-Growth Management

The Secretary of Agriculture issued Memorandum 1044-009, Addressing Sustainable Forestry in Southeast Alaska, dated July 2, 2013. The memorandum guides management of the Tongass National Forest to:

> "Speed the transition away from old-growth timber harvesting and towards a forest industry that utilizes second growth – or young growth – forests. Moreover, we must do this in a way that preserves a viable timber industry that provides jobs and opportunities for residents of Southeast Alaska" (USDA 2013, p. 1).

The objective of this Secretarial Memorandum is to ensure that the USDA, the Chief of the Forest Service, the Alaska Region of the Forest Service, and the Tongass National Forest work together to catalyze a transition from a timber sale program based on old growth to one based on young growth. Pursuant to this Memorandum, the Secretary asks the Forest Service to:

a) Seek opportunities to supply sufficient old-growth "bridge timber" while the industry re-tools for processing young growth. The first step is the Big Thorne timber sale. This project along with other planned timber sales would supply timber to existing mills for several years and allow the Forest Service to reallocate staff to young-growth projects.

b) As soon as possible, allocate staff and financial resources to planning young growth projects, ramping down old-growth sales and increasing investments in young growth.

c) Continue to work with Congress to exempt a limited amount of young growth on the Tongass from current requirements that generally restrict harvesting young growth timber until it has reached maximum growth rates, or Culmination of Mean Annual Increment (CMAI). Providing flexibility with regard to CMAI is essential to permit the development of economically viable young growth projects within the timeframe set as a goal for the transition.

Public Law 113-291 provided the Tongass flexibility to harvest young growth without meeting CMAI requirements in addition to exceptions allowed under the National Forest Management Act.

Managing young-growth forests in Southeast Alaska will become an increasingly important component of forest management on the Tongass in the next decade. Young-growth stands can be treated through thinning and other intermediate treatments to concentrate growth in fewer, larger trees, improve lumber quality, and/or to enhance habitat conditions for wildlife. Zaborske et al. (2000) concluded that the types of treatments applied to young stands will have a

profound effect on the types of materials available in the future, including log diameter, knot size, and wood strength.

Over 200,000 acres have been precommercially thinned on the Tongass since 1979. In recent years, precommercial thinning has averaged approximately 5,600 acres per year. The Forest has less experience with other young-growth management techniques, such as pruning and commercial thinning.

Barbour et al: (2005) estimated that precommercial thinning at age 20 with a spacing of 12 by 12 feet would produce more merchantable wood volume at age 70 than wider spaced thinnings. However, there is a trend toward wider tree spacing in precommercial thinning prescriptions to maintain or enhance understory plant cover. These treatments could increase taper, knot size and stimulate the production of epicormic branches in spruce. These changes could adversely affect wood strength and stiffness (McClellan 2005). There is also a concern that wider spacing may increase the occurrence of fluting on sites where this is a problem (Julin et al. 1993; Holsten et al. 2001).

Pruning removes lower branches and can increase future lumber quality. However, care must be taken not to remove too much of the live crown, which can affect tree growth.

There has been increased interest in commercial thinning in recent years, not only to improve timber values, but as a tool to improve wildlife habitat. Studies in other forest types in the Pacific Northwest indicate that stand structures that are similar to old-growth forest conditions can be developed through thinning (Thysell and Carey 2000). However, there are many unanswered questions as to how to implement thinning treatments that provide a sustainable source of high-value wood products while maintaining biological diversity (Zaborske et al. 2000). In a study comparing the lumber harvested from thinned and unthinned, 90-year-old stands on the Tongass National Forest, Christensen et al. (2002) found that there was no difference in volume recovery or lumber grade in thinned and unthinned Sitka spruce. For western hemlock, the unthinned stands produced more wood volume, but the thinned stands produced more high-grade lumber. The Prince of Wales Commercial Thinning Study was awarded as an Integrated Resource Service Contract at the end of FY2008. This study looks at five different commercial thinning prescriptions that offer a range of potential treatments that could be used on the Tongass. The five different prescriptions were implemented at three replicates: near Harris River, in the Maybeso Experimental Forest, and near Naukati. The objectives of the study are to assess how mechanized equipment operates, how the different prescriptions hold up to Southeast Alaska's weather, and what the understory response is after treatment. A 5-year re-measurement of the sites was completed in 2014.

There is also increased interest in managing young-growth stands to increase and maintain understory vegetation, especially as forage for deer and other wildlife. Hanley et al. (2005) noted that much research is needed on new approaches involving thinning of older stands, including red alder in the secondary successional sequence. Zaborske et al. (2002) found that thinning greatly increased forage production, though the amount of useful forage produced varied by the type of thinning implemented. Refer to the *Wildlife* section for a discussion of thinning and wildlife habitat.

In additional to their continuing research on managing young forests, scientists at the Pacific Northwest Research Station joined with the Tongass National Forest in 2001 to establish an operational-scale adaptive management study of young-growth management options. This program, called the Tongass-wide Young-Growth Studies (TWYGS), is designed to evaluate the potential benefits of

treating young-growth stands to increase wildlife habitat and wood production. Currently, TWYGS includes experiments that test the effectiveness of alder interplanting, precommercial thinning, slash treatments, girdling and pruning.

Regeneration Methods

Regeneration methods are the harvest methods used to create a new age class within a stand. The methods used on the Forest are not expected to be differ when applied to old-growth or young-growth stands. A description of the primary methods is provided below.

Even-aged Systems. This system includes clearcuts, seed tree, and shelterwood harvest methods. These methods are described in detail in Appendix G of the 1997 Tongass Land Management Plan FEIS. Under an even-aged system, the intention is to replace the entire (or nearly the entire) stand with a new crop of trees that are all of the same age. Under the National Forest Management Act (NFMA), clearcutting can only be used when it is the optimum system. This is determined through a site-specific prescription approved by a certified silviculturist. Also under NFMA, a stand must have reached at least 95 percent of CMAI. This is the point at which the stand reaches its highest average growth. The exact age that this occurs varies by site and stand treatment. A stand on a high site will generally reach CMAI sooner than one on a lower site. However, stand treatments, such as precommercial thinning and commercial thinning, will generally extend the period of fast growth, causing the stand to take longer to reach CMAI. There are, however, exceptions to this NFMA requirement that the Tongass would likely qualify for under the current situation.

Public Law 113-291 specifies that the Tongass may harvest trees prior to 95 percent of CMAI to facilitate the transition away from commercial timber harvest of old-growth stands. However, the sale of young-growth trees harvested under this exception shall not: (i) exceed 15,000 acres during the 10-year period beginning on the date of enactment of the Act (December 19, 2014), with an annual maximum of 3,000 acres sold; (ii) exceed a total of 50,000 acres, with an annual maximum of 5,000 acres sold after the first 10-year period; and (iii) be advertised if the indicated rate is deficit (defined as the value of the timber is not sufficient to cover all logging and stumpage costs and provide a normal profit and risk allowance under the appraisal process of the Forest Service) when appraised using a residual value appraisal. The NFMA also provides exceptions to the CMAI requirement.

Clearcutting, with reliance on natural seeding, has been the most commonly used silvicultural system in the Sitka spruce-western hemlock forest type of Southeast Alaska (Ruth and Harris 1979; Deal et al. 2002). Clearcutting is used where timber production is the primary use and where it is the optimal method. The clearcutting method is favored for several reasons. Clearcutting increases exposure to the sun, which raises soil temperature, speeds up organic decomposition, and thus improves soil productivity. Sitka spruce is less tolerant of shade than western hemlock (USDA Forest Service 1990); therefore, in the mixed spruce-hemlock forests of Southeast Alaska, the open conditions created by clearcutting favor the regeneration of Sitka spruce (Ruth and Harris 1979). Shade intolerance also favors cedar species regeneration in clearcuts relative to western hemlock (S. Spores, Tongass Forest Silviculturist, personal communication, September 2015). Clearcutting in stands infected by dwarf mistletoe substantially reduces infection in the regenerated stand (Shaw and Hennon 1991). Logging costs are lower than with other systems, and the clearcut method has proven very successful in the regeneration (regrowth) of

healthy forested stands (refer to Appendix G in the 1997 FEIS for additional discussion).

A variant of this system, referred to as clearcutting with reserves, involves retaining approximately 10 percent of the stand, either in single trees or in small groups. This method is generally used to meet scenery or wildlife needs in areas where timber production is the primary goal.

In 1992, the Chief of the Forest Service directed that the even-aged system (clearcutting) be limited to areas where it is essential to meet Forest Plan objectives. Clearcutting has traditionally been used in the hemlock-spruce forests of Southeast Alaska to reduce mistletoe infection by eliminating infected trees from the overstory, reduce heartrot and stem diseases that may result from logging damage to leave trees, and to eliminate the risk of blowdown of residual trees. As the Forest begins to rotate younger stands, clearcutting may also be used to promote regeneration of desirable species. In addition, it requires fewer miles of road for a given volume (Ruth and Harris 1979; USDA Forest Service 1983). Because more volume is harvested from each acre than would be the case under uneven-aged management, many fewer acres are impacted for the same harvest volume.

Two-aged Systems. In this system, for example, up to 30 percent of a stand is left as residual (or reserve) trees, either as single trees or in patches, and the rest of the stand is harvested. The reserve trees remain unharvested and provide structural diversity and an older aggregation of trees within the otherwise young-growth stand. This system has been used on the Tongass to meet scenery objectives. Logging costs can be higher because of the need to protect the reserve trees.

Experience in other regions indicated that retaining overstory trees led to regeneration of more shade-tolerant species (which would favor hemlock over Sitka spruce in Southeast Alaska), reduced growth, increased dwarf mistletoe infection in understory trees, and resulted in windthrow of overstory trees (Harris and Farr 1974). However, a retrospective study of 18 partial cut stands in Southeast Alaska found that partial cutting had little effect on tree species composition, diameter growth, or dwarf mistletoe levels (Deal and Tappeiner 2002; Deal et al. 2002). Mortality of residual trees was only marginally higher in partial cut stands than in uncut stands; although the location of these stands may have contributed to the relatively low level of wind damage. The stands sampled in this study were all below 100 feet in elevation and within 1.25 miles of the shoreline. Stands on exposed south-facing ridges and on slopes are likely to have a greater risk of windthrow (Nowacki and Kramer 1998). Windthrow may be of particular concern because one of the predicted outcomes of climate change in Southeast Alaska is an increase in the frequency of severe wind storms. Juday et al. (1998) considered it highly likely that there would be increased blowdown across Southeast Alaska in the future.

Uneven-aged Systems. This system typically involves harvesting of single trees or of small groups of trees (usually less than 2 acres) from within a stand. This method maintains a multi-aged, multi-layered stand structure by removing some trees in all age groups. It has been used on the Forest to meet scenery and wildlife habitat needs. Uneven-aged management often involves higher costs due to the generally needing to use a helicopter or a lateral yarder for harvest. Larger harvest areas than would be needed for the same harvest volume under an even-aged or two-aged system (Ruth and Harris 1979). Also, the frequent entries in the stand to remove individual or small groups of trees increases

logging costs and the risk of damaging the remaining trees (USDA Forest Service 1983).

Deal (2001) concluded that it may closely mimic the natural disturbance regime of Southeast Alaska based on a retrospective study of 18 partial cut stands. Stand structures were similar to uncut old-growth stands, and cutting had no significant effect on species composition (Deal and Tappeiner 2002). Uneven-aged systems have potential benefits, including protection of wildlife habitat, scenery, and slope stability as well as the maintenance of biological diversity (McClellan et al. 2000).

Growth rates. Estimation of future yields from young-growth stands created by timber harvest is critical for developing project timber sale quantities (PTSQs) for the Forest Plan. Growth and yield tables have been developed for even-aged stands in Southeast Alaska (Taylor 1934; Farr 1984). Although published growth and yield tables have not been developed for stands regenerated under two-aged or uneven-aged methods, unpublished yield tables for these harvest types were developed by the Forest Service for use in estimating sustained yield limit (SYL) and PTSQ. These are part of the planning record.

Given that over 30 percent of the volume in old-growth stands is defective (Farr and Harris 1971), it is unlikely that these trees would respond to the additional growing space made available through partial harvest. While young western hemlock stands respond well to thinning, trees older than 100 years respond poorly to release (USDA Forest Service 1990). Western hemlock is shade tolerant and may grow well under partial shade. Sitka spruce is less shade tolerant than hemlock and it is reasonable to expect some growth loss when Sitka spruce is grown under residual overstory trees. However, Deal and Tappeiner (2002) reported that, in most cases, concerns about greatly reduced stand growth and vigor were unsubstantiated, based on a retrospective study of 18 stands in Southeast Alaska that had been partially cut 12 to 90 years earlier. Analysis of these stands did not detect significant changes in tree species composition, stand growth, hemlock dwarf mistletoe infection, or mortality rates (Deal et al. 2002).

Species Composition

Of the four major commercial tree species on the Tongass, western hemlock is the most shade tolerant, followed by western redcedar, yellow-cedar, and Sitka spruce, in that order (USDA Forest Service 1990). Western hemlock is by far the most prevalent species, making up 83 percent of the old-growth forests (Farr and McClellan 1994). Dwarf mistletoe commonly infects western hemlock. Sitka spruce and yellow-cedar are rarely infected by dwarf mistletoe and western redcedar is not infected (USDA Forest Service 2001b). Western hemlock also appears to have more insect enemies than Sitka spruce (USDA Forest Service 1974). In addition, western hemlock has the lowest economic value of these four species. Having a diverse species mix contributes to wildlife habitat quality, economic value, and minimizes losses due to insect and diseases that are species specific.

Five years following even-aged harvest, Harris (USDA Forest Service 1967) reported that 53 percent of the regenerated stand was western hemlock, 41 percent Sitka spruce, and 6 percent cedar. As even-aged stands age, the density of Sitka spruce decreases and relatively few Sitka spruce exist in old-growth stands, especially in the smaller diameter classes (USDA Forest Service 2000b).

Regeneration harvest methods that create open conditions and expose bare mineral soil, such as clearcutting, would encourage germination and growth of Sitka spruce and the cedars. Group selection with openings of at least 2 acres could also encourage germination and growth of Sitka spruce and the cedars, but to a lesser degree than clearcutting due to side shading. The amount of sun reaching the surface would vary depending on the size, shape, and aspect of the opening. Regeneration methods that create less ground disturbance and smaller openings in the canopy such as single tree selection, smaller sized groups in group selection, overstory removals, and treatments with many reserve trees would encourage growth of western hemlock at the expense of the other species. However, limited retrospective studies indicate that Sitka spruce can be maintained in mixed hemlock-Sitka spruce stands over a wide range of cutting intensities if enough Sitka spruce trees are present in the stand after harvest (McClellan 2005). Two-aged harvest would be similar to even-aged harvest if leave trees are concentrated near the unit boundaries but may be more favorable for western hemlock regeneration if reserve trees are scattered through the unit, due to shading from the residual overstory.

Reforestation

The NFMA requires assurance that all areas receiving final removal harvest can be adequately restocked with trees within 5 years of that harvest. On the Tongass, natural restocking is usually adequate to meet this objective because both western hemlock and Sitka spruce are prolific seed producers (USDA Forest Service 1983). The new stand originates from advance regeneration and from seeds that come from residual trees or from trees adjacent to the harvest unit. Since 1988, natural regeneration has accounted for 94 percent of the reforestation program. The remaining 6 percent has been artificial regeneration (planting). The future need for planting would be determined on a site-specific basis to achieve management objectives such as increasing the abundance of Sitka spruce where western hemlock or brush may have a competitive edge or increasing the abundance of yellow-cedar or western redcedar, where natural regeneration of these species is anticipated to be inadequate. The desired species composition, required number of seedlings, and method of regeneration should be displayed in the silvicultural prescription.

Intermediate Treatment Methods

Intermediate treatments are any manipulation in a stand that occurs between two regeneration periods (Daniel et al. 1979). The regeneration period establishes the new stand, either through natural regeneration or through planting. Intermediate treatments are done to ensure that the new stand has the desired species composition, tree health, growth, and spacing, as well as to recover product value. They can also be used to create or improve habitat for wildlife. Intermediate treatments may be used if approved as part of a site-specific silvicultural prescription. Currently, the only intermediate treatment commonly used on the Tongass is pre-commercial thinning.

Precommercial thinning is applied in young stands that have not reached merchantable size. It is the most commonly applied intermediate treatment in Southeast Alaska. It is used to:

- Favor preferred tree species.
- Concentrate tree growth on fewer individuals to produce larger trees in a shorter period of time.

- Increase the amount of light reaching the forest floor, thereby retaining understory vegetation that is valuable wildlife forage (DellaSalla et al. 1994).

There are concerns over the effects of precommercial thinning on future wood quality, especially wider spacing of residual trees (McClellan 2005). Thinning can increase epicormic sprouting on the Sitka spruce trees (Deal et al. 2003). Lower density thinnings could increase taper and increase the size and longevity of lower branches, thus reducing future wood quality (McClellan 2005). Larger lower branches increase fluting in western hemlock, which reduces wood quality (Julin et al. 1993) (refer to the *Forest Health* section for a discussion of fluting).

Pruning removes the lower branches of a tree at an early age in order to produce knot-free wood. It is the only way to produce clear lumber in rotations less than 100 years (Daniel et al. 1979). However, pruning Sitka spruce trees can encourage epicormic sprouting in Sitka spruce and can limit diameter growth for all species. Deal et al. (2003) found that the total number of sprouts was similar among different levels of pruning but significantly more large sprouts were produced when more of the crown was removed.

Commercial thinning is applied to young stands that have reached merchantable size. The primary difference between commercial and precommercial thinning is that the trees cut in a commercial thinning operation are removed and sold. Commercial thinning can be used to:

- Meet market demand for wood products, either from suitable or unsuitable lands (harvest would only be used on unsuitable lands to meet resource objectives, such as improving wildlife habitat, and where no irreversible damage would occur).
- Maintain or increase the growth rate of dominant and co-dominant trees by removing trees in the lower crown classes, increasing merchantable yields over the rotation.
- Stimulate development of more complex canopy structures or enhance forage in the understory in order to meet wildlife habitat needs.
- Maintain or improve scenic quality.

By maintaining or increasing growth rates, commercial thinning lengthens the time needed for a stand to reach CMAI, extending the rotation length (Daniel et al. 1979).

Precommercial thinning would be implemented under all alternatives based on funding. Pruning is likely to play a minor role in the foreseeable future under all alternatives. Commercial thinning is expected to play a larger role in meeting future demand under all alternatives over the next few decades, as areas harvested in earlier decades reach commercial size. Over the long term, previously harvested stands would regenerate and could be commercially thinned again.

Yarding Methods

On the Tongass, most logs have been yarded downhill using cable logging systems such as highlead and skyline. Access has usually been from valley bottoms, because road building on steep slopes is difficult and costly. Most logging occurs inland, with logs transported via road systems to marine access points, also referred to as log transfer facilities, at tidewater (see the *Transportation* section). Harvest by tractor (shovel yarding) has proven effective on flat to moderate slopes; it is not practical on steep slopes. Harvest by

helicopter is typically the costliest method, but also has fewer adverse effects on other resources.

Yarding methods can be divided into three "operability" classes, which relate to the methods necessary to harvest and transport trees under various conditions (see Table 3.13-2). Normal operability includes the standard ground-based and cable logging systems used in areas where access is relatively easy and helicopter logging with distances of up to 0.75 mile. These areas have the lowest logging costs. Difficult operability includes long-span cable systems and helicopter logging with distances between 0.75 and 2.0 miles, occurring where ground access is challenging or not possible. Difficult operability involves higher costs. The third class, isolated operability, consists of isolated stands 2.0 miles or more from a helicopter landing site. These tend to be uneconomical under even high timber markets.

The 2007 LSTA indicates that approximately 89 percent of the suitable timber land would be accessible using normal harvest methods, 10 percent would be difficult, and 1 percent would be isolated. When economic and environmental risk factors are considered, additional areas are likely to be identified as difficult or isolated during project planning (see Table 3.13-2). Risk factors assigned by the LSTA team and district personnel, indicate that about 85 percent of the suitable acres with old-growth forest would be in the normal category.

In the past, stands adjacent to the shoreline were sometimes harvested from the water using A-frame logging, where a floating yarder was used to move logs to the marine waters. As a result, isolated young-growth stands exist within the beach and estuary fringe that are not connected to existing road systems. This yarding system has not been used on the Tongass in decades and it is unlikely any operators currently have the equipment, though it could be built. While currently uncommon, current beach yarding options include shovel access from roads if present, shovel access from the beach (working with barges), helicopter yarding, or some combination of these. Other methods could be employed as long as they meet management objectives.

Tongass Timber Sale Program

The primary sources of timber within Southeast Alaska are the Tongass National Forest, private corporations (principally Alaska Native Corporations formed through the Alaska native Claims Settlement Act (ANSCA), and the State of Alaska (Table 3.13-5). Between 1980 and 1990, harvest from the Tongass contributed about 50 percent of the timber supply in Southeast Alaska. From 2002 to 2014, Alaska Native Corporations harvested an average of 69 MMBF and the State harvested an average of 26 MMBF. This information is presented in greater detail in the *Economic and Social Environment* section of this EIS (see Table 3.22-5). Timber under contract and demand for timber products from the Tongass National Forest are discussed in detail in the *Economic and Social Environment* section.

One objective of the Alaska National Interest Lands Conservation Act (ANILCA) was the maintenance of timber supply for the Southeast Alaska timber industry because of its contribution to the local and regional economies of Southeast Alaska. For similar reasons, TTRA (Section 101) directs the Forest Service to seek to provide a supply of timber from the Tongass that meets annual market demand and the market demand for each planning cycle to the extent consistent with providing for the multiple-use and sustained-yield of all renewable resources. The planning cycle is assumed to be the 10- to 15-year period between Forest Plan revisions.

The current Tongass timber program is composed of a large sale program, a small sale program, and a firewood and personal use program. Annual harvest volumes averaged 36 MMBF between 2002 and 2014 (USDA Forest Service 2015a), notably lower than the Allowable Sale Quantity (ASQ) of 267 MMBF per year approved in the 2008 Record of Decision.

The timber sale program has been in transition since the end of the long-term contracts. Many operators are in the process of developing direct markets for value-added products, such as molding, tongue-in-groove, paneling, and furniture. A census of timber processors in Alaska in 2011 identified 27 sawmills in Southeast Alaska, with almost half this total (12 facilities) located on Prince of Wales Island (Berg et al. 2014). Berg classified essentially all of these mills except one (Viking Mill in Klawock) as small operators if they produce less than 2 MMBF per year

The Forest has created a microsale program to make wood available to small operators. This program allows operators to identify sales of dead and down wood of up to 50,000 board feet or with a value of up to $10,000. These sales are then approved by the Ranger and made available to local purchasers by competitive means.

The Forest Service and the University of Alaska have created the Ketchikan Wood Technology Center to focus on ways to help the local timber industry. Among other things, the center has developed log grades for Alaskan wood products.

Table 3.13-5
Timber Harvest and Imports for Southeast Alaska, 1997-2011 (MMBF)[1]

		1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Tongass NF	Sawlogs	94.4	107.6	132.8	133.7	39.8	30	44.1	40.9	43.3	39.4	14.8	24	25.3	30.3	30.2
	Utility Logs[2]	12.2	12.2	12.9	13	7.9	3.8	6.7	5.4	6.2	3.7	3.9	4	3.1	5.1	2.4
State of Alaska[3]	Sawlogs	5.2	5.6	7.3	47.8	48	48	32.7	21.9	40.7	43.6	38.8	10.3	11.8	9	15.5
	Utility Logs	0.3	1.9	0.1	12.1	5.2	9.3	2.1	2.3	2.2	1	5.8	1.6	1.7	1.5	0.8
Bureau of Indian Affairs	Sawlogs and Utility[2]	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Alaska Native Corps.[4]	Sawlogs	335.9	157.6	193.6	114.6	106.5	93.6	98.1	92	99.3	67.1	46.9	45.5	46.9	62.5	58.2
	Utility Logs[2]	47.6	59	45.4	46	13.3	8.1	7.6	6.9	4.6	4.1	3.1	6.8	4.9	3.9	4.9
Southeast Alaska	Sawlogs	435.5	270.8	333.7	296.2	194.3	171.6	174.9	154.8	183.3	150.1	100.5	79.8	84	101.8	103.9
	Utility Logs[2]	60.1	73.1	58.4	71.1	26.3	21.2	15.4	14.6	13.2	8.8	12.8	12.4	9.7	10.5	8.1
Total	Total	495.6	343.9	392.1	367.2	220.6	192.8	190.3	169.4	196.5	158.9	113.3	92.2	93.7	112.3	112
Alaskan Imports[5]	Sawlogs	0	0	0	0.1	3.2	1.7	0.1	2.6	1.7	7.7	7.8	1.1	0	0	0.1
	Utility Logs[2]	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
	Chips	0	0	0	0	0	0	0	0	0	0	0.1	0.3	0.2	0.2	0.1

[1] National Forest and Bureau of Indian Affairs (BIA) harvests reported for fiscal years. All other ownerships reported in calendar years.
[2] Utility volume includes logs with less than one-third net sawlog but at least one-half firm usable pulp chips.
[3] Harvests from Alaska Mental Health Trust and University of Alaska lands omitted prior to 2000.
[4] Source: USDA Forest Service 2012d.

Environmental Consequences

The analysis of the potential effects of the alternatives addresses the following questions:

- How much land would be allocated to timber production?
- What silvicultural systems and vegetative practices would be utilized?
- What would the PTSQ be under each alternative?
- What projected log grade or quality would be provided?

- What would the product mix be, in terms of sawlogs and utility logs?
- What would the SYL be under each alternative?
- What are the factors that affect the attainment of the PTSQ?
- What would be the future condition of the Forest in 100 years?

The analysis of timber supply and demand for timber products, as well as how existing sales under contract and timber volume in preparation may be affected by the alternatives, is discussed in the *Economic and Social Environment* section.

The effects on the timber industry infrastructure and employment levels are also discussed in that section.

Suitable Timber Lands

There are approximately 5.5 million acres of productive forest land on the Tongass. Approximately 1 million acres of this is mapped as suitable under the 2008 Forest Plan (which includes roadless areas). However, as described below, only an estimated 773,000 acres are actually suitable for harvest. This includes old-growth and young-growth forest. Appendix A of the Forest Plan contains a discussion of the determination of suitable lands. In this FEIS, the amount of suitable land would vary by alternative both for young growth and old growth.

During a plan amendment or revision, the Responsible Official is to identify the amount of timber that can be removed annually in perpetuity on a sustained-yield basis from the applicable national forest. This amount of timber is the forest's SYL. The sustained yield limit is the amount of timber that could be produced on all lands that may be suitable for timber production, assuming all of these lands were managed to produce timber without considering other multiple uses or fiscal or organizational capability. The projected wood sale quantity (PWSQ) is an estimate of the volume of all timber and other wood products that is expected to be sold during the plan period from expected harvests for any purpose (except salvage harvest or sanitation harvest) on all lands in the plan area. The PWSQ includes all woody material likely to be sold from these harvests whether or not the woody material meets the utilization standards. The projected timber sale quantity (PTSQ) is a subset of the PWSQ and is an estimate of the quantity of timber expected to be sold during the plan period. The volume in the PTSQ is the volume that meets utilization standards. The estimation of both the PWSQ and the PTSQ must take into account the fiscal capability of the planning unit and be consistent with all plan components. Both the PWSQ and the PTSQ vary for each alternative (see Table 3.13-8). Table 3.13-6 displays the distribution of forest lands, suitable acres, projected harvest acres, and the PTSQ for old growth and young growth by alternative.

The amount of suitable land would vary from 9 percent to 15 percent of the productive forest land. However, no alternative would have projected old-growth harvest of more than 1.3 percent of the productive old growth (POG). The annual PTSQ would be 46 MMBF for all alternatives during the first decade. Alternative 2 would contribute the highest proportion of young growth and Alternative 1 would contribute the lowest. In the second decade, the PTSQ would range from 46 to 86 MMBF per year following the same pattern for young-growth contribution.

Table 3.13-6
Land Classification, Suitable Lands, Projected Harvest, and PTSQ for Old-Growth and Young-Growth Harvest under Each Alternative[1]

Classification	Alternative 1	2	3	4	5
Total National Forest land (thousands of acres)	16,756	16,756	16,756	16,756	16,756
Non-Forest land (includes water)	6,649	6,649	6,649	6,649	6,649
Forest land	10,107	10,107	10,107	10,107	10,107
Productive Forest Land (thousands of acres)	**5,547**	**5,547**	**5,547**	**5,547**	**5,547**
Productive Old Growth (POG)	5,002	5,002	5,002	5,002	5,002
Productive Young Growth (includes natural young growth)	544	544	544	544	544
Mapped Suitable forest lands (thousands of acres)	**592**	**724**	**866**	**533**	**568**
Suitable Old Growth	329	349	517	269	229
Suitable Young Growth	264	375	350	264	339
Projected Harvest Acreage after 25 years (thousands of acres)	**48**	**79**	**70**	**64**	**67**
Old Growth Harvest after 25 years	39	15	17	23	24
Young Growth Harvest after 25 years	10	64	54	41	43
Projected Harvest Acreage after 100 years (thousands of acres)	**272**	**368**	**349**	**277**	**327**
Old Growth Harvest after 100 years	63	33	36	43	42
Young Growth Harvest after 100 years	210	335	313	235	284
Projected Timber Sale Quantity (PTSQ)– annual (MMBF) 1st Decade Total	**46**	**46**	**46**	**46**	**46**
Old Growth	38	24	26	35	34
Young Growth	8	22	20	11	12
Projected Timber Sale Quantity (PTSQ) – annual (MMBF) 2nd Decade Total	**46**	**96**	**88**	**69**	**72**
Old Growth	31	5	5	12	12
Young Growth	15	91	83	56	60

[1] Sums and differences may not appear exact due to rounding.
Source: Forest Service GIS database and Woodstock modeling.

Silvicultural Systems and Practices

This section describes vegetation management practices prescribed in the Forest Plan, including regeneration methods, reforestation, and intermediate treatments. Definitions for each of these practices, how they will be applied, and expected effects on the timber resource are provided.

Harvest Methods

For planning purposes, the 2008 Forest Plan considered the three regeneration methods for old growth, discussed under Regeneration Systems: even-aged system, two-aged system, and uneven-aged system (group selection). These same methods were also considered in this Plan Amendment. This does not mean that these are the only regeneration methods that will be used on the Tongass. Other even-aged methods such as shelterwood may be utilized to meet specific objectives and would be similar to clearcut with reserves in regard to appearance and effects (or to clearcuts if the shelterwood is later cut). For modeling purposes, only even-aged and uneven-aged systems were used and displayed. The affected environment section and Appendix G of the 1997 Tongass Land Management Plan Revision FEIS contain detailed descriptions of the various silvicultural systems and their advantages and disadvantages. In addition, other regeneration methods may be applied on a limited scale to test their utility in achieving other forest management objectives.

Implementation of any Forest Plan alternative would include a full array of silvicultural prescriptions, including modification of these methods, depending on the site-specific conditions. The choice of the regeneration method and rotation length would be based upon site-specific analysis done at the project level, would consider multiple resource needs and objectives, and would include the rationale for using the selected regeneration method. This would be documented in the silvicultural prescription, which must be approved by a Region 10 certified silviculturist.

Transitioning to young growth as fast as possible means it is important to harvest stands at the youngest age possible. Based on collective experience of timber managers on the Tongass and discussions with industry representatives, it was decided that in order for a young timber stand to have a chance of being economic, the majority of trees harvested need to produce two logs. Production of one log per tree not only increases logging costs relative to revenues substantially, but also creates a large amount of slash left behind, which can have negative effects on wildlife, scenery, economics and recreation. Based on analysis of yield tables it was decided that to produce two logs per tree for the majority of trees in a stand, a minimum age of 65 years would be used for modeling of high site stands and a minimum age of 75 years would be used for lower site stands.

Harvesting trees at 65 to 75 years of age is prior to their CMAI age, which is likely to be in the 90 to 110 year range. Although this would likely shorten the transition time, in the long term it should be recognized that it would result in lower growth rates and lower overall volumes produced.

Table 3.13-7 displays the annual number of acres estimated for each of the main regeneration methods by alternative for the first and second decades of the Plan based on the Woodstock model outputs. The acreages displayed are for modeling purposes only in order to estimate Forest Plan outputs and do not limit the use of any harvest method to best meet project goals and objectives.

For young growth, harvest methods used for modeling included even-aged systems (primarily clearcutting), patch cuts, and commercial thinning. Patch cuts include harvesting up to 35 percent of the stand in patches or groups with a maximum opening size of 10 acres. Patch cuts are modeled only in Alternative 5 for beach and estuary fringe, riparian management areas, and the Old-Growth Habitat LUD. Commercial thinning in the model includes removal of up to 33 percent of the stand volume. Commercial thinning is used in all of the action alternatives for beach and estuary fringe, riparian management areas, and non-development LUDs, where applicable.

In the first two decades, even-aged management would prevail. However, commercial thinning of young growth would become more significant in the second decade, particularly in Alternatives 2 and 4. Alternative 5 is the only alternative where patch cutting becomes important.

Alternative 1 would result in the most old-growth harvest overall, and the most even-aged harvest, followed by Alternatives 5, 4, 3, and 2 in that order. Alternatives 1 and 5 would have the greatest amount of old-growth uneven-aged management, although the relative amount would be small.

Table 3.13-7
Timber Management Practices as Modeled

Average Annual Harvest Acres of Suitable Lands Modeled in First Decade					
	Alternative				
	1	2	3	4	5
Harvest[1,2]					
OG Even-aged	1,776	1,134	1,236	1,611	1,626
OG Uneven-aged	32	0	0	0	0
YG Even-aged	246	682	619	285	285
YG Patch Cut	0	0	0	0	2
YG Commercial Thinning	0	93	82	243	247
Total Old Growth	**1,808**	**1,134**	**1,236**	**1,611**	**1,626**
Total Young Growth	**246**	**775**	**701**	**528**	**534**

Average Annual Harvest Acres of Suitable Lands Modeled in Second Decade					
	Alternative				
	1	2	3	4	5
Harvest[1,2]					
OG Even-aged	1,365	247	286	592	543
OG Uneven-aged	9	0	0	0	57
YG Even-aged	551	2,675	2,615	1,667	1,747
YG Patch Cut	0	0	0	0	274
YG Commercial Thinning	0	854	247	452	232
Total Old Growth	**1,374**	**247**	**286**	**592**	**600**
Total Young Growth	**551**	**3,529**	**2,862**	**2,119**	**2,253**

[1] Even-aged acres modeled as full timber yield by Woodstock.
[2] Uneven-aged acres modeled as reduced timber yield by Woodstock
OG = old growth; YG = young growth
Source: Woodstock Modeling results

Projected Timber Sale Quantity

Projected Timber Sale Quantity

The PTSQ of each of the alternatives is an indicator of possible future timber supply level that each alternative would produce. PTSQ is the estimated quantity of timber meeting applicable utilization standards that is expected to be sold during the plan period. As a subset of the PWSQ, the PTSQ includes volume from timber harvest for any purpose from all lands in the plan area based on expected harvests that would be consistent with the plan components. The PTSQ is also based on the planning unit's fiscal capability and organizational capacity.

Table 3.13-8 displays the projected timber output for the first through fourth decades that could result from implementing each of the five alternatives. Each alternative is judged by its ability to transition to predominantly young-growth harvest. This condition is judged to be fully achieved when 46 MMBF can be harvested per year with only 5 MMBF coming from old growth. The period required to reach this point is estimated to be approximately 12 years for Alternative 2, 13 years for Alternative 3, 16 years for Alternatives 4 and 5, and 32 years for Alternative 1. All of the action alternatives would produce a majority of the 46 MMBF per year for young growth in less than 15 years. Alternative 1 would require about 25 to 30 years. See Figures 2-1, 2-3, 2-5, 2-7, and 2-9 in Chapter 2 for graphical representations of PTSQ showing old-growth and young growth volume contributions over 100 years.

Table 3.13-8
Projected Timber Sale Quantity (Decades 1 – 4, Annual)

	1st Decade		2nd Decade	
Alt	Old Growth (MMBF)[1]	Young Growth (MMBF)[1]	Old Growth (MMBF)[1]	Young Growth (MMBF)[1]
1	38.4	7.6	30.8	15.2
2	23.8	22.2	5.0	90.6
3	25.8	20.2	5.0	82.9
4	35.2	10.8	12.3	56.5
5	34.5	11.5	11.6	60.2
	3rd Decade		**4th Decade**	
Alt	Old Growth (MMBF)[1]	Young Growth (MMBF)[1]	Old Growth (MMBF)[1]	Young Growth (MMBF)[1]
1	28.5	17.5	5.0	103.6
2	5.0	119.8	5.0	119.8
3	5.0	115.8	5.0	115.8
4	5.0	86.6	5.0	86.6
5	5.0	92.6	5.0	92.6

[1] MMBF = million board feet, long log bureau scale
[2] Source: Woodstock model outputs.

Factors Affecting the Projected Timber Sale Quantity

Within LUDs where timber harvest is compatible with the resource objectives of the area, there may be “intrusions,” “physical factors,” and “unmapped” standards and guidelines that limit timber management opportunities. These factors (discussed below), often termed “falldown,” have been recognized at the forest level, and the anticipated timber output adjusted appropriately. These limitations may include lands that are not capable of supporting a sustained timber management program. In other cases, where there are physical limitations, a less intensive or perhaps unregulated output may be scheduled for this period. Other factors also contribute to differences between PTSQs and timber sales, such as budgets and legal challenges.

The Forest-wide estimates used to develop the PTSQ considered many of the factors contributing to differences between PTSQs and the actual volumes produced in timber sales. These include factors affecting the suitability determination of forest lands that are usually encountered in on-the-ground examinations (e.g., sale reconnaissance, stand exams, layout, and sale preparation). For each alternative, areas were set aside (not scheduled for harvest) to allow for those factors most often encountered. Data from previous case studies, monitoring, site visits, inventory data, the GIS database, and an updated vegetation map were used to develop the acreage estimates (see Appendix B for more information).

Economics is an important consideration in determining whether lands should be harvested; however, experience has proven that it is not feasible to effectively factor in economics as part of the suitability determination. Economic conditions fluctuate greatly during the course of a plan period. One year a certain area of land or species may be uneconomic to harvest, and in another year, market conditions may have changed to where the same area or species would be in demand. This makes it difficult to meaningfully assess the economics of harvesting a particular site over a 10-year period. Also, the value of the timber sale program must be considered as a whole rather than by only evaluating individual timber sales or harvest units, because some sales or units of low value are offset by other higher-value sales or units. The economics of harvesting any

particular site can be considered as part of the project decision to approve harvest of the area.

Other Factors that Affect the Timber Sale Program

Other factors that may affect the amount of timber actually sold include the cost of preparing a timber sale due to budget constraints, administrative appeals and lawsuits (which may delay or forestall sales), transportation and fluctuating fuel costs (which affect the cost of harvesting a sale, especially a helicopter sale), and market conditions that may discourage purchasers from bidding on sales. Additional harvest may occur on lands that are not suitable for timber management, for example, to stimulate development of more complex canopy structures or to enhance forage in the understory in order to meet wildlife habitat needs or to salvage timber to improve wildlife habitat. Another example would be incidental harvest on steep slopes if they were found to be stable after a site-specific analysis.

Sustained Yield Limit and Projected Timber Sale Quantity

SYL is the amount of timber, meeting applicable utilization standards, “which can be removed from [a] forest annually in perpetuity on a sustained-yield basis” (NFMA at section 11, 16 U.S. Code 1611; 36 Code of Federal Regulations 219.11(d)(6)). It is the volume that could be produced in perpetuity on lands that *may be suitable* for timber production. Calculation of the limit includes volume from lands that may be deemed not suitable for timber production after further analysis during the planning process. The calculation of the SYL is not limited by land management plan desired condition, other plan components, or the planning unit's fiscal capability and organizational capacity. The SYL is not a target but is a limitation on harvest, except when the plan allows for a departure.

The projected yield over the next 10 decades that could contribute to the PTSQ is expected to increase over time as young-growth forests mature and become available for harvest. The average volume per acre of suitable old-growth forest is approximately 29 thousand board feet (MBF) per acre. The expected volume of 100-year-old stands of young growth in the central portion of the Tongass is approximately 56 to 60 MBF per acre (based on the Forest’s managed yield tables for this area), depending on stand management (see below). As more 100-year-old stands become available for harvest, the PTSQ could increase, or the land base needed to produce a given PTSQ could decrease.

The PTSQ does not exceed the SYL during the 100-year-plus planning horizon. The potential PTSQ is expected to be between 37 and 56 percent of the SYL for the rotation under all alternatives based on the SYL calculations (with roadless areas excluded). Table 3.13-9 displays the PTSQ and SYL by alternative. For all alternatives, the PTSQ never exceeds the SYL during the planning horizon.

Table 3.13-9
Projected Timber Sale Quantity and Sustained Yield Limit (MMBF[1])

Alt.	Decade 1 to 2: Annual Volume	Decades 3 to 5: Annual Volume	Decades 6 to 10: Annual Volume	SYL: Annual Volume[2]	Maximum PTSQ as % of SYL
1	46	46-138	138	248	56%
2	46-125	125	125	248	50%
3	46-121	121	121	248	49%
4	46-92	92	92	248	37%
5	46-98	98	98	248	40%

[1] MMBF: million board feet
[2] SYL in table is based on a land base that excludes roadless areas. If roadless areas are included in the land base, then the SYL would increase to approximately 412 MMBF per year.
SOURCE: Woodstock modeling results

Future Conditions

Approximately 90 percent of the existing timber stands on the Tongass are beyond CMAI. Timber stands that exceed CMAI are either in decline or are not growing at optimal rates for their site's potential productivity. The western hemlock-Sitka spruce forest type is one of the world's most productive forest types (USDA Forest Service 1983). The forest yield tables for the Tongass estimate that a normally stocked stand 40 years old would contain 7 MBF of merchantable wood per acre. By age 70, volume should increase to 29 MBF of wood per acre, assuming no precommercial thinning occurred. The age of CMAI would be around 100 years with a merchantable volume of 56 MBF per acre, assuming no precommercial or commercial thinning. If the same stand is thinned, volume at CMAI is estimated to be 60 MBF, in addition to an estimated 8 MBF of commercial thinning volume. Yields from uneven-aged silvicultural systems would be considerably less, approximately 28 MBF at age 200, based on the updated forest yield tables.

As a greater proportion of the Forest is converted from slower growing, highly-defective old-growth stands to stands well-stocked with vigorously growing conifers, total forest growth would increase. Because of higher volumes and lower defect, managed young-growth would be able to provide higher harvests on the same land base or support the same harvest on a smaller land base. However, as noted previously, harvesting trees at 65 to 75 years of age, well prior to CMAI, would shorten the transition time, but in the long term it would result in smaller piece sizes, resulting in fewer options for wood products and lower overall volumes produced.

Only a portion of the Forest would emphasize timber management; most of the existing mature and old-growth stands on the Forest would be maintained. Under all alternatives, more than 100 years from now, the predominant age class on the Tongass would still be greater than 150 years as old-growth forest. The percent of total productive forest land that would be managed stands of less than 150 years of age is expected to be a relatively small component of the forest landscape on a Forest-wide basis for all alternatives. Old growth would still be the predominant vegetative structure on the Tongass (Table 3.13-10).

Conifer growth in young stands can be accelerated through silvicultural treatments to control conifer stocking. Benefits from such treatments may include larger piece size and consequently lower logging costs, increased stand variability, higher quality wood, and employment opportunities. In addition, treatments may shorten the time period spent in the stem exclusion phase of stand development and offer other resource benefits.

Table 3.13-10
Forest-wide Stand Structures Existing and after 100 Years (thousands of acres)

	Alternative					
Stand Structure	**Existing**	**1**	**2**	**3**	**4**	**5**
0 to 149 years, including natural young growth	544	540	542	535	529	538
Productive Old-growth (150+ years)	5,002	5,010	5,008	5,014	5,020	5,012

Note that the alternative totals take into account the harvest over 100 years, as well as the acres of existing young growth that will be over 150 years (POG) after 100 years from now.
Source: Woodstock modeling and GIS analysis results. Numbers may not add correctly due to rounding.

Managing stands to enhance wildlife and fish habitat carrying capacity is one of the objectives of the Tongass National Forest. To help meet this objective, the Forest Service has implemented studies on stand management, including the Tongass wide Young-Growth Study, the Prince of Wales Commercial Thinning Study, the Alternatives to Clearcutting study, and other Pacific Northwest research, some of which has been discussed in this section.

Cumulative Effects

Cumulative effects to timber include past and present and proposed harvest discussed above. Table 3.13-9 presents a comparison of harvest and SYL by alternative, an important measure of the cumulative effect on the growing stock on NFS land. Maximum harvest levels on NFS lands proposed under all alternatives are well within the SYL. Table 3.13-10 displays Forest-wide stand structure on NFS lands under existing conditions and after 100 years. Cumulative effects on timber resources across Southeast Alaska are presented below.

In 1954, there were approximately 6.3 million acres of productive forest land on all ownerships inside the Tongass Forest boundary (including Annette Island). The amount of forest land in Southeast Alaska that is available for timber management has declined over the past century, largely due to Wilderness and LUD II designation by Congress, land selections by the State and ANSCA, and to land allocated to non-development LUDs in the current Forest Plan. This, along with mill closures and changes in timber markets, has contributed to a decline in timber harvest. Harvest on all lands in Southeast Alaska peaked from the late 1960s through the early 1990s and has been in decline since then. Total harvest on federal, state, and private lands declined from just under 1,000 MMBF in 1989 to less than 200 MMBF in 2005. Approximately 722,000 acres of productive forest land have been harvested since 1954 in this portion of Southeast Alaska, approximately 64 percent of this is NFS land and 36 percent is on Native corporation, state, and other lands.

Currently, there are between 0.51 and 0.83 million acres of NFS lands considered suitable for timber management on the Tongass, depending on the alternative. In addition, nearly 0.52 million acres of state, Native corporation, and other private lands are available for harvest. The allowable sale quantity from the Tongass National Forest is an average of 267 MMBF per year under the 2008 Forest Plan, although actual harvests have averaged 30 to 40 MMBF per year for the last few decades. Potential annual harvest on state and private land is estimated to be approximately 90 MMBF (Daniels et al. 2015). Based on past experience, most of the harvest on private land would be exported and would not contribute to meeting local demand. Using this estimate, cumulative harvest in

Southeast Alaska would be about 136 MMBF for the next decade, increasing slowly in succeeding decades, and would be the same for all alternatives. Table 3.13-11 displays the cumulative harvest under the alternatives.

Table 3.13-11
Maximum Estimated Annual Timber Harvest in Southeast Alaska during the First Decade (MMBF)

Alternative	National Forest[1]	State and Private[2]	Total
1	46	90	136
2	46	90	136
3	46	90	136
4	46	90	136
5	46	90	136

[1] Woodstock model estimates, 2015
[2] 70 MMBF/year from Native corporation lands and 20 MMBF/year from state land (Daniels 2015). Most harvest on private land is exported.
MMBF = million board feet.

See Appendix C for a complete list of actions considered in this analysis.

Minerals

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Affected Environment

Mineral deposit types and mineral resource occurrences were described thoroughly in the 2008 Land and Resource Management Plan (Forest Plan) Amendment Environmental Impact Statement (EIS) and the 1997 Forest Plan EIS. This section will briefly summarize the affected environment for minerals and provided updated information where conditions have changed.

Mineral resources occurring within the boundaries of the Tongass National Forest include gold, silver, molybdenum, and uranium, and nationally designated "strategic" and "critical" minerals such as lead, zinc, copper, tungsten, and platinum group metals. The Forest Service recognizes that minerals are fundamental to the Nation's well-being and, as policy, encourages the exploration and development of the mineral resources it manages. The Secretary of Agriculture has provided regulations (36 Code of Federal Regulations [CFR] 228) to ensure surface resource protection, while encouraging the orderly development of mineral resources on National Forest System (NFS) lands.

With respect to National Forest management, mineral resources are legally divided into three groups: locatable minerals, leasable minerals, and salable minerals. The authority of the Forest Service to influence and regulate the exploration, development, and production phases of mining operations varies with each group. As a result, the Forest Service manages mineral resource programs that are specific to each group of minerals.

Locatable Minerals

A locatable mineral is any mineral that is "valuable" in the usual economic sense, or has a property that gives it distinct and special value. These are typically what are known as "hardrock" minerals. Locatable minerals may be recovered from lode deposits (solid rock) or placer (surficial) deposits. Examples of some locatable minerals on the Tongass National Forest are gold, silver, copper, molybdenum, iron, nickel, lead, and zinc. The General Mining Law of 1872, as amended, grants every United States citizen the right to prospect and explore public domain lands open to mineral entry. The right of access is guaranteed and is not at the discretion of the Forest Service.

The Forest Service works with mining claimants to provide reasonable access to their claims, minimize adverse environmental impacts on surface resources, and ensure reasonable reclamation of disturbed lands affected by mining operations. Protection of surface resources is accomplished by reviewing the mining plan of operations submitted by the claimant, disclosing impacts of the proposed mining operations in a site-specific environmental document, approving only those activities that are reasonably incident to the proposed operation, monitoring

operations to ensure environmental standards are met, and ensuring prompt and reasonable reclamation of disturbed areas.

By law, designated Wilderness, National Monuments, Research Natural Areas, Enacted Municipal Watersheds, and Wild Rivers (when designated by Congress) are withdrawn from mining claim location. These withdrawn areas are, however, subject to mining claims with valid existing rights established before the date the areas were withdrawn from mineral entry. As a consequence, some mining claims located within existing or proposed withdrawn areas could be developed in the future.

On the Tongass, Modified Landscape, Scenic Viewshed, Recreational Rivers, Timber Production, and Minerals Land Use Designations (LUDs) are open to mineral entry. The Primitive Recreation, Semi-Remote Recreation, Old-Growth Habitat, Experimental Forest, Special Interest Areas, Scenic Rivers, and LUD II LUDs remain open to mining activities; however, special stipulations and more stringent mitigation measures may be required for mining activities in these LUDs.

Leasable Minerals

Certain types of minerals, primarily energy resources (e.g. oil, gas, coal and geothermal resources), are not subject to mining claim location, but are available for exploration and development under provisions of the Mineral Leasing Act of 1920. Access to these types of minerals is provided through leases, permits, or licenses that include fee and/or royalty payment conditions. Federally owned leasable minerals include oil, gas, coal, geothermal resources, potassium, sodium, phosphates, and sulfur. The authority to manage these minerals is presently administered by the U.S. Department of Interior, Bureau of Land Management (BLM) in cooperation with the Forest Service.

No leasable minerals are presently being produced on the Tongass National Forest, and the anticipated demand is expected to remain low. The BLM conducted an assessment of mineral resource potential in support of a resource management plan for the Ring of Fire planning area (BLM 2006), which includes Southeast Alaska. The assessment indicated the potential for oil and gas occurrence in the Yakutat region was considered to be high, based on geologic factors (URS Corporation 2006). While there has been exploration activity in the Yakutat area in the relatively recent past, the resource development potential is considered low; therefore, the BLM expects no exploration or development activity within the next 10 to 15 years. Outside of the Yakutat area, oil and gas occurrence potential elsewhere in the Tongass is considered low to none.

Occurrences of coal found at several locations in Southeast Alaska; however, the BLM considers development of these resources to be uneconomic in the near future, other than possibly for local use, and does not foresee associated exploration or development activity.

Geothermal resources occur in 19 known locations in Southeast Alaska. Thermal springs in several locations have been developed for small-scale commercial uses such as tourism, aquaculture, community bathhouses, and district heating of buildings (URS Corporation 2006). There has been some recent interest in geothermal resources in the Bell Island area.

In 2008, in response to the Energy Policy Act (EPAct) of 2005, the BLM and the Forest Service, in cooperation with the Department of Energy, jointly prepared a Final Programmatic EIS (PEIS) for Geothermal Leasing in the Western United States (BLM and USDA Forest Service 2008). The PEIS provides a framework to facilitate the BLM and Forest Service efforts regarding geothermal lease applications that were pending as of the EPAct of 2005, as well as future

determinations for projects on BLM and NFS lands. The PEIS considered pending leases, including the three Bell Island leases that encompass much of Bell Island and a portion of the Cleveland Peninsula on the adjacent mainland. The PEIS analyzed whether or not the lands should be made available for the BLM to lease to a private geothermal developer. In December 2013, the Tongass National Forest completed an additional environmental analysis for the Bell Island Geothermal Leases with the publishing of a Supplemental EIS (USDA Forest Service 2012c). Of note, the SEIS considered effects to inventoried roadless areas and changed social and economic conditions. A Record of Decision (ROD) was published, documenting the Forest Service's decision to provide a consent determination to the BLM for the issuance of the three pending lease applications on Bell Island and the adjacent mainland.

While the occurrence potential for geothermal resources is considered high in several locations and some exploration could occur, geothermal development activity is not anticipated in the near future.

Salable Minerals

Salable, or "common variety," minerals on NFS lands are sold rather than located or leased. These minerals include petrified wood and common varieties of sand, rock, building stone, gravel, pumice, clay, and other similar materials. These minerals are most commonly used as building materials and are also used for agriculture, cleaners and abrasives, and as inputs to manufacturing processes.

The predominant salable commodity extracted on the Tongass National Forest is crushed rock used to construct roads. The supply of quality rock sources is largely dependent upon the locations of active logging operations. Presently, there is an adequate supply of rock sources with suitable quality (hardness and durability) in the southern third of the Tongass. However, rock quality is poor in the northern two-thirds of the Forest, and good material sources are difficult to locate in current timber production areas. Sand and gravel sources are scarce throughout the Forest, except within the Yakutat Ranger District.

Limestone and marble are abundant in Southeast Alaska, and both have historically been produced from quarries in the region for use as building stone (BLM 2006). Identified marble resources in the region are estimated at over 800 million tons. Large quantities of limestone have been quarried from Prince of Wales and Dall Islands. Continued exploitation of these building material resources could be expected in the future. While several areas in Southeast Alaska also have geologic formations that are favorable for the occurrence of pumice deposits, market and location conditions indicate there will be little or no foreseeable development potential for pumice (URS Corporation 2006).

Mineral Resource Inventory and Development Potential

The 2008 Forest Plan Amendment provides a summary of Mineral Resource Inventory and Development potential on the Tongass including identified mineral resources and undiscovered resources. There has been no update to mineral inventories since that time.

Mineral Resource Demand

The extent to which identified and undiscovered mineral resources on the Tongass will be exploited in the future will depend largely upon the level of demand for those resources. Demand for mineral resources can be inferred based on the amount of money spent by the mining industry to prospect and explore for mineral resources in Southeast Alaska. Between 1982 and 1987, the mineral industry spent an average of $2.92 million per year on mineral exploration in Southeast Alaska, with a high of $5.85 million in 1987 (USDA Forest Service 1997a). Exploration expenditures increased drastically for the 1988 to 1991

period, when the industry spent more than $20 million each year. Expenditures generally declined for the next 10 years, reaching $1.6 million in 2001, before increasing again to a level of $9.9 million in 2006 (Alaska Department of Natural Resources [ADNR], Alaska's Mineral Industry annual reports and summaries for 1997 to 2005). Annual exploration expenditures remained high between 2007 and 2013, averaging $20 million with a high of $34.3 million in 2011.

Mineral Production

Mineral production in Southeast Alaska in recent years has been dominated by the Greens Creek Mine at the north end of Admiralty Island and Kensington Gold Mine located on the mainland north of Berners Bay. Greens Creek is an underground mining operation that opened in 1989 and produces silver, zinc, lead, and gold. In 2013, the mine milled about 805,000 tons of ore worth about $397 million and reported 306 total employees (Athey et al. 2014). Another operating mine on the Tongass is the Kensington Gold Mine, located about 45 air miles north of Juneau, which began production in 2010. The Kensington Mine milled about 554,000 tons of gold bearing ore in 2013 and reported 300 total employees (Athey et al. 2014).

Tongass Land Management for Minerals

As described previously, the Forest Service administers mineral exploration, development, and production activities through the legal/regulatory systems for locatable, leasable, and salable minerals. The Forest Service also accounts for mineral resources in the land management planning process. One way of recognizing the importance and potential of mineral resources is through the designation of Minerals LUDs in the Forest-wide land allocation. The intent of the Minerals LUD designation is to encourage exploration and development of locatable minerals in areas of high mineral potential, while taking other resource values into account. The Tongass Forest Plan includes management prescriptions for those areas, and standards and guidelines specific to minerals and geology.

The current Tongass Forest Plan, as amended, allocates several areas of the Forest to the Minerals LUD. The 2008 ROD expanded the Minerals LUD to about 249,570 acres, an increase of about 80,000 acres. These areas are widely distributed across most portions of the Tongass, excluding Wilderness and LUD II lands. Several Minerals LUDs are clustered around Juneau (near Lynn Canal, Berners Bay, Stephens Passage, Gastineau Channel, and Taku Inlet); on the north end of Admiralty Island; on Yakobi Island and on the mainland east of Wrangell; a cluster near Clarence Strait and the southern part of Prince of Wales Island; and an area near Hyder.

Unlike other LUDs, the Minerals LUD is an "overlay" designation that applies management prescriptions for minerals to the affected area in addition to the prescriptions of the underlying LUD, with the Minerals LUD having priority.

Environmental Consequences

None of the alternatives propose any changes to the current Minerals LUD. Expenditures for mineral prospecting and exploration, the demand for access to National Forest lands for the purpose of mineral exploration, and development is expected to remain high in the near future. Mineral entrants will continue to submit plans of operation to the Forest Service for approval, and regulations under which those operating plans are processed will not change by alternative. Identified and undiscovered mineral resource tracts, characteristics and location

of mineral deposits, and Southeast Alaska geology will not vary as a result of implementing any of the alternatives.

Direct and Indirect Effects

Locatable Minerals

The effects of the Forest Plan alternatives on locatable minerals are not discussed in detail, as there are no aspects of the Forest Plan that would have a specific direct or indirect effect on activity related to locatable minerals. Under any alternative, future exploration and development (except for valid, currently existing rights) would be precluded in areas withdrawn from mineral entry, such as Wilderness. None of the alternatives would modify the boundaries of existing LUDs in a manner that would economically constrain existing or future mineral activities.

Leasable Minerals

Alternative 1
Similarly, the effects of the Forest Plan alternatives on leasable minerals are not discussed in detail because there are no aspects of the Forest Plan that would have a specific direct or indirect effect on activity related to leasable minerals. The Tongass has no current leasable mineral activity, and the anticipated demand for leasable minerals is expected to remain low. The Forest Service is aware of some level of interest in oil and gas, coal, and geothermal resources in specific areas of the Tongass. Consistent with the current Forest Plan, any mineral leasing activity would need to be consistent with the standards and guidelines for the respective LUDs affected by leasing. The effects of any mineral leasing activity will be analyzed at the appropriate future time if the Forest Service receives specific requests for access to leasable minerals.

Alternatives 2, 3, 4, and 5
Each of the action alternatives includes new plan components governing the development of renewable energy projects, including geothermal resources. Any geothermal project would need to be consistent with the new plan components for Renewable Energy (Forest Plan Chapter 5). The effects of any geothermal energy project will be analyzed at the appropriate future time if the Forest Service receives specific requests for such projects. For all other mineral leasing activity, the effects would be the same those of Alternative 1.

Salable Minerals

Salable or common variety minerals, primarily crushed rock, are utilized in each of the alternatives. Their predominant use is to construct roads in support of the Tongass National Forest transportation system, and thus the amounts used will correspond closely to the miles of new road construction by alternative. These are shown in Chapter 2 as well as the *Transportation* section of this chapter.

Effects on Other Resources

The development of mineral resources in the Forest generally requires construction of an underground or surface mine complex, a millsite, road and pipeline systems, tailings and waste rock disposal areas, a marine transfer/docking facility, and lodging accommodations if the mine location is not close to an existing community. Total surface-disturbing acreage can vary markedly with specific project characteristics; the operating Greens Creek mine involves about 350 acres for facility development. The Kensington mine project

occupies about 280 acres. The effects of any such development are analyzed at the time a specific project is proposed.

Cumulative Effects

There are no aspects of any of the alternatives that would have a specific direct or indirect effect on activity related to locatable, leasable (excluding geothermal) or saleable minerals. Thus, there are no cumulative effects to these resources from any of the alternatives. Under all alternatives, the right to prospect and explore public domain lands open to mineral entry are preserved. Existing mineral projects are expected to continue and new projects are expected to be explored and developed. The effects of any mineral activity operating under the standards and guidelines of the Forest Plan would be evaluated at the time appropriate future time if the Forest Service receives specific requests for such projects. Appendix C of this EIS provides a full list of all the projects considered in the cumulative effects analysis.

See the *Renewable Energy* section for a discussion of renewable energy direct, indirect, and cumulative effects.

Recreation and Tourism

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Affected Environment

The affected environment portion of the recreation and tourism analysis is divided into two broad sections, the first addressing the supply of recreation opportunities, and the second addressing existing use levels and trends. The supply section discusses the existing supply of recreation opportunities in terms of the Forest Service's Recreation Opportunity Spectrum (ROS) classes and inventoried recreation places on the Tongass. The existing use and trends section discusses overall forest use, resident recreation, tourism, and commercial outfitter/guide use.

The remainder of this introductory section provides a general overview of recreation in Southeast Alaska and the Tongass National Forest, which comprises approximately 80 percent of the region. Southeast Alaska possesses a remarkable and unique combination of features including inland waterways with over 11,000 miles of shoreline, mountains, fiords, glaciers, and large or unusual fish and wildlife populations that provide opportunities for a wide range of outdoor recreation experiences. Southeast Alaska imparts a sense of vastness, wildness, and solitude. These sentiments are enhanced by a small resident population and a relative absence of development compared to most other National Forests.

Recreation and tourism on National Forests encompasses more than the provision of facilities or recreation sites. This is especially true on the Tongass National Forest where most recreation and tourism attractions occur in remote undeveloped areas. Many Alaska residents purposefully live in proximity to such settings as a part of their lifestyle. Most visitors who travel long distances to see Alaska expect to find it in a wild and "unspoiled" state, but also expect comfort and convenience, reliable transportation, and other features requiring some level of infrastructure and development. The challenge to managers is to identify and understand the relationship between the settings and the variety of client groups. Commercial providers of recreation activities base much of their marketing strategy on particular environmental settings and identified recreation places within those settings.

The Tongass National Forest includes approximately 17 million acres of land available for recreation. This land contributes greatly to the feeling of vastness and solitude that dominates the region; however, much of the land is not suitable for outdoor recreation. Difficult and steep terrain, wetlands, icefields, glaciers, and heavy vegetation confine most recreation activities to accessible shorelines, river and stream bottoms, and around the many lakes within the Forest. Extensive use is made of some of the icefields and alpine areas (above tree line), but access to these areas is usually by aircraft. Both residents and visitors use the developed campground and picnic areas, beaches, trails, cabins, shelters,

and visitor centers that are located near communities. An inventory of developed recreation sites on the Tongass is presented in Table 3.15-1.

Table 3.15-1
Tongass Recreation Facilities, 2015

Type of Facility	Number
Anchor Buoys	42
Boating Sites	7
Campgrounds	15
- Number of Sites	220
Camping Areas	7
Day Use Areas	10
Picnic Sites	33
Group Picnic Sites	2
Hotel, Lodge, Resort	2
Interpretive Site	3
Interpretive Visitor Centers	3
Lookout/Cabin	147
Shelters	39
Observation Site	2
Recreation Residence	3
Swimming Site	2
Trailheads	120
Trails (number of miles):	
– Nonwilderness	900
– Wilderness	93
Total Trail Miles	993
Wildlife Viewing Sites	10

The National Park Service manages 3.3 million acres in three park units in Southeast Alaska: Glacier Bay National Park and Preserve, Sitka National Historic Park, and Klondike Goldrush National Historic Park. The majority of this land is located within the Glacier Bay National Park and Preserve.

The State of Alaska also administers land for recreation. Many of the state land selections were made with recreation opportunities for the residents of local communities in mind. Most of these opportunities are still undeveloped. State selections were also made for future development of a system of marine parks. Currently, Alaska State Parks manages about 80,000 acres and 34 park units, including 16 marine parks, in Southeast Alaska. In addition, the Alaska Department of Fish and Game (ADF&G) manages two state wildlife refuges, two critical habitat areas, and one wildlife sanctuary, and the Alaska Division of Forestry manages the 247,000-acre Haines State Forest (Alaska State Parks 2009).

Community road systems are limited and heavily used for access to recreation sites and attractions near local communities. Existing road systems are primarily located near the larger communities of Juneau, Sitka, Ketchikan, Petersburg, and Wrangell. There is an extensive road system connecting the small communities on Prince of Wales Island, as well as road systems near the communities of Hoonah and Kake. There is no interconnecting highway system between islands or between communities on the mainland.

Haines, Skagway, and Hyder all have highway connections to Canada and the Alaska Interior, as well as the lower 48 states, and serve as gateways for tourists heading north. Haines and Skagway are also visited by cruise ships and served by the Alaska Marine Highway System (AMHS).

Roads exist in other locations where timber harvest has taken place. Independent visitors from outside the state and residents from other parts of Southeast Alaska use road systems that are accessible from the AMHS ferries or from local communities for recreational purposes. Roads in locations where there are no communities or interconnecting access to the AMHS receive relatively low levels of recreation use. However, recreation-related vehicle use has been growing on some remote islands, including Kruzof, Zarembo, and Etolin Islands, and isolated systems on Kuiu and Kupreanof Islands. While the total amount of recreation use on these islands is low, it can be heavy at times, such as during hunting season.

Supply of Recreation Opportunities

The supply of recreation opportunities is described in this analysis using two concepts: ROS and recreation places. These concepts describe the quantity of recreation opportunities. Quality is addressed using the "Home Range" concept and by assigning a value to the recreation places. These concepts are discussed in the following sections.

The Tongass National Forest has the potential to provide a wide variety of recreation settings. The ROS has been developed to help identify, quantify, and describe these settings. The ROS system portrays the combination of activities, settings, and experience expectations along a continuum that ranges from highly modified to primitive environments. Seven classifications are identified along this continuum: Urban (U), Rural (R), Roaded Modified (RM), Roaded Natural (RN), Semi-Primitive Motorized (SPM), Semi-Primitive Non-Motorized (SPNM), and Primitive (P). The ROS inventory may be used to assess the potential effects of the alternatives on recreation settings.

The seven ROS classes are summarized in Table 3.15-2, based on seven elements that are considered in the allocation and management of recreation settings. Forest-wide ROS acres are presented in Table 3.15-3.

Table 3.15-2
Comparison of ROS Classes

	Urban (U)	Rural (R)	Roaded Modified (RM)	Roaded Natural (RN)
Scenic Quality	Alterations to landform and vegetation dominate landscape; nonrecreational activities not to exceed Low SIO - FG; Very Low SIO - MG.	Alterations to landform and vegetation dominate landscape; nonrecreational activities not to exceed Low SIO - FG; Very Low SIO - MG.	Alterations dominate the landscape; nonrecreational activities/structures evident, but do not exceed Very Low SIO.	Alterations to landscape subordinate; nonrecreational activities not to exceed Low SIO though typically Moderate SIO.
Access[1]	Access and travel facilities are highly intense, motorized, and often with mass transit supplements.	All methods of access and travel may occur, but subject to formal regulation.	All methods of access and travel when needed and compatible with intended activities.	All methods of access and travel may occur when compatible with intended activities; zones of non-motorized use.
Remoteness	Remoteness from sites and sounds of human activity not available or important.	Remoteness from sites and sounds of human activity not available or important.	Remoteness from continuous sounds of human activity is of moderate importance.	Remoteness from continuous sounds of human activity is expected.
Visitor Management	Intensive on-site controls are numerous and obvious.	On-site regimentation and control is obvious.	On-site regimentation and control is obvious.	On-site regimentation and controls are few.

Table 3.15-2 (continued)
Comparison of ROS Classes

	Urban (U)	Rural (R)	Roaded Modified (RM)	Roaded Natural (RN)
On-site Recreation Development	Recreation structures and facilities readily evident, but appropriate for setting; designed for high use levels. Information and interpretive facilities may be large and complex.	Recreation structures and facilities readily evident, but appropriate for setting, designed for high use levels. Information and interpretive facilities may be large and complex.	Recreation structures and facilities provided for site protection and user convenience. Facilities are contemporary but of rustic design and harmonize with natural setting.	Recreation structures and facilities may be present, but are provided primarily for protection of the resource rather than user convenience. Facilities are rustic and harmonize with a backcountry setting.
Social Encounters	High concentrations of people at one time.	Moderate to high concentrations of people at one time.	Interactions with others may be moderate to high. Moderate concentrations of people, especially on trails and in dispersed areas.	Moderate concentration of users on roads and little evidence of others or interactions at campsites.
Visitor Impacts	Very noticeable, but managed to prevent physical resource degradation.	Very noticeable, but managed to prevent physical resource degradation.	Human use noticeable, but not degrading to resources. Site hardening dominates campsites, parking areas.	Visitor use noticeable, but not degrading to resources; established SIOs.

	Semi-Primitive Motorized (SPM)	Semi-Primitive Non-Motorized (SPNM)	Primitive (P)
Scenic Quality	Alterations few and subordinate to landscape; designed and located to not exceed Moderate SIO.	Alterations few and subordinate to landscape; nonrecreational activities and structures designed not to exceed High SIO.	Alterations to landscape not evident; structures do not exceed High SIO.
Access[1]	Travel on trails designed for/open to motor vehicles; roads maintained for high clearance vehicles; motorboats operating on waterways; may establish zones of non-motor use for facility/resource protection.	Trails closed to motorized use; nonmotorized boats used on freshwater lakes and streams.	Trails closed to motorized use; non-motorized boats used on freshwater lakes and streams.
Remoteness	Nearby sights and sounds of human activity are rare; distant sounds may occur.	Nearby sounds of human activity are rare; distant sounds may occur.	Sounds of human activity are very infrequent to nonexistent.
Visitor Management	On-site regimentation and controls are few.	On-site regimentation and controls are rare.	On-site regimentation and controls are very rare.
On-site Recreation Development	Recreation structures and facilities may be present, provided primarily for protection of site rather than user convenience. Facilities, when present, are rustic and harmonize with natural setting.	Recreation structures and facilities may be present but provided primarily for protection of site. Facilities, when present, are rustic and harmonize with natural setting.	Recreation structures are rarely present, provided primarily for the protection of the site. Facilities, when present, are rustic and harmonize with natural setting.
Social Encounters	Low interaction between users. Campsites seldom within sight or sound of another group except during peak periods.	Low interaction between users. Campsites seldom within sight or sound of another group except during peak periods.	Very low interaction between users and no other groups in sight or sound of overnight camps.
Visitor Impacts	Human use noticeable, but not degrading to resource or backcountry setting.	Human use noticeable, but not degrading to resource elements.	Human use essentially unnoticeable. Site hardening—boardwalks, boat moorings, food caches.

[1] Subject to ANILCA provisions.
Note: SIO = Scenic Integrity Objective, FG = Foreground, MG = Middleground
Source: USDA Forest Service 1997a (Table 3-30).

Viewed in terms of acres, the Primitive ROS setting is the largest on the Tongass, with approximately 10.4 million acres allocated to this setting (Table 3.15-3). The Wilderness and Natural Setting Land Use Designation (LUD) groups currently account for 47 and 46 percent of this total, respectively (Table 3.15-4). Approximately 33 percent of the areas presently inventoried as SPNM (3 million acres) are located in the moderate development (11 percent) or intensive development (22 percent) LUD groups[1], with 19 percent located in existing Wilderness. Areas inventoried as SPM account for approximately 1.5 million acres Forest-wide and are mostly located in the Wilderness (31 percent) and Natural Setting (48 percent) LUD groups. Approximately 72 percent of areas allocated to the RN, RM, Rural, and Urban settings are located in the moderate development (22 percent) or intensive development (50 percent) LUD groups (Table 3.15-4).

Existing Wilderness on the Tongass is mostly associated with the Primitive ROS setting (82 percent), with the remaining 18 percent comprised of SPNM (10 percent) and SPM (8 percent). Much of the area inventoried as SPM on the Tongass is accessed via motorized watercraft. The Primitive ROS setting also comprises a large share of the Natural Setting LUD group (64 percent), with SPNM accounting for a further 20 percent (Table 3.15-4).

Table 3.15-3
Forest-wide Recreation Opportunity Spectrum Acres, 2015

ROS Class	Acres	Percent of ROS Total
Primitive (P)	10,357,832	62
Semi-Primitive Non-Motorized (SPNM)	3,052,410	18
Semi-Primitive Motorized (SPM)	1,458,528	9
Roaded Natural (RN)	157,386	1
Roaded Modified (RM)	1,662,825	10
Rural and Urban (R and U)	5,618	<0

Note:
The total acres by ROS class shown in this table is slightly lower than the Forest-wide total because the ROS inventory does not include the entire Forest.

[1] The Recreation and Tourism analysis divides the Tongass LUDs into four groups:

- Wilderness: Wilderness, Wilderness National Monument, and Non-Wilderness National Monument.
- Natural Setting: LUD II, Research Natural Area, Old Growth Habitat, Special Interest Area, Municipal Watershed, Wild River, Scenic River, Recreational River, Remote Recreation, and Semi-Remote Recreation.
- Moderate development: Modified Landscape, Scenic Viewshed, and Experimental Forest.
- Intensive development: Timber Production.

Table 3.15-4
Forest-wide Recreation Opportunity Spectrum Acres by LUD Group, 2015

LUD Group	P	SPNM	SPM	RN	RM	R+U
Acres by LUD Group and ROS						
Wilderness	4,841,150	575,099	450,580	19,669	18,862	468
Natural Setting	4,789,784	1,474,340	701,878	87,088	369,164	4,043
Moderate Development	159,971	327,470	170,247	39,256	370,468	399
Intensive Development	566,863	675,473	135,749	11,347	904,262	684
Percent of ROS Setting						
Wilderness	47	19	31	12	1	8
Natural Setting	46	48	48	55	22	72
Moderate Development	2	11	12	25	22	7
Intensive Development	5	22	9	7	54	12
Percent of LUD Group						
Wilderness	82	10	8	0	0	0
Natural Setting	64	20	9	1	5	0
Moderate Development	15	31	16	4	35	0
Intensive Development	25	29	6	0	39	0

Notes:
[1] P=Primitive, SPNM=Semi-Primitive Non-Motorized, SPM=Semi-Primitive Motorized, RN=Roaded Natural, RM=Roaded Modified, R+U=Rural and Urban
[2] The total acres by ROS class shown in this table is slightly lower than the Forest-wide total because the ROS inventory does not include the entire Forest.
[3] The Recreation and Tourism analysis divides the Tongass LUDs into four groups:

- Wilderness: Wilderness, Wilderness National Monument, and Non-Wilderness National Monument.
- Natural Setting: LUD II, Research Natural Area, Old Growth Habitat, Special Interest Area, Municipal Watershed, Wild River, Scenic River, Recreational River, Remote Recreation, and Semi-Remote Recreation.
- Moderate development: Modified Landscape, Scenic Viewshed, and Experimental Forest.
- Intensive development: Timber Production.

Recreation Places

The Tongass offers a unique recreation setting because it provides an island and marine environment in close proximity to major mountain ranges and icefields. Forested mountains rising from the saltwater provide unique and remote coastal recreation opportunities not found in other areas of the United States. Recreation enthusiasts are able to view a variety of natural landforms and wildlife, such as glaciers, old-growth forests, humpback whales, spawning salmon, brown bears, and bald eagles. The immense amount of land on the Tongass National Forest provides a great diversity of recreation attractions and opportunities. Most recreation activities take place in, and are dependent on, settings that are primarily undeveloped and widely dispersed. The surrounding saltwater, which is not managed by the Forest Service, allows for motorized boat and floatplane access throughout Southeast Alaska.

The pattern of use associated with known protected boat anchorages, boat landings, aircraft landing sites, and the limited road systems makes it possible to identify specific “recreation places.” Recreation places are those areas that are used for recreation activities and are easy to access. Approximately 1,436 recreation places, totaling about 3.6 million acres (22 percent of the total Tongass National Forest), have been identified. Approximately 22 percent, or 311 of these places, are located in existing designated wildernesses. Although these areas comprise only 22 percent of the Forest-wide number of recreation places, they account for 36 percent of total recreation place acres.

The setting of a recreation place plays a key role in its attractiveness and use. Many recreation opportunities, such as viewing scenery or pursuing solitude, are dependent on this relationship and require a natural type of setting, whereas

others, such as hunting or fishing, are less dependent on the type of setting. Table 3.15-5 identifies the distribution of recreation place acres by ROS class. Recreation places can be categorized into three general groupings based on their principle uses and attractions. These three general groupings, marine, freshwater, and land-based, are discussed in the *Recreation and Tourism* section of the 1997 Forest Plan Revision Final Environmental Impact Statement (FEIS) (USDA Forest Service 1997a, pp. 3-107, 3-108). The distribution of recreation places among these general groupings is presented in Table 3.15-6.

For the purposes of this analysis, recreation places are classified in two basic ways. First, recognizing that access plays a key role in recreation in Southeast Alaska, "home ranges" were defined for each community. Inventoried recreation places were classified into two categories: those located within a radius of approximately 20 miles from communities ("home range") and those outside ("rest of forest"). Almost half (48 percent) of the recreation place acres are within a community home range. Second, recreation places are identified as either important or ordinary/ common based on five categories: facilities, marine, hunting, fishing, and tourism. The Forest Service developed this rating system in response to public comments received on the 1990 Draft Environmental Impact Statement (DEIS). Recreation places may be important for one, several, or none of the identified categories. Important recreation places by category are summarized in Table 3.15-7 and discussed further in the *Recreation and Tourism* section of the 1997 Forest Plan Revision FEIS (USDA Forest Service 1997a, pp. 3-109, 3-111).

Table 3.15-5
Distribution of Recreation Place Acres by Recreation Opportunity Spectrum Class

ROS Class	Acres (1,000s)
Primitive	1,306
Semi-Primitive Non-Motorized	916
Semi-Primitive Motorized	870
Roaded Natural	103
Roaded Modified	432
Rural and Urban	3

Note: These totals include all identified recreation places within the Tongass National Forest boundary, including those on state and private lands.

Table 3.15-6
Distribution of Recreation Places by General Use

	Number of Places	Percent of Total	Acres (1,000s)[1]	Percent of Total
Marine	617	43	1,234	34
Freshwater	302	21	908	25
Land-based	531	37	1,488	41
Total	**1,436**	**100**	**3,630**	**100**

[1] Updated acreages were calculated using the ratios from USDA Forest Service 1997a (pp. 3-107, 3-108) and the total acres identified in Table 3.15-5. Totals may not sum exactly due to rounding.

Table 3.15-7
Important Recreation Places by Category[1]

	Number of Places	Percent of Total[2]	Acres (1,000s)	Percent of Total[2]
Facilities[3]	402	28	1,053	29
Marine[4]	617	43	1,089	30
Hunting[5]	373	26	1,452	40
Fishing[6]	187	13	472	13
Tourism	876	61	1,924	53
Total Acres/Places	**1,436**	**NA**	**3,630**	**NA**

[1] Recreation places are rated as either important or common/ordinary.
[2] Percent columns sum to more than 100 because a recreation place can be rated important in more than one category.
[3] All recreation places with facilities were rated as being important. In addition, other recreation places with some type of facility, such as a viewing platform, and facilities authorized by a special use permit for recreation purposes, were identified as important.
[4] The marine category identified here is different to the marine type identified in Table 3.15-6. The marine category in this table only includes those recreation places that are truly unique or typify the Southeast Alaska marine experience.
[5] Important hunting areas were distinguished from ordinary hunting areas based on a number of factors, including heavy recurring use, hunter success, ease of access, opportunities for several species, and prized species, such as mountain goats and moose.
[6] Important fishing recreation places were identified using ADF&G ratings for recreational fishing.
Note: This estimate of total recreation place acres is slightly higher than the estimate used in the current Forest Plan Revision FEIS (USDA Forest Service 1997a). The database used to develop these estimates has been updated and these estimates were developed using a more precise methodology than the grid-sampling approach that was employed in the 1997 Forest Plan Revision FEIS analysis.
Source: USDA Forest Service 1997a (pp. 3-109, 3-111).

Existing Use Levels and Trends

The following section is divided into four parts that discuss forest use in general, resident recreation, tourism, and commercial outfitter/guide use on the Tongass National Forest.

Forest Use

Although there are some locations on the Tongass where fees are collected and locations where people can be easily counted, much of the information regarding general public use has been historically based on long-term observations, anecdotal information, and professional estimates, adjusted by quantitative indicators where available. In general, many residents and nonresidents seek the same type of recreation experiences and many engage in similar activities. Alaska has a reputation for vastness, rugged beauty, and solitude, and both residents and nonresidents usually expect to find these qualities in recreation settings. Expectations often vary by group and individual, however, with some people having higher expectations of wilderness and solitude than others.

The Alaska Region of the Forest Service (Region 10) has been participating in the Forest Service's National Visitor Use Monitoring (NVUM) program since 2000. Based on the results of the NVUM program and supplemental survey results for 2008 and 2009, White and Stynes (2010) calculated a revised visitation estimate of 1,885,513 annual visits to the Tongass National Forest. The revised estimate took into account previously undocumented travel to the forest via boat and plane (the visitation estimate based on the national survey was 1,628,000). Half of Alaska residents surveyed who live in Southeast Alaska reported using a boat or plane to access the national forest. This is different to the ways national forests are accessed in other states and reflects the undeveloped and remote nature of Southeast Alaska, and is one reason

recreation sampling in Alaska is very challenging (USDA Forest Service 2013f). Based on more recent NVUM surveys conducted as part of the NVUM Round 3 (2010 to 2014), the current estimate for the Tongass National Forest is approximately 1,836,000 annual visits (USDA Forest Service 2015f).

Resident Recreation

Many residents of Southeast Alaska place a high value on the quality and availability of outdoor recreation opportunities in the region, with the proportion of Alaskan residents who participate in outdoor activities generally much higher than elsewhere in the United States (Bowker 2001). Many local residents engage in dispersed recreation activities on National Forest System (NFS) land and adjacent saltwater. Accurate data on this type of use are difficult to obtain and estimates tend to either underestimate the nature and extent of much of this use or overcompensate in inconsistent ways (USDA Forest Service 1997a, p. 3-120). The net result is that while there is a general consensus that outdoor recreation opportunities and activities provided by the Tongass are highly important to residents, there is limited data that accurately quantifies resident recreation use.

Resident recreation demand is influenced by a number of factors, including regional population levels, per capita participation rates, and recreation travel behavior. Over time, the supply of certain recreation opportunities in Southeast Alaska has increased. Road systems have expanded into previously inaccessible areas and visitor services and tourism marketing have also increased. In some cases, supply-induced increases in participation have occurred. On Prince of Wales, Wrangell, and Mitkof Islands, for example, road systems developed for timber harvesting created an opportunity for road-related access to previously inaccessible recreation settings and an opportunity for recreation activities involving wheeled vehicles.

Supply-induced participation changes have also been accompanied by additional demand for specific recreation places or facilities for a related activity. Increased opportunities for roaded access and activities are typically accompanied by a need for parking, dispersed campsites, picnic sites, trails to scenic attractions, and additional short access routes to cabin sites and previously inaccessible beaches. Increased tourism has resulted in increased demand for interpretive services as well as walking and hiking opportunities near the major communities.

The use of off-highway vehicles (OHVs) and over-snow vehicles is another growing activity on the Tongass. Use is limited by topography, dense vegetation, and wet soils. These types of vehicles are most frequently used on road systems connected to communities, with riders seeking out primitive roads or spurs. Limited accessibility often results in OHV use on muskegs, beaches, tidal areas, and river channels during low flows.

NFS routes (roads and trails) and areas designated as open to motorized use are identified on the Motor Vehicle Use Map (MVUM) for the Tongass. The MVUM also displays allowed uses by vehicle class (such as highway-legal vehicles, vehicles less than 50 inches wide and motorcycles), seasonal allowances, and distance allowances, and provides information on other travel rules and regulations. Routes not shown on the MVUM are not open to public motor vehicle travel. The MVUM is updated annually in January with separate maps available for each ranger district. In the next few years, the Tongass will address the management of over-snow vehicles in a similar manner with the issuance of maps identifying areas where their use is permitted after holding public meetings and subsistence hearings.

Tourism

Nonresident pleasure visitors or tourists can be generally divided into package and independent visitors. Package visitors are typically the cruise ship clients, though some arrive by ferry and airplane. The vast majority of visitors to Southeast Alaska are cruise ship passengers. The Summer 2011 statewide Alaska Visitor Statistics Program (AVSP)[2] found that cruise ship passengers accounted for 85 percent of visitors to Southeast Alaska compared to 57 percent of visitors statewide (McDowell Group 2012). Cruise ship passengers as a share of total visitors in Southeast Alaska varied by community, ranging from 12 percent of summer visitors to Prince of Wales Island to 98 percent of visitors to Hoonah. Cruise ship passengers also accounted for more than 90 percent of summer visitors to Juneau, Ketchikan, and Skagway (McDowell Group 2012).

The Tongass is home to a vibrant and growing tourism industry. Tourism from large and small cruise ships and independent tour operators plays an important role in the economies of communities throughout Southeast Alaska. Cruise ship and other package visitors are a very large group that uses the Tongass National Forest primarily as a scenic resource. These visitors spend less time in the area and generally follow preplanned and regimented itineraries. Shore excursions have, however, become an important part of the cruise ship experience, with much of this activity centered around communities. Half-day and day excursions into the Forest have also increased in popularity.

Independent visitors, who constitute a much smaller group, tend to arrive by air, ferry, and highway and engage in a variety of activities. Independent visitors spend more time in the communities and on the Forest, and may secure the services of outfitters and guides, restaurants, motels, and transportation services such as floatplanes, boats, and gas stations. Independent travelers tend to plan their own itineraries, but often secure the services of mini-packages, such as day excursions or fishing charters. These types of visitors compete more directly with residents for recreation opportunities on the Forest. Lodges have grown in popularity in recent years, with fishing lodges in particular playing an important role in the tourism industry in some local areas. This is, for example, the case with Elfin Cove, a small town located west of Hoonah, where nine recreational fishing lodges are located in the vicinity of the town (Dugan et al. 2006). Fishing lodges accounted for 65 percent of the non-cruise, multi-day packages identified in Summer 2011, with remote-lodges accounting for a further 15 percent of the total. Adventure tours (8 percent), rail packages (4 percent), motor coach tours (4 percent), rental car/RV package (4 percent) and “other” (1 percent) accounted for the remaining share of multi-day packages (McDowell Group 2012).

The marketing of recreation opportunities by commercial suppliers has important similarities to resident recreation concerns. For example, many businesses that provide boat or aircraft access for wildlife viewing and other activities have a low tolerance for the presence of other groups in the same area. The presence of more than two or three other parties in a bay or area may cause such operators to seek substitute locations. The ability to market Alaska tourism is dependent on meeting customer expectations of seeing and experiencing vast, untamed land and its wildlife. Resident recreationists who traditionally use an area may, however, be discouraged by commercial businesses operating in the same area.

[2] The AVSP is a significant visitor industry research project conducted periodically by the State of Alaska. The most recent study was conducted in 2011 (McDowell Group 2012).

Visitors to Southeast Alaska

The 2011 Summer AVSP found that city/sightseeing tours, cultural activities, and wildlife viewing were the most popular activities among visitors to Southeast Alaska based on estimated participation rates, with 46 percent, 46 percent, and 42 percent of visitors engaging in these activities, respectively (Table 3.15-8). Other popular activities included hiking/nature walk (28 percent), day cruises (26 percent), flightseeing (15 percent), tramway/gondola (14 percent), and fishing (11 percent) were other popular activities among visitors to Southeast Alaska based on participation rates (Table 3.15-8).

Table 3.15-8
Activities Participated in by Visitors to Southeast Alaska, Summer 2011

Activities	Percent of Visitors
City/Sightseeing Tours	46
Cultural Activities	46
Wildlife Viewing	42
Hiking/Nature Walk	28
Day Cruises	26
Flightseeing	15
Tramway/Gondola	14
Fishing	11

Note:
[1] The McDowell Group (2012) identified 12 other activities with participation rates ranging from less than 1 percent to 10 percent.
Source: McDowell Group 2012

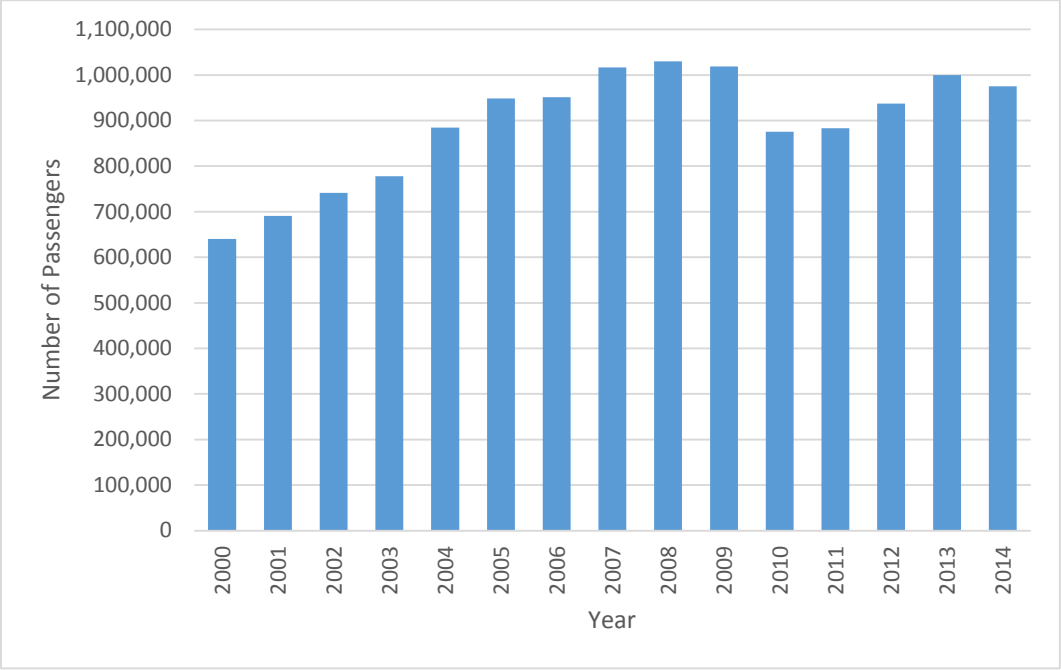
Southeast communities accounted for four of the six most frequently visited communities and places in the state in 2011: Juneau ranked first, Ketchikan second, Skagway fourth, and Glacier Bay sixth (McDowell Group 2012).

Trends in Visitation

The number of summer visitors to Alaska increased dramatically in the 1990s and the first part of the 2000s, increasing from 861,100 in 1993 to 1,631,500 in 2006, which equates to an average annual growth rate of 5 percent and a total net increase of 89 percent. Statewide, visitation peaked in 2007 and 2008 with approximately 1.71 million visitors. The total number of visitors dropped in 2009 and 2010 due to the nationwide economic recession (McDowell Group 2012). The State as a whole received an estimated 1,659,600 summer visitors in 2014. Cruise ship visitors accounted for 58 percent of the 2014 total, with 38 percent arriving via air, and 4 percent by highway or ferry (McDowell Group 2012).

Average annual visitation grew at an even faster rate in Southeast Alaska in the 1990s and early 2000s, increasing by 131 percent from 502,800 in 1993 to 1,160,000 in 2006 (McDowell Group et al. 2007). An estimated 1,037,000 people visited Southeast Alaska in 2011, approximately 67 percent of total statewide visitation during the summer of that year. Cruise ship passengers make up a much larger share of visitors to Southeast Alaska than they do statewide, accounting for 85 percent of all visitors in 2011 compared to 57 percent statewide (McDowell Group 2012 – Summer 2011 AVSP). The annual number of cruise passengers visiting Southeast Alaska is shown for 2000 through 2014 in Figure 3.15-1. An estimated total of 975,000 cruise passengers visited Southeast Alaska in 2014 (Southeast Conference 2014).

Figure 3.15-1
Southeast Alaska Cruise Passengers, 2000-2014



Notes:
1/ Data for 2014 are a preliminary estimate.
Source: Southeast Conference (2014)

The sheer magnitude of the cruise ship industry has important implications for recreation planning on the Tongass. Shore excursions have become an integral part of the cruise ship experience, providing increased revenues for ship operators and opportunities for local entrepreneurs. Much of this activity has been concentrated at ports of call that accommodate large or mid-sized cruise ships. Survey data from 2005, for example, indicate that approximately 83 percent of cruise visitors to Juneau participated in at least one tour while they were in Juneau. Glacier tours were the most popular type of tour in 2005, with 42 percent of cruise visitors taking this type of tour. Wildlife/marine life viewing, the Mt. Roberts Tramway, and flightseeing via helicopter were also popular (McDowell Group 2005).

Alongside the international cruise lines, several small and mid-size cruise operators are active in the region, often taking their customers to smaller places such as Metlakatla and Petersburg in addition to the larger communities. The Alaska Department of Economic Development (ADED) (2013) found that small cruise ships – generally those with capacities of less than 100 passengers – accounted for about 1 percent of Alaska's cruise passengers in 2011. Although accounting for a small share of the overall market, this segment of the cruise market is important for smaller communities that do not have the infrastructure to accommodate larger vessels. Twelve of the 18 communities visited by small ship operators in 2011 had very limited economic activity (ADED 2013).

Table 3.15-9 and Figure 3.15-2 provide information on non-cruise visitation to the region. The number of Southeast Alaska State ferry passengers has generally declined since 2000 with a pre-recession peak of 268,335 visitors in 2008. The number of Juneau airline departures also dropped sharply between 2008 and

2009, but has since increased to close to pre-recession levels. The number of arrivals by land at Haines and Skagway have generally declined since 2000, with fewer arrivals in 2013 than in 2000 in both cases (Table 3.15-9; Figure 3.15-2).

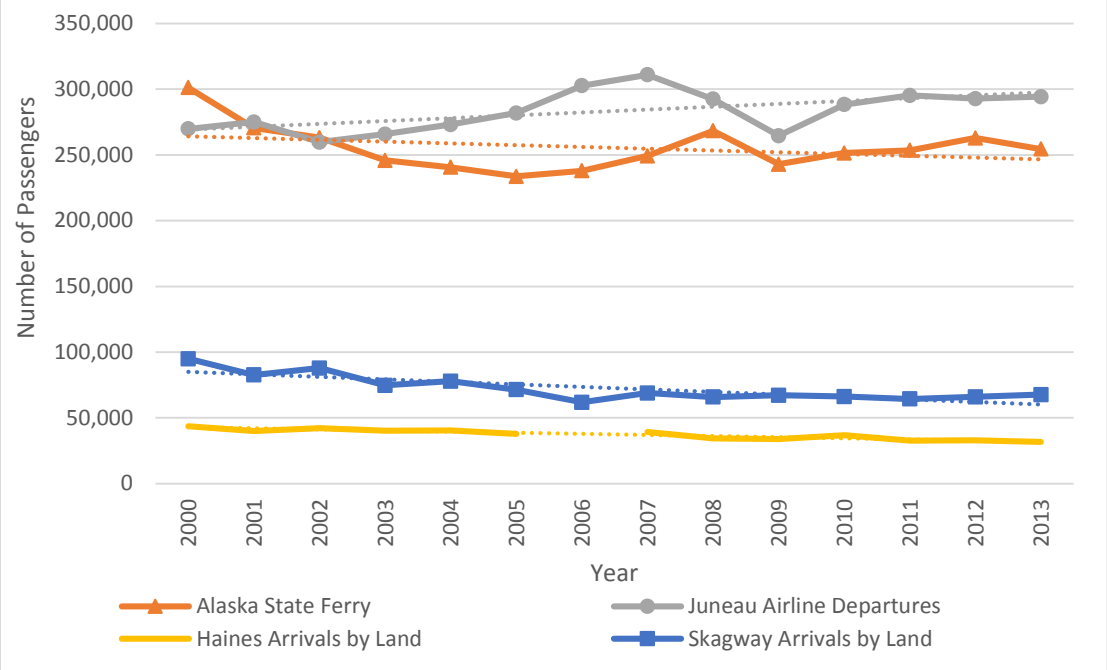
Table 3.15-9
Southeast Alaska Visitation, 1990 to 2013

Year[1]	Southeast Alaska State Ferry Passengers[2]	Juneau Airline Departures	Haines Arrivals by Land[3]	Skagway Arrivals by Land
2000[4]	301,244	269,880	43,621	94,925
2001	270,507	275,074	39,865	82,629
2002	263,105	259,759	42,290	87,851
2003	245,818	265,815	40,238	74,750
2004	240,666	273,152	40,438	77,837
2005	233,667	281,870	37,756	71,387
2006	237,965	302,710	na	61,870
2007	249,310	310,938	39,338	68,855
2008	268,335	292,474	34,434	65,826
2009	242,940	264,646	33,931	67,232
2010	251,503	288,300	36,806	66,238
2011	253,554	295,277	32,603	64,368
2012	262,931	292,789	33,040	66,016
2013	254,437	294,347	31,631	67,610

na – not available
[1] In addition to visiting tourists, visitation estimates in this table include Alaska residents and nonresidents visiting for reasons other than recreation and tourism.
[2] These totals do not include Inter-Island Ferry Authority passengers.
[3] Arrivals by land are per passenger.
[4] The ferry Columbia was out of service for most of the summer season, which reduced total ferry passengers.
Sources: Alaska Marine Highway System (2014), Alaska DOT (2006), Alaska Travel Industry (2006), Haines Convention and Visitors Bureau (2014), Juneau Economic Development Council (2014a, 2014b), Skagway Convention and Visitors Bureau (2014), and USDA Forest Service (2008a) (Table 3.13-15).

Essentially, all cruise ship use is by nonresident tourists. Ferry and airline passenger volumes and arrivals by land, on the other hand, also include Alaska residents and nonresidents visiting for reasons other than recreation and tourism, such as business or visiting relatives or friends. Larger communities; like Juneau, Ketchikan, and Sitka, also provide medical and other services that are not available in smaller communities.

Figure 3.15-2
Southeast Alaska Visitation, 2000 to 2014



Notes:
1/ This figure shows visitation by means other than cruise ship.
2/ State ferry data do not include Inter-Island Ferry Authority passengers.
3/ Data on Haines arrivals by land are not available for 2006 (Haines Convention and Visitors Bureau 2015).
Source: See Table 3.15-9.

Data on the division between visitor and resident arrivals are not available for Southeast Alaska, but are available for the state as a whole. In summer 2011, non-residents accounted for an estimated 77 percent of total arrivals (Table 3.15-10). The percent of total arrivals accounted for by non-residents varied by type of transport, ranging from 32 percent of arrivals by highway to 100 percent of arrivals by cruise ship. Non-residents accounted for 68 percent and 81 percent of domestic air and international air arrivals, respectively, and 64 percent of arrivals by ferry (Table 3.15-10). These data are for the state as a whole, but are likely broadly representative of Southeast Alaska and illustrate the importance of the state ferry and domestic airlines to local residents.

Table 3.15-10
Alaska Arrivals by Transport Type and Visitor/Resident, Summer 2011

	Percent Visitor	Percent Resident
Domestic Air	68	32
International Air	81	19
Highway	32	68
Ferry	64	36
Cruise Ship	100	0
Total	**77**	**23**

Source: McDowell Group (2012)

The ferry data provided in Tables 3.15-9 and 3.15-10 and Figure 3.15-2 are for the AMHS only. These data do not include passengers transported by the Inter-Island Ferry Authority (IFA), which is a public corporation providing transportation

to island communities in southern Southeast Alaska. Roundtrip service is currently (as of winter 2014) provided between Hollis and Ketchikan (IFA 2014). This service has been operating since 2002 and connects with AMHS vessels at Ketchikan. Annual ridership on this route from 2002 to 2013 averaged 52,000 (Sheinberg Associates 2014). An estimated 11 percent of this total (5,740 rides) are made by summer tourists and fall hunters visiting Prince of Wales Island (Sheinberg Associates 2014). Roundtrip service operated between Coffman Cove and Wrangell and Petersburg during the summers of 2006, 2007, and 2008, but has since been on hold. The availability of inter-island ferry services could affect resident recreation patterns in the future, as well as the recreation patterns of independent visitors to the region.

Visitation trends for two popular excursions, Juneau Icefield and Mendenhall Glacier, are presented in Table 3.15-11. The number of visitors to these areas has increased considerably since 1990. The number of Juneau Icefield helicopter landing tour passengers peaked in 2004 with almost 95,000 passengers reported. Nearly 66,600 Juneau Icefield helicopter landing tour passengers were reported in 2014. A total of approximately 449,200 people visited the Mendenhall Glacier in 2014, up from about 440,400 in 2013 (Table 3.15-11).

Table 3.15-11
Juneau Icefield and Mendenhall Glacier Visitation, 2000 to 2014

Year	Juneau Icefield Tour Passengers	Mendenhall Glacier Visitors[1]
2000	85,531	NA
2001	89,961	236,340
2002	85,680	250,363
2003	85,407	284,867
2004	94,928	319,630
2005	93,902	367,333
2006	81,047	372,464
2007	89,250	414,138
2008	81,592	424,359
2009	69,889	434,391
2010	60,292	386,751
2011	66,864	385,245
2012	64,966	407,264
2013	69,502	440,405
2014	66,579	449,168

[1] These data are for visitors to the Mendenhall Glacier Recreation Area entering via the Visitors Center Unit on the east side of the Mendenhall Glacier Recreation Area. Use also occurs on the west side of the Recreation Area, though to a lesser degree.

Sources: 2001 to 2005: USDA Forest Service (2006c; 2006d); 2006 to 2014: USDA Forest Service (2015g, 2015h)

Commercial Outfitter/Guide Use

The Forest Service authorizes outfitter and guiding services to provide for public health and safety and foster successful small businesses consistent with the Forest Plan. Outfitter and guiding services facilitate greater participation in programs by organizations and businesses that work with youth and educational groups. Also, outfitters and guides are normally skilled and experienced individuals who conduct activities in a manner that protects environmental resources and ensures that national forest visitors receive high-quality services. Due to its remote and rugged nature, recreation use on much of the Tongass National Forest requires good outdoor skills and/or specialized equipment. Commercial outfitters and guides provide access and equipment to assist people who might not otherwise be able to pursue certain recreation activities on the

Forest. Outfitter/guides on the Tongass range from small family-run operations to larger corporations and non-profit organizations.

Commercial recreation activities in Southeast Alaska and on the Tongass National Forest cover a broad spectrum of uses, ranging from fishing and hunting to helicopter flights and photography. Both residents and nonresidents use the services of outfitter/guides, but nonresidents tend to use outfitter/guides more often because they do not have the local knowledge or necessary equipment. Local residents tend to use their own boats and equipment to reach the Forest. Outfitter/guides are authorized use through special use permits to operate on the Tongass and are required to report annual use as part of their permit.

Most outfitter/guides using the Forest shorelines access them via boat from saltwater. Some clients access NFS lands from beaches, while others are also guided on land. The majority of charter boats in Southeast Alaska operate exclusively on saltwater for fishing or sightseeing without ever using the Forest (USDA Forest Service 2004g).

While people often participate in several different activities in one or more settings on any given trip, different activities result in different numbers of people in a group and different amounts of time spent on the Forest. At one end of the spectrum, guided bear hunting consists of many small groups of one or two people. (State regulations require non-resident hunters to use guides for hunting brown bear and mountain goats which are present in southeast Alaska). Hunters are dispersed across a large area and are on the Forest for long periods of time, typically 5 to 10 days, during spring and fall. At the other end of the use spectrum are mid-sized nature-viewing tour boats with relatively large group sizes (from 12 to 70 people). These groups are typically concentrated in a few areas of the Forest. Their use is short-term and concentrated in the summer season.

The Shoreline Outfitter/Guide FEIS, prepared for four northern Ranger Districts on the Tongass (USDA Forest Service 2004c), found that recreation group size is highly variable along shorelines in that study's project area. Groups generally consisted of less than 12 people, although larger groups, often associated with commercially guided groups from tour boats, may also be present. The largest shoreline group identified as part of that EIS was a tour boat with 70 people.

This type of use accounts for a large number of visitors, but tends to be concentrated in relatively few areas of the Forest. Businesses providing services to these types of larger groups are heavily influenced by physical conditions that allow for large boat access and their schedules.

Helicopter landing tours are another popular form of outfitter/guide use (Table 3.15-12). An estimated 67,000 cruise ship passengers visiting Juneau in 2014 (about 7 percent of all cruise passengers visiting that year) participated in helicopter landing tours on the Juneau Icefield (Table 3.15-11). These tours to the Juneau Icefield involve high volumes of people concentrated at specific locations for short periods of time, typically 2 to 4 hours. Helicopter traffic, in groups of one to three helicopters, is almost continuous to and from icefield locations during the summer. Clients are typically outfitted and guided to walk, photograph, hike, or trek on, and explore the glacial environment.

Table 3.15-12
Helicopter Tour Locations by Client and Group, 2014

Area	Number of Groups[1]	Number of Clients
Juneau Icefield 1 – Gilkey Backcountry	175	832
Juneau Icefield 3 – Herbert	2,086	10,726
Juneau Icefield 4 – Mendenhall	8,577	42,919
Juneau Icefield 5 – Lemon	1	3
Juneau Icefield 7 – Norris	2,005	8,984
Juneau Icefield 8 – Taku	1,192	6,266
P24 Baird Patterson Glaciers	2	8
Skagway Icefield – Denver	1,921	10,109
Skagway Icefield – Meade	2,827	14,352
Skagway Icefield – Shubee	34	173

[1] These numbers are an estimate of the total number of helicopter landings, including gratuity, training, and tour landings.
Source: USDA Forest Service (2015i)

Helicopter landing tours also occur in a number of locations elsewhere on the Forest, including the Skagway Icefield and Baird Patterson Glaciers (Table 3.15-12). Visitors to the Juneau Icefield accounted for about three-quarters of the total number of groups (75 percent) and clients (74 percent) in 2014, with most of the remainder visiting the Skagway Icefield.

The number of reported outfitter/guide clients and groups in 2013 are presented by Ranger District in Table 3.15-13. A total of 607,000 clients and 25,000 groups were reported in 2013. The Juneau Ranger District accounted for 92 percent of the total clients in 2013, with 72 percent of these clients (403,657) visiting the Mendenhall Glacier Visitor's Center.

Table 3.15-13
Outfitter/Guide Use by Ranger District, 2013

Ranger District	Clients	Groups
Admiralty National Monument	2,446	611
Craig	2,326	350
Hoonah	3,224	313
Juneau	557,980	17,008
Ketchikan - Misty	12,096	2,009
Petersburg	8,036	1,264
Sitka	11,248	1,797
Thorne Bay	904	126
Wrangell	8,472	1,259
Yakutat	56	7
Total	**606,788**	**24,744**

Note:
Data are likely underreported for the Yakutat Ranger District.
Source: USDA Forest Service 2015j

This diversity in the range of activities, the season of use, and types of recreation experience offered by outfitter/guide businesses can lead to conflicts between businesses when incompatible activities occur in close proximity. Comments received during the Shoreline Outfitter/Guide EIS process highlighted conflicts between helicopter and wheeled airplane access on one hand and some boat or foot travel access on the other. Several comments noted that the activities of smaller operations tend to be similar and compatible resulting in minimal conflicts, while larger operations often tend to detract from the setting and expectations of smaller groups. Some smaller operators believe that they are being displaced from their traditional use areas by larger commercial operations

(such as mid-sized cruise ships). On the other hand, some tour boat operators providing services to large groups felt they have been progressively excluded from areas on the Tongass National Forest over the past two decades (USDA Forest Service 2004g).

Environmental Consequences

Direct and Indirect Effects

This section describes the potential direct, indirect, and cumulative effects of the proposed alternatives on recreation and tourism. The following subsections review the potential effects of the alternatives on the existing supply of recreation opportunities in terms of the Forest Service's ROS settings and inventoried recreation places on the Tongass. Potential effects to developed recreation facilities, resident recreational use, and tourism are also discussed.

Timber Harvest

Recreation Opportunity Spectrum

As discussed in the preceding affected environment section, the ROS system is designed to help identify and quantify different types of recreation setting on the Tongass National Forest and portrays the appropriate combination of activities, settings, and experience expectations along a continuum that ranges from highly modified to primitive environments (Table 3.15-2). Estimated maximum acres likely to be harvested after 100 years by ROS setting and alternative are presented in Table 3.15-14.

Table 3.15-14
Estimated Maximum Acres Likely to be Harvested after 100 Years by ROS Setting

	Alternative 1		Alternative 2		Alternative 3		Alternative 4		Alternative 5	
ROS Setting	Young Growth	Old Growth	Young Growth	Old Growth	Young Growth	Old Growth	Young Growth	Old Growth	Young Growth	Old Growth
P	119	2,169	1,277	1,068	1,187	1,325	117	63	346	22
SPNM	577	5,121	2,549	2,909	2,897	9,272	716	2,686	822	2,347
SPM	1,805	2,940	12,263	1,687	12,086	3,001	4,103	1,602	6,430	1,655
RN	982	2,034	2,005	1,002	2,211	312	527	643	1,283	678
RM	206,286	50,538	316,831	25,919	294,430	21,647	229,238	37,587	275,131	37,759
R and U	87	25	285	12	283	11	107	15	94	17
Unmapped	27	24	135	12	121	0	76	0	39	0
TOTAL	**209,882**	**62,851**	**335,344**	**32,609**	**313,216**	**35,568**	**234,885**	**42,597**	**284,144**	**42,479**

Notes:
P = Primitive, SPNM=Semi-Primitive Non-Motorized, SPM=Semi-Primitive Motorized, RN=Roaded Natural, RM=Roaded Modified, R and U=Rural and Urban
[1] The total acres shown in this table are slightly lower than the Forest-wide total because the ROS inventory does not include the entire Forest.

Recreational visitors with an expectation of a remote experience would be most affected by timber production in Primitive, SPNM, and SPM settings. In terms of maximum acres likely to be harvested after 100 years, Alternatives 2 and 3 would involve the largest amount of young-growth harvest in these three ROS settings (Table 3.15-14). Alternatives 5, 4, and 1 would all involve less young-growth harvest in these ROS settings, with the amount decreasing in that order. Alternatives 3 and 1 would include the largest amount of old-growth harvest in the P, SPNM, and SPM ROS settings, followed by Alternatives 2, 4, and 5 in that order (Table 3.15-14). As a percentage of total ROS acres, however, less than one percent of total Primitive, SPNM, and SPM setting acres would likely be harvested (young-growth or old-growth) under any of the alternatives. Similarly, less than 1.5 percent of total RN acres would be harvested (young-growth or old-growth) under any of the alternatives.

Most harvest would occur in ROS settings where some modification of the natural environment is expected. Alternatives 2 and 3 have the greatest amount of likely young-growth harvest in the Rural and Urban setting, at 285 and 283 acres, respectively, compared to 107 acres for Alternative 4 and less than 100 acres for Alternatives 1 and 5 (Table 3.15-14). Young-growth harvest would be most heavily concentrated in the RM setting, with all alternatives allowing harvest of more than ten percent of existing RM acres. Alternatives 2 and 3 would allow the largest area of young-growth harvest in RM, at 316,831 acres (19 percent of total RM acres) and 294,430 acres (18 percent), respectively (Table 3.15-14). While less extensive, representing 3 percent or less of RM acres, old-growth harvest is also most concentrated in the RM setting, ranging from 21,647 acres under Alternative 3 to 50,538 acres under Alternative 1 (Table 3.15-14).

Land Use Designation

The Forest Plan LUDs govern allowable uses and desired conditions on the Tongass, including specific designations for recreation. Table 3.15-15 presents the estimated maximum acres likely to be harvested after 100 years by LUD group, LUD, and alternative. All LUDs where harvest could take place allow recreation access, with varying degrees of focus on the recreational experience. Viewed by LUD, young-growth and old-growth harvest could occur in nine LUDs depending on the selected alternative.

The maximum acres likely to be harvested after 100 years are mostly or entirely located in the Intensive Development (Timber Production) and Moderate Development (Modified Landscape and Scenic Viewshed) LUD groups under all five alternatives, with the majority in Timber Production and Modified Landscape LUDs. Alternatives 2, 3, and 5 also include acres in the Natural Setting LUD group, with 12 percent, 11 percent, and 1 percent of total harvest acres in the Natural Setting LUD group, respectively. The majority (Alternatives 2 and 3) or all (Alternative 5) of these Natural Setting LUD group acres (9 percent, 8 percent, and 1 percent of the total, respectively) are located in the Old-Growth Habitat LUD. Other Natural Setting LUDs affected under Alternatives 2 and 3 include Semi-remote Recreation and Special Interest Area (Table 3.15-15). Total acres likely to be harvested in these LUDs represent a very small share of total acres and were harvest to occur in these areas it would have very limited impact on the supply of recreational experiences allowed in these LUDs.

Recreation Places

This analysis assesses the potential effects of the proposed alternatives on recreation places based on the estimated maximum acres of young-growth and old-growth likely to be harvested after 100 years. In general, timber harvest can have adverse impacts on recreation places while also increasing access to some recreation opportunities via new road construction. Adverse impacts would be most pronounced in recreation places within natural setting LUDs, where recreationists are seeking a remote experience in a near pristine environment. No old-growth acres harvest is proposed within the natural setting LUD Group in recreation places under any alternative; however, young-growth harvest is proposed in natural setting LUDs under Alternatives 2, 3, and 5, varying between alternatives and by recreation place category. For all alternatives and recreation places, proposed harvest is concentrated within the moderate development and intensive development LUD groups. Recreation places within the home range of communities, and those important for developed facilities, marine recreation, hunting, fishing, and tourism are discussed below.

Table 3.15-15
Approximate Maximum Acres Potentially Harvested after 100 Years by LUD Group and LUD

	Estimated Maximum Harvest (Acres)					Estimated Maximum Harvest (Percent of Total)				
	Alternative					Alternative				
LUD Group/LUD	**1**	**2**	**3**	**4**	**5**	**1**	**2**	**3**	**4**	**5**
Intensive Development										
Timber Production	189,103	219,432	210,236	189,221	220,797	69	60	60	68	68
Subtotal	***189,103***	***219,432***	***210,236***	***189,221***	***220,797***	***69***	***60***	***60***	***68***	***68***
Moderate Development										
Modified Landscape	68,153	84,197	80,536	74,207	84,897	25	23	23	27	26
Scenic Viewshed	15,477	19,731	18,785	14,054	19,118	6	5	5	5	6
Subtotal	***83,631***	***103,928***	***99,321***	***88,261***	***104,015***	***31***	***28***	***28***	***32***	***32***
Natural Setting										
Old-Growth Habitat	0	31,640	26,186	0	1,811	0	9	8	0	1
Semi-remote Recreation	0	6,625	7,224	0	0	0	2	2	0	0
Remote Recreation	0	360	391	0	0	0	0	0	0	0
Special Interest Area	0	5,966	5,425	0	0	0	2	2	0	0
Recreation River	0	0	0	0	0	0	0	0	0	0
Scenic River	0	0	0	0	0	0	0	0	0	0
Subtotal	***0***	***44,592***	***39,226***	***0***	***1,811***	***0***	***12***	***11***	***0***	***1***
TOTAL	**272,733**	**367,952**	**348,783**	**277,481**	**326,623**	**100**	**100**	**100**	**100**	**100**

Home Range Recreation Places

Home range recreation places are those inventoried recreation places within an approximate 20-mile radius from one or more communities. Estimated maximum acres of young-growth and old-growth harvest in home range recreation places are summarized for each alternative in Table 3.15-16. Alternatives 2, 3, and 5 include young-growth acres in natural setting LUDs within home range, ranging from 8,693 acres for Alternative 5 to 13,195 acres for Alternative 2. Overall, the total percent of home range recreation place harvest acres ranges from 3.4 percent under Alternative 4 to 4.9 percent under Alternative 2 (Table 3.15-16).

Table 3.15-16
Estimated Maximum Acres of Harvest in Home Range Recreation Places, by LUD Group

	Alternative 1		Alternative 2		Alternative 3		Alternative 4		Alternative 5	
LUD Group	**Young Growth**	**Old Growth**	**Young Growth**	**Old Growth**	**Young Growth**	**Old Growth**	**Young Growth**	**Old Growth**	**Young Growth**	**Old Growth**
Natural Setting	0	0	13,195	0	12,183	0	0	0	8,639	0
Moderate Development	21,291	6,208	31,642	3,089	28,856	2,872	24,515	3,860	27,814	4,034
Intensive Development	24,935	7,571	34,167	3,879	30,368	3,490	26,246	5,235	30,602	5,263
TOTAL	**46,226**	**13,779**	**79,004**	**6,968**	**71,408**	**6,362**	**50,761**	**9,095**	**67,056**	**9,297**
% of Total Home Range Acres	**2.7%**	**0.8%**	**4.5**	**0.4**	**4.1**	**0.4**	**2.9**	**0.5**	**3.8**	**0.5**
	3.5		**4.9**		**4.5**		**3.4**		**4.7**	

Important Recreation Places

Recreation places are identified as either important or ordinary/common based on five categories: facilities, marine, hunting, fishing, and tourism. Individual recreation places may be important for one, several, or none of these categories. The following sections discuss the long-term effects of the proposed alternatives on important recreation places by category.

Facilities. Estimated maximum acres of harvest in recreation places important for facilities are summarized in Table 3.15-17. The potential effects of timber harvest would likely vary by the type of facility. The importance of a remote public recreation cabin may, for example, be greatly enhanced by the solitude and natural scenery the area provides. This type of setting may be of only secondary importance for a similar cabin where the attraction might be the outstanding steelhead fishing in the spring or fall. Alternatives 2, 3, and 5 include young-growth harvest acres in natural setting LUDs within recreation places important for facilities. Overall, a relatively small portion of recreation places important for facilities include estimated maximum young-growth and old-growth harvest acres, ranging from 1.4 percent under Alternative 1 to 2.3 percent under Alternative 2 (Table 3.15-17).

Table 3.15-17
Estimated Maximum Acres of Harvest in Recreation Places Important for Facilities, by LUD Group

	Alternative 1		Alternative 2		Alternative 3		Alternative 4		Alternative 5	
LUD Group	**Young Growth**	**Old Growth**	**Young Growth**	**Old Growth**	**Young Growth**	**Old Growth**	**Young Growth**	**Old Growth**	**Young Growth**	**Old Growth**
Natural Setting	0	0	3,609	0	3,485	0	0	0	1,555	0
Moderate Development	5,370	2,023	8,664	1,017	7,951	964	7,551	1,301	7,566	1,437
Intensive Development	6,177	1,541	9,529	796	8,737	688	8,145	1,252	8,340	1,010
TOTAL	**11,548**	**3,564**	**21,801**	**1,813**	**20,173**	**1,651**	**15,696**	**2,552**	**17,462**	**2,447**
% of Total	**1.1**	**0.3**	**2.1**	**0.2**	**1.9**	**0.2**	**1.5**	**0.2**	**1.7**	**0.2**
Acres Important for Facilities	**1.4**		**2.3**		**2.1**		**1.7**		**1.9**	

Marine. Estimated maximum acres of harvest in recreation places that are important for marine recreation are summarized in Table 3.15-18. The perception of naturalness and scenery are very important values among Forest visitors engaged in the unique marine recreation opportunities offered by the Tongass. Approximately 30 percent of inventoried recreation place acres are currently important for marine recreation activities (Table 3.15-7). Many of these recreation places are within the beach fringe and are allocated to the SPM ROS. Alternatives 2, 3, and 5 include young-growth harvest acres in natural setting LUDs within recreation places important for marine recreation. Overall, the portion of recreation place acres important for marine recreation with potential young-growth and old-growth harvest ranges from 2.0 percent under Alternative 1 to 3.2 percent under Alternative 2 (Table 3.15-18).

Table 3.15-18
Estimated Maximum Acres of Harvest in Recreation Places Important for Marine Recreation, by LUD Group

	Alternative 1		Alternative 2		Alternative 3		Alternative 4		Alternative 5	
LUD Group	**Young Growth**	**Old Growth**	**Young Growth**	**Old Growth**	**Young Growth**	**Old Growth**	**Young Growth**	**Old Growth**	**Young Growth**	**Old Growth**
Natural Setting	0	0	4,881	0	5,091	0	0	0	2,066	0
Moderate Development	8,533	2,491	15,564	1,229	14,309	1,099	12,669	1,707	13,300	1,882
Intensive Development	7,736	2,457	12,727	1,188	11,843	1,423	10,950	1,616	11,097	1,470
TOTAL	**16,269**	**4,948**	**33,172**	**2,418**	**31,242**	**2,522**	**23,619**	**3,323**	**26,463**	**3,351**
% of Total	**1.5**	**0.5**	**3.0**	**0.2**	**2.9**	**0.2**	**2.2**	**0.3**	**2.4**	**0.3**
Acres Important for Marine Rec	**2.0**		**3.2**		**3.1**		**2.5**		**2.7**	

Hunting. Estimated maximum acres of harvest in recreation places that are important for hunting are summarized in Table 3.15-19. Hunters who favor hunting in an undisturbed, natural setting would likely prefer those alternatives that have the least acres of harvest in these recreation places. Hunters who prefer using roads and road access would generally benefit from those alternatives with more potential acres of harvest. Approximately 40 percent of inventoried recreation place acres are currently important for hunting (Table 3.15-7). Alternatives 2, 3, and 5 include young-growth harvest acres in natural setting LUDs within recreation places important for hunting. Overall, the portion of

recreation place acres important for hunting with potential young-growth and old-growth harvest ranges from 2.4 percent under Alternative 4 to 3.9 percent under Alternative 2 (Table 3.15-19).

Table 3.15-19
Estimated Maximum Acres of Harvest in Recreation Places Important for Hunting, by LUD Group

	Alternative 1		Alternative 2		Alternative 3		Alternative 4		Alternative 5	
LUD Group	**Young Growth**	**Old Growth**	**Young Growth**	**Old Growth**	**Young Growth**	**Old Growth**	**Young Growth**	**Old Growth**	**Young Growth**	**Old Growth**
Natural Setting	0	0	9,059	0	8,211	0	0	0	5,746	0
Moderate Development	11,865	3,084	16,933	1,506	14,888	854	11,799	1,553	15,465	1,614
Intensive Development	17,895	5,596	25,854	2,770	22,269	2,238	18,801	3,261	23,403	3,336
TOTAL	**29,761**	**8,680**	**51,846**	**4,276**	**45,369**	**3,092**	**30,599**	**4,814**	**44,614**	**4,949**
% of Total Acres Important for Hunting	**2.0**	**0.6**	**3.6**	**0.3**	**3.1**	**0.2**	**2.1**	**0.3**	**3.1**	**0.3**
	2.6		**3.9**		**3.3**		**2.4**		**3.4**	

Fishing. Estimated maximum acres of harvest in recreation places that are important for fishing are summarized in Table 3.15-20. Approximately 13 percent of inventoried recreation places acres are currently important for fishing (Table 3.15-7). Access to streams and areas immediately adjacent to streams may be subject to modifications, with the settings adjacent to the stream side corridors appearing more modified over time. Access may affect the quality of the fishing experience regardless of the degree of setting changes leading up to the stream. Alternatives 2, 3, and 5 include young-growth harvest acres in natural setting LUDs within recreation places important for fishing. Overall, the portion of recreation place acres important for fishing with potential young-growth and old-growth harvest ranges from 2.2 percent under Alternative 4 to 4.2 percent under Alternative 2 (Table 3.15-20).

Table 3.15-20
Estimated Maximum Acres of Harvest in Recreation Places Important for Fishing, by LUD Group

	Alternative 1		Alternative 2		Alternative 3		Alternative 4		Alternative 5	
LUD Group	**Young Growth**	**Old Growth**	**Young Growth**	**Old Growth**	**Young Growth**	**Old Growth**	**Young Growth**	**Old Growth**	**Young Growth**	**Old Growth**
Natural Setting	0	0	3,380	0	3,144	0	0	0	2,009	0
Moderate Development	5,974	913	9,558	446	8,025	284	5,944	457	8,217	502
Intensive Development	3,503	1,897	5,679	950	4,629	1,124	3,166	1,073	5,084	940
TOTAL	**9,476**	**2,810**	**18,616**	**1,396**	**15,798**	**1,408**	**9,110**	**1,531**	**15,310**	**1,442**
% of Total Acres Important for Fishing	**2.0**	**0.6**	**3.9**	**0.3**	**3.3**	**0.3**	**1.9**	**0.3**	**3.2**	**0.3**
	2.6		**4.2**		**3.6**		**2.2**		**3.5**	

Tourism. Estimated maximum acres of harvest in recreation places that are important for tourism are summarized in Table 3.15-21. Approximately 53 percent of inventoried recreation place acres are currently considered important for tourism (Table 3.15-7). Based on surveys and marketing campaigns for visitors, it is widely accepted that natural beauty and scenery are some of the principal factors attracting visitors to the region. Alternatives 2, 3, and 5 include young-growth harvest acres in natural setting LUDs within recreation places

important for tourism. Overall, the portion of recreation place acres important for tourism with potential young-growth and old-growth harvest is relatively low under all alternatives, ranging from 1.2 percent under Alternative 4 to 1.9 percent under Alternative 2 (Table 3.15-21).

Table 3.15-21
Estimated Maximum Acres of Harvest in Recreation Places Important for Tourism, by LUD Group

	Alternative 1		Alternative 2		Alternative 3		Alternative 4		Alternative 5	
LUD Group	Young Growth	Old Growth	Young Growth	Old Growth	Young Growth	Old Growth	Young Growth	Old Growth	Young Growth	Old Growth
Natural Setting	0	0	6,380	0	5,910	0	0	0	3,467	0
Moderate Development	9,841	3,210	15,260	1,592	13,323	1,025	10,934	1,544	13,234	1,670
Intensive Development	7,140	3,531	11,720	1,761	10,098	1,632	7,804	2,024	10,286	1,368
TOTAL	**16,980**	**6,740**	**33,360**	**3,353**	**29,330**	**2,657**	**18,738**	**3,569**	**26,987**	**3,039**
% of Acres Important for Tourism	**0.9**	**0.4**	**1.7**	**0.2**	**1.5**	**0.1**	**1.0**	**0.2**	**1.4**	**0.2**
	1.3		**1.9**		**1.6**		**1.2**		**1.6**	

Developed Recreation Facilities
The number of developed recreation facilities that are located within 0.5-mile of suitable harvest areas is shown in Table 3.15-22, broken out by LUD group (no harvest acres are proposed in the Wilderness LUD group). The potential effects of timber harvest would likely vary by the type of facility. In addition, expectations for the type of recreation experience would vary by LUD group. Visible timber harvest in natural setting LUDs may be perceived as a more severe adverse impact, than similar harvest located in intensive development LUDs.

The total number of developed facilities within 0.5 mile of suitable old-growth and young-growth stands ranges from 180 facilities under Alternative 5 to 235 facilities under Alternative 2 (Table 3.15-22). Alternative 2 has the most facilities within 0.5-mile of both suitable old-growth (124 total) and young-growth (111 total) (Table 3.15-22). Across all alternatives, larger numbers of recreation facilities are within 0.5 mile of suitable acres in moderate development LUDs than natural setting or intensive development LUDs. Recreation facilities within 0.5 mile of young-growth or old-growth suitable acres in natural setting LUDs range from 38 facilities under Alternative 4 to 63 facilities under Alternative 2.

Table 3.15-22
Number of Developed Recreation Facilities within 0.5-mile of Suitable Old-Growth and Young-Growth Stands, by LUD Group

	Alternative 1		Alternative 2		Alternative 3		Alternative 4		Alternative 5	
LUD Group	Young Growth	Old Growth	Young Growth	Old Growth	Young Growth	Old Growth	Young Growth	Old Growth	Young Growth	Old Growth
Natural Setting	20	27	36	27	35	22	20	18	28	12
Moderate Development	36	57	43	59	43	44	37	40	39	39
Intensive Development	29	37	32	38	32	36	26	34	29	33
Totals	**85**	**121**	**111**	**124**	**110**	**102**	**83**	**92**	**96**	**84**
	206		**235**		**212**		**175**		**180**	

Resident Recreational Use
As noted in the Affected Environment part of this section, resident recreation demand, like other forms of recreation demand, is influenced by a number of

factors, including regional population levels, per capita participation rates, and recreation travel behavior. The alternatives evaluated here are unlikely to affect broader trends in recreation behavior, but it is possible that they could result in different supply-induced changes in participation. These potential changes, along with the potential effects of the alternatives on recreation places, would likely affect resident recreationists.

In the past, supply-induced changes in participation on the Tongass have been mainly related to changes in road systems and road access. This type of change in participation appears to have occurred on Prince of Wales, Wrangell, and Mitkof Islands, for example. In these locations, road systems developed for timber harvesting created an opportunity for road-related access to previously inaccessible recreation settings and, therefore, an opportunity for recreation activities involving wheeled vehicles. In addition, new roads that provide easier access to a wider area may create new semi-primitive opportunities that increases the capacity of a recreation place or creates a new recreation place. Over time, continuation of such new opportunities would be dependent on the availability of funds for road maintenance and other system management needs.

Under all alternatives, while there would be some new road access in the long run, nearly all new roads constructed under the alternatives would be closed following harvest. These roads would, therefore, not be available for use by highway vehicles or high-clearance vehicles. They would, however, be available for access by other methods and would, as a result, have the potential to affect existing recreation patterns. Any potential increase in recreational access may be limited by the extent to which road closures include restoring the road bed to a more natural condition, possibly blocking or discouraging non-vehicle access as well. In general, new roads would be required to harvest old growth while reconstruction of existing closed or decommissioned roads would be required to harvest young growth.

Viewed at a programmatic level, changes in participation related to road systems and access are more likely to occur under alternatives that involve higher levels of projected road construction and reconstruction. Based on the miles of new road construction projected under each alternative and viewed at a programmatic level, Alternative 1 would involve the construction of most new roads over 25 years: 281 miles of new roads versus the next highest maximum of 267 miles under Alternative 5. However, Alternative 1 would require much less road construction on decommissioned roadbeds and road reconstruction over this period than the other alternatives, with a maximum combined total length of 224 miles versus 306 miles (Alternative 4) to 381 miles (Alternative 2) under the other alternatives.

Viewed over 100 years, new road construction would range from 871 miles (Alternative 4) to 1,056 miles (Alternative 2), with road construction on decommissioned roadbeds and road reconstruction miles ranging from 1,315 miles (Alternative 1) to 1,791 miles (Alternative 2). Harvest would be limited to areas outside Inventoried Roadless Areas (IRAs) under Alternatives 1, 4, and 5 and would, therefore, tend to increase road density in already roaded areas rather than provide new access to presently undeveloped areas.

As the preceding discussion suggests, the trend across all alternatives is toward an increase in general recreation access and a corresponding decrease in primitive recreation opportunities. Viewed at this level, Alternative 1 would have the lowest impact on primitive areas and associated opportunities because no potential timber harvest is proposed within the existing Inventoried Roadless Areas (IRAs) on the Tongass and it would involve the least road construction.

Alternatives 4 and 5 would have the next lowest potential impacts in that order, as they also do not include potential harvest acres within IRAs and would involve fewer new road miles than Alternatives 2 and 3. Alternatives 2 and 3 would both include young-growth and old-growth harvest within IRAs that could impact primitive recreation opportunities, and have the greatest potential road construction. While Alternative 3 would involve less road construction than Alternative 2, it would involve more timber harvest in IRAs and therefore the greatest potential impacts to primitive recreation opportunities. In both cases, the areas in IRAs expected to be harvested represent a small percentage of total IRA acres (0.1 to 0.3 percent) (see the *Inventoried Roadless Areas* section). As discussed in the *Inventoried Roadless Areas* section, timber harvest and road construction in IRAs is not consistent with the 2001 Roadless Rule. Harvest and road constructions in IRAs would be deferred until there was a change in the Rule or the Tongass Roadless Rule exemption were reinstated.

Given the programmatic nature of this planning document, it is not possible to predict site-specific changes that would occur under any of the alternatives. Potential impacts to recreation places and recreation activities in other areas would be evaluated on a project-by-project basis and in accordance with the applicable Forest Plan standards and guidelines under all alternatives.

The Forest will change over time under all of the alternatives, and recreation demand and use patterns are also likely to change. Recreationists may respond to changes to specific areas and locations in three general ways. Some may adapt to new situations, and changes in settings will have little or no impact to these current Forest users. For others, change may not be acceptable, and these users will be displaced to other areas where the setting and use patterns are more in line with their expectations and needs. A third group of current recreationists may find that they cannot adapt to the new situation nor find suitable substitute areas, and as a result, substitute other leisure activities in place of recreating on the Forest.

Tourism

The vast majority of visitors to Southeast Alaska are cruise ship passengers, accounting for 85 percent of visitors to Southeast Alaska in 2011 (McDowell Group 2012). Future development of the tourism industry in Southeast Alaska and elsewhere in the United States is dependent on a wide range of factors, including the value of the dollar in foreign countries, the price of oil, world events and international unrest, and political and social change. In addition, regions like Southeast Alaska directly compete with other locations and activities for tourist dollars. As a result, changes in other tourist markets, both positive and negative, have the potential to affect the tourism industry in Southeast Alaska. These factors are, for the most part, unrelated to management of the Tongass National Forest.

While it is reasonable to assume that the vast majority of tourism activity in the region is related to the natural environment, many visitors experience the Tongass passively—from the deck of a cruise ship, for example—without directly using the Forest for recreation purposes. Effects to this type of visitor would depend on the level of visibility of proposed timber production along cruise ship and other marine corridors. According to the analysis in the *Scenery* section, harvest areas under Alternatives 1 and 4 would be the least visible to viewers from waterways, while harvest under Alternative 2 would be the most visible. See the *Scenery* section for detailed impact discussions by viewshed and alternative.

Cruise ships have heavily marketed Forest-related activities in recent years, and many passengers take at least one trip to the Forest during their visit. As discussed in the affected environment portion of this section, the tourism industry and outfitter/guides in Southeast Alaska offer a wide spectrum of recreation activities, ranging from guided bear hunting through helicopter tours and guided wildlife-viewing boat tours. Viewed in terms of Forest management, the requirements of these activities are often at odds with one another. Some activities require developed facilities, utilities, and easy access, while others require vast and remote areas in a natural setting, with outfitter/guides providing only the basic essentials for their clients.

There are indications that demand exceeds supply in some recreation places, especially those used more extensively by tourist operators and outfitter/guides. Activities that are presently near or at capacity include bear-viewing areas and helicopter use in the immediate vicinity of urban areas. Other areas may be able to accommodate current levels of tourism and potential increases in the future without negatively affecting the tourist experience or causing detrimental environmental effects. The number of visitors cruising the Inside Passage or viewing Mendenhall Glacier may, for example, be sustainable at current and future levels of use (Schroeder et al. 2005).

Management practices for specific areas, such as limiting the number of visitors by permit, would continue to be evaluated on a project-by-project basis and in accordance with the applicable Forest Plan standards and guidelines under all alternatives.

Assuming that the volume of tourists remains at its current level or more substantially recovers from the recession-induced dip during the late 2000s, the overall recreation trend would likely be toward more group experiences on the Tongass and fewer opportunities for solitude and isolation in natural areas close to cruise ship stops.

Renewable Energy Development

All renewable energy development projects built and operated in Southeast Alaska have to meet detailed local, state and, in most cases, federal laws, regulations, and requirements. Projects are also subject to Tongass National Forest Plan standards and guidelines. The Forest Plan identifies three types of area related to energy development on the Tongass based on the existing LUDs: windows, which represent areas potentially available for energy development; avoidance areas; and exclusion areas. Avoidance areas are those LUDs where development of energy projects are inconsistent with land use management objectives and desired future conditions. Alternative locations in other LUDs must be exhausted before facilities are considered in avoidance areas. LUDs classified as windows and avoidance areas make up 38 percent and 62 percent of the Forest, respectively. There are no exclusion areas on the Tongass due to special authorities provided in the Alaska National Interest Lands Conservation Act, Title XI. These classifications and the standards and guidelines in the current Forest Plan would continue to apply under Alternative 1. Under Alternatives 2 through 5, renewable energy sites would be managed under the new Renewable Energy Plan Components identified in Chapter 5 of the Forest Plan amendment. This is discussed in more detail in the *Renewable Energy* section of this EIS.

The Forest Service has identified 11 proposed renewable energy projects in Southeast Alaska that are currently active (Table 3.12b-3). Five of these proposed projects would be located in important recreation places. All five

projects are located within recreation places important for tourism, four are within home range recreation places or places important for facilities, and one is within a place important for marine and hunting recreation.

In addition, two developed recreation sites are within 0.5 mile of a proposed renewable energy project: the Swan Lake boat dock and the marine access point at Indian River. The proposed renewable energy projects are further discussed in in the *Renewable Energy* section of this EIS.

Effects from the proposed projects on recreation would depend on site-specific plans. In general, project activities that would impact recreation could include new access road construction, forest clearing, ground disturbance, temporary construction noise, temporary (construction) or long-term (operations) access restrictions, and visual impacts depending on the location and design features. Any associated transmission lines could also impact recreation areas and activities through forest clearing and potential additional road construction. All potential impacts to specific recreation resources would be addressed during the permitting and licensing of the projects, including National Environmental Policy Act (NEPA) assessment.

Cumulative Effects

This section considers the incremental effects of the alternatives when added to other past, present, and reasonably foreseeable actions. The effects of past and present actions on recreation are included in the Affected Environment portion of this section, which discusses current recreation facilities and activities on the Tongass. Past actions include past timber harvest and road building that has facilitated roaded recreation and changed ROS settings, as well as the development of recreation facilities, such as cabins, campgrounds, interpretive sites, and visitor centers. Present actions include the impacts of current management policies on existing recreation patterns, particularly those that are authorized by special use permits.

Despite the recent recession-related drop, the number of cruise ship passengers visiting the region remains a significant source of current and future recreation demand on the Tongass. Current recreation patterns on the Tongass also reflect past timber harvest and road building activities on adjacent private and Native corporation lands, as well as wildland recreation opportunities on federal- and state-managed lands elsewhere in the region.

Reasonably foreseeable actions on NFS lands include the projected levels of future timber harvest and renewable energy development that are used in the preceding analysis to assess the potential impacts of the alternatives on the supply of recreation opportunities and recreation use and demand.

Other reasonably foreseeable actions include regional transportation development as defined by the State Transportation Plan and the Forest Service Alaska Region Long Range Transportation Plan, as well as road paving on Prince of Wales Island, the closing of roads, and construction of the Angoon Airport. In addition, the expansion of cities like Juneau and Ketchikan, recreational cabin development, and land auctions by the State could include additional road construction. Appendix C provides a full list of all the projects considered in the cumulative effects analysis.

It is not possible at this time to predict exactly which roads would be developed or their likely impact on future recreation patterns. None of the alternatives is expected to affect this type of future road development, which would be expected to go or not go forward regardless of the selected alternative. The overall cumulative effect of new regional road corridors viewed in conjunction with the

Forest Plan alternatives would be a trend toward the roaded end of the ROS spectrum that would be highest under Alternative 2 and lowest under Alternative 1.

Other reasonably foreseeable future actions include an expected growth in recreation and tourism businesses based on recovery in the cruise ship industry, as well as the development of additional fishing and other lodges. This type of development would facilitate additional recreation and tourism in the region and on the Forest. Human settlement expansion is expected to occur around the region's larger cities, such as Juneau and Sitka, with residential expansion also expected as a result of state land auctions. These developments would likely result in increased demand for a range of recreation activities, with some developments favoring developed recreation opportunities, and others more dependent on undeveloped lands.

Mining activities are expected to expand at existing sites, including Greens Creek on Admiralty Island and Kensington Gold Mine north of Juneau, as well as possible future sites, including the Bokan Mountain and Niblack sites on the southern end of Prince of Wales Island. Mining projects are for the most part expected to have a negative effect on recreation activities, because most recreational activities are incompatible with these types of land use.

Risk and Uncertainty

As stated in a number of locations in this section, recreation and tourism in Southeast Alaska and on the Tongass is influenced by a number of factors that are largely independent of forest management decisions. Future recreation and tourism demand is difficult to predict with any precision and no attempt is made to quantify future demand in this section. The number of cruise ship visitors to the region is generally expected to remain at current levels or continue to increase, but there is uncertainty that this will be the case for the foreseeable future.

Likely impacts to the supply of recreation opportunities on the Forest are easier to project, as they are directly affected by management decisions, at least to the extent that proposed harvest levels and renewable energy projects affect different types of recreation. Much of the analysis in this section is based on this relationship, which allows a comparison between alternatives over time.

Changes in Southeast Alaska's climate (discussed in the *Climate and Air* section) could affect recreation and tourism in the region in the future. Many tourists visiting the region travel long distances from across the United States, as well as from other countries. Many tourists arriving by cruise ships travel a considerable distance by air before even boarding the cruise ship in Seattle, Vancouver, or elsewhere. Others travel directly to Southeast Alaska via air. Future regulatory or market-based pressures to reduce transportation-related greenhouse gases could affect the level of visitation to the region.

Recreation activities could also be directly affected by global warming, with, for example, fewer winter recreation opportunities available and for shorter periods of time. Climate change could also affect recreational fishing through changes in biodiversity and water levels, as well as changes in the length of season and user experience (Kelly et al. 2007).

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Scenery

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Affected Environment

The Tongass National Forest offers a variety of scenery to its visitors, from spectacular mountain ranges and the glaciers of the mainland to low-lying marine landscapes composed of intricate waterways, bays, and island groups. The Forest is viewed from a variety of vantage points, including the communities of Southeast Alaska, the Alaska Marine Highway ferry route, cruise ship routes, existing road systems, popular small boat routes and anchorages, developed recreation sites and facilities, and hiking trails. Tourist-related flight seeing via small aircraft is increasing in popularity and provides aerial views of the forest landscape.

The Forest Service developed a Visual Management System (VMS) in 1974 to integrate aesthetic considerations into large-scale resource management decisions. Due to advances in technology, as well as the increased demand for high-quality scenery, the Scenery Management System (SMS) was released in 1996. The SMS integrates the increased understanding of ecosystem processes and cultural landscapes in identifying the effects of various management practices on scenic resources. The SMS was used in this analysis to inventory existing scenic resources, provide measurable scenic quality management objectives for each portion of the landscape, and estimate the landscape's sensitivity based on the visibility from priority travelways and use areas.

In order to apply SMS to the Forest, a viewshed analysis of the entire Tongass National Forest was completed using the Tongass Geographic Information System (GIS) for the 2008 Land and Resource Management Plan (Forest Plan) Amendment. The analysis was completed separately for each Ranger District. Step one involved identifying the Visual Priority Routes (VPRs) and use areas (listed in Appendix F of the 2008 Forest Plan). These are the major points from which people view the forest. They include the Alaska Marine Highway; cruise ship and small boat routes; major roads, trails, and anchorages; and important recreation areas on the land. The viewshed analysis identified points at regular intervals along the VPRs and use areas. Each viewpoint along a route was assigned a viewing height from which a person would observe the forest. For example, the average height of a person was selected for the viewing height along a hiking trail, and the height of the cruise ship's deck was used for the cruise ship route. Each cell in the digital elevation model was evaluated for visibility from each of the points along each VPR and use area. Visibility was assessed separately for each marine viewpoint and land viewpoint.

The second phase of the analysis identified distance zones, breaking the visible areas into foreground, middleground, and background from each viewpoint, based on distance. Foreground is the visible area within 0.5 mile of a VPR; background is the visible area greater than 5 miles and less than 15 miles from a

VPR; and middleground is the visible area between foreground and background of a VPR. Areas more than 15 miles from any viewpoint and those not seen from any of the VPRs or Use Areas were considered seldom seen. Distance zones were also assessed separately for land and water viewpoints. The final layers for each Ranger District were generated by combining the results from the marine analysis and the land analysis. Any point that was visible from either a land or marine viewpoint was considered visible in the final layer. Any area that was foreground from either a land or marine viewpoint was considered foreground, and any land that was only background from either a land or marine viewpoint became background. All other visible land became middleground. Any areas not seen from any viewpoints are referred to as unseen or seldom seen. The distance zones were subsequently overlaid with the land use designations (LUDs) to generate the Scenic Integrity Objectives (SIOs) (refer to the Forest-wide standards and guidelines in the Tongass Land and Resource Management Plan for details on how SIOs were determined for each LUD).

Existing Scenic Integrity

The existing scenic resources of the Tongass encompass everything from vast tracts unmodified by human activity to extensive areas of heavily modified landscapes. Existing Scenic Integrity (ESI) ratings are used by the Forest Service to analyze the degree of intactness of the landscape character. These ratings are used to categorize the degree of alteration visible in the landscape on a continuum from a natural setting to a heavily altered landscape. The ratings apply to the broad landscape affected, not just the acres altered. As described below, ESI ratings range over six levels of integrity, from Very High to Unacceptably Low.

- **Very High**—Landscapes where the valued landscape character is intact with only minute deviations, if any. The existing landscape character and sense of place is expressed at the highest possible level.
- **High**—Landscapes where the valued landscape character appears intact. Deviations may be present, but must repeat the form, line, color, texture, and pattern common to the landscape character so completely and at such scale that they are not evident.
- **Moderate**—Landscapes where the valued landscape character appears slightly altered. Noticeable deviations must remain visually subordinate to the landscape character being viewed.
- **Low**—Landscapes where the valued landscape character appears moderately altered. Deviations begin to dominate the valued landscape character being viewed, but they borrow valued attributes such as size, shape, edge effect and pattern of natural openings, vegetative type changes or architectural styles outside the landscape being viewed. They should not only appear as valued character outside the landscape being viewed, but compatible or complimentary to the character within.
- **Very Low**—Landscapes where the valued landscape character appears heavily altered. Deviations may strongly dominate the valued landscape character. They may not borrow from valued attributes such as size, shape, edge effect and pattern of natural openings, vegetative type changes, or architectural styles within or outside the landscape being viewed.
- **Unacceptably Low**—Landscapes where the valued landscape character being viewed appears extremely altered. Deviations are extremely dominant and borrow little if any form, line, color, texture, pattern or scale from the landscape character.

Table 3.16-1 displays the percent of acres of each ESI for the Tongass. In this and succeeding tables, a breakdown between "seen" and "seldom seen" areas is presented. Seen areas are those areas that can be viewed in the foreground, middleground, or background from inventoried VPR and Use Areas with a concern level of 1 or 2, the travelways and use areas with the highest number of users. Seldom seen areas are all the rest of the Forest. The ESI for wilderness is also included in this table. Approximately 88 percent of the Tongass is rated as a Very High ESI, which is a visually unaltered condition. About 10 percent of the land is rated as Low, Very Low, or Unacceptably Low, which indicates noticeable development activity. The remainder of the Forest is rated as High or Moderate. Some of the wilderness acres have a High or lower rating. This is mostly due to the landscape effect of developments adjacent to wilderness and past development activities within wildernesses.

Table 3.16-1
The Existing Scenic Integrity of the Tongass National Forest (percent)

ESI Rating	Very High/High	Moderate	Low	Very Low	Unaccept-ably Low
Seen	26.5	1.0	2.5	4.2	0.1
Seldom seen	27.1	0.2	0.9	1.9	0.1
Wilderness	34.1	0.1	0.0	0.0	0.0
Subtotals	**87.7**	**1.3**	**3.6**	**6.1**	**0.2**

Note: Numbers are GIS estimates and are not exact. Columns and rows may not sum exactly due to rounding. Less than 1 percent of the Forest is unclassified.

Under the 1997 Forest Plan, all land has a designated LUD, which guides the types and intensity of development actions. The LUDs designate the SIOs for each area, which define the degree to which the natural landscape can be altered, and provide guidelines for timber harvest, road building, and other activities to ensure they are conducted in a way that allows the scenic objectives to be achieved. A LUD may have different SIOs depending on the distance zone (foreground, middleground, background) in which the development activity is to take place. SIOs are classified using the same terms outlined above for ESI: Very High, High, Moderate, Low, and Very Low. The Unacceptably Low rating is only used to inventory existing conditions and cannot be used as a management objective.

- The current adopted SIOs for all land within the Tongass are displayed in Table 3.16-2. This table separates the percent of acres of each SIO into five categories: foreground, middleground, background, seldom seen, and other (municipal watersheds and non-wilderness national monuments where the SIO is determined on a project-by-project basis). The Very High SIO is typically assigned to wilderness; however, it is not used for Tongass wilderness because of the potential alterations allowed under the Alaska National Interest Lands Conservation Act (ANILCA). In reality, the vast majority of wilderness acreage will be managed through the specific wilderness plans with a Very High SIO. Thus, over 60 percent of the Tongass is to be managed at the High or Very High Scenic Integrity level.

- Demand for scenic quality can best be represented by the increase in tourist-related travel to the Tongass, as well as a heightened awareness and sensitivity of Alaskan residents to scenic resource values. These facts result in a strong indirect connection between scenic resource values and the economy of Southeast Alaska. For example, Southeast Alaska's Inside Passage is advertised and promoted by the Division of Tourism, cruise ship operators, and the Southeast Alaska Tourism Council. Their marketing strategy focuses on the scenery of the Tongass National Forest as a major

attraction. The visitors to Southeast Alaska would, therefore, arrive with expectations and an image of the environment and scenery awaiting them. If current trends continue, demand for viewing scenic landscapes will increase. A report published by the Alaska Department of Community and Economic Development show that the largest number of visitors (1.96 million) for 2013-2014 was 5,000 more than the last record set in 2007-2008. This increase also represents a 6 percent increase over 2012-2013.

Table 3.16-2
Adopted Scenic Integrity Objectives for the Tongass (percent)

	Scenic Integrity Objective				
	High	**Moderate**	**Low**	**Very Low**	**Other[1]**
Foreground	7.7	3.6	1.4	0.1	0.1
Middleground	18.3	7.2	2.3	6.0	0.1
Background	0.8	0.4	0.0	0.2	0.0
Seldom seen	33.9	8.8	0.5	6.9	0.1
Unmapped	0.0	0.0	0.0	0.0	0.3
Total	**60.7**	**20.0**	**4.2**	**13.1**	**0.6**

[1] Includes land in the Municipal Watershed and Non-wilderness National Monument LUDs. SIOs in these LUDs are to be determined on a project-by-project basis. Generally, the High SIO will be met.
Source: USDA Forest Service, GIS. Numbers are not exact and may not sum correctly due to rounding.

Lands adjacent to the Alaska Marine Highway, cruise ship routes, flight-seeing routes, high-use recreation areas, and other marine and land-based travel routes will be seen by more people, more frequently, and for greater duration.

Environmental Consequences

The Tongass has adopted specific management objectives for scenic resources (i.e., SIOs) for each LUD in the Forest. The adopted SIOs indicate the desired or acceptable level of human-induced alteration to the valued landscape character. Harvest of old growth would follow the SIOs of the 2008 Forest Plan for all alternatives. However, Alternatives 2, 3, and 5, have relaxed these SIOs for young-growth harvest in order to increase the availability of young growth, especially in the first few decades. In other words, these alternatives have reduced SIOs in viewsheds where young growth is to be harvested. As a result, the current SIO designated for the LUD in which young-growth harvest takes place, is not likely to be met in many cases. Each alternative described in this Environmental Impact Statement (EIS) would, if implemented, maintain or alter the visual character of the landscape to varying degrees. By varying the degree of change in SIOs for the harvest of young-growth, the alternatives would result in different amounts of land managed under each SIO. The adopted SIOs for young growth are, therefore, the units used to measure potential change in visual resources for each alternative.

Adopted SIOs can be thought of as an indicator of long-term cumulative effects. SIOs are adopted to provide a threshold for the amount of modification to the landscape during land altering activities; therefore, land may have an adopted SIO of Low, but currently meet the High SIO.

The potential effects to the scenic resource are primarily described in the following three ways:

1. A display of acres of each SIO adopted for suitable young growth, along with LUD and distance zone, for each alternative.

2. A display of the number of acres of SIO Changes for suitable young growth and the degree of change (e.g., from Moderate to Low) for each alternative.
3. A display of the effects of each alternative on a selected group of key viewsheds throughout the Tongass.

Effects associated with renewable energy development are also addressed.

Direct, Indirect, and Cumulative Forest-wide Effects

Table 3.16-3 displays the acres of suitable young growth in each SIO that would result from the five alternatives. Table 3.16-3 also shows the acres under each alternative and SIO that would be located within different LUDs and distance zones. Distance zones stratify the landscape into seen areas and unseen areas, relative to inventoried travelways and use areas. The seen areas are stratified further into foreground, middleground, and background zones. The acres displayed for Alternative 1 (No Action) and Alternative 4 are based on the current mix of adopted SIOs because these alternatives include no SIO changes. Alternative 2 relaxes the SIO for young-growth harvest to Very Low, no matter what the SIO is currently. Alternative 3 would relax the SIO for young-growth harvest by one level in all LUDs, except in Timber Production. The Timber Production LUD SIOs would not change (i.e., Low in the Foreground and Very Low in the Middleground and Background). This is because the currently prescribed SIO of Low in the foreground is already very permissive (up to 60-acre clearcut) and probably in concert with anticipated unit sizes. Alternative 5 would relax the SIOs for young-growth harvest to Very Low, no matter what the SIO is currently, in all development LUDs. However, Alternative 5 also includes harvest in the Old Growth Habitat LUD and there would be no change in the SIO for this LUD (it would remain High).

Alternatives 2 and 3 include no acres designated as High SIO for young growth. Alternative 5 would include acreage designated as High SIO because it does not change SIOs in the Old Growth Habitat LUD. Alternative 2 would include no acreage designated as Moderate or Low SIO either; all acres would be designated Very Low. Alternative 3 on the other hand, would include almost 40 percent in Moderate and Low (Table 3.16-3).

A more direct way to assess the relative effects of the alternatives on scenic integrity is to compare the area under each alternative where the SIO would change and the degree of this change. This analysis is presented in Table 3.16-4.

Table 3.16-4 demonstrates again that Alternatives 1 and 4 would result in no changes to SIOs. The alternative with the most significant changes is Alternative 2, which would result in about 102,000 acres changing from High or Moderate to Very Low. The next most significant change would be with Alternative 5, which would result in about 46,000 acres changing from High or Moderate to Very Low. Alternative 3 would not result in any acres dropping more than one level.

Table 3.16-3
Scenery Integrity Objectives for Suitable Young Growth by LUD, Distance Zone, and Alternative (percent)

	Scenery Integrity Objectives					
	High	**Moderate**	**Low**	**Very Low**	**Other[1]**	**Total**
Alternative 1						
Timber Production						
Foreground			15%			**15%**
Middleground				34%		**34%**
Background				+		**+**
Seldom Seen Areas				20%		**20%**
Unmapped Areas					+	**+**
Subtotal	**0%**	**0%**	**15%**	**55%**	**+**	**70%**
Modified Landscape						
Foreground		9%				**9%**
Middleground			13%			**13%**
Background			+			**+**
Seldom Seen Areas				4%		**4%**
Unmapped Areas					+	**+**
Subtotal	**0%**	**9%**	**13%**	**4%**	**+**	**26%**
Scenic Viewshed						
Foreground	2%					**2%**
Middleground		2%				**2%**
Background		+				**+**
Seldom Seen Areas						
Unmapped Areas					+	**+**
Subtotal	**2%**	**2%**	**0%**	**0%**	**+**	**5%**
Total	**2%**	**11%**	**28%**	**59%**	**+**	**100%**
Suitable Acres	**5,721**	**29,773**	**73,382**	**154,970**	**30**	**263,905**
Alternative 2						
Timber Production						
Foreground				13%		13%
Middleground				27%		27%
Background				+		**+**
Seldom Seen Areas				18%		18%
Unmapped Areas				+		**+**
Subtotal	**0%**	**0%**	**0%**	**58%**	**0%**	**58%**
Modified Landscape						
Foreground				9%		9%
Middleground				11%		11%
Background				+		**+**
Seldom Seen Areas				3%		3%
Unmapped Areas				+		**+**
Subtotal	**0%**	**0%**	**0%**	**23%**	**0%**	**23%**
Scenic Viewshed						
Foreground				3%		3%
Middleground				2%		2%
Background				+		**+**
Seldom Seen Areas				+		**+**
Unmapped Areas				+		**+**
Subtotal	**0%**	**0%**	**0%**	**5%**	**0%**	**5%**
Non-Development LUDs						
Foreground				6%		6%
Middleground				5%		5%
Background				+		**+**
Seldom Seen Areas				3%		3%
Unmapped Areas				+		**+**
Subtotal	**0%**	**0%**	**0%**	**14%**	**0%**	**14%**
Total	**0%**	**0%**	**0%**	**100%**	**0%**	**100%**
Suitable Acres	**0**	**0**	**0**	**374,712**	**0**	**374,712**

Table 3.16-3 (continued)
Scenery Integrity Objectives for Suitable Young Growth by LUD, Distance Zone, and Alternative (percent)

	Scenery Integrity Objectives					
	High	**Moderate**	**Low**	**Very Low**	**Other[1]**	**Total**
Alternative 3						
Timber Production						
Foreground			13%			13%
Middleground				28%		28%
Background						
Seldom Seen Areas				17%		16%
Unmapped Areas					+	**+**
Subtotal	**0%**	**0%**	**13%**	**45%**	**+**	**58%**
Modified Landscape						
Foreground			9%			9%
Middleground				11%		11%
Background				+		**+**
Seldom Seen Areas				3%		3%
Unmapped Areas					+	**+**
Subtotal	**0%**	**0%**	**9%**	**14%**	**+**	**23%**
Scenic Viewshed						
Foreground		2%				**2%**
Middleground			2%			**2%**
Background			+			**+**
Seldom Seen Areas				+		**+**
Unmapped Areas					+	**+**
Subtotal	**0%**	**3%**	**2%**	**+**	**+**	**5%**
Non-Development LUDs						
Foreground		4%	1%			**6%**
Middleground		5%				**5%**
Background		+	+			**+**
Seldom Seen Areas		3%	+			**3%**
Unmapped Areas		+	+			**+**
Subtotal	**0%**	**11%**	**1%**	**0%**	**0%**	**14%**
Total	**0%**	**13%**	**26%**	**59%**	**0%**	**100%**
Suitable Acres	**0**	**48,355**	**93,866**	**207,574**	**75**	**349,870**
Alternative 4						
Timber Production						
Foreground			16%			16%
Middleground				33%		33%
Background				+		**+**
Seldom Seen Areas				19%		19%
Unmapped Areas					+	**+**
Subtotal	**0%**	**0%**	**16%**	**52%**	**+**	**68%**
Modified Landscape						
Foreground		11%				11%
Middleground			12%			12%
Background			+			**+**
Seldom Seen Areas				3%		3%
Unmapped Areas					+	**+**
Subtotal	**0%**	**11%**	**12%**	**3%**	**+**	**27%**
Scenic Viewshed						
Foreground	2%					2%
Middleground		2%				2%
Background		+				**+**
Seldom Seen Areas						0%
Unmapped Areas					+	**+**
Subtotal	**2%**	**2%**	**0%**	**0%**	**+**	**5%**
Total	**2%**	**13%**	**29%**	**56%**	**0%**	**100%**
Suitable Acres	**6,315**	**35,015**	**75,540**	**146,763**	**75**	**263,708**

Table 3.16-3 (continued)
Scenery Integrity Objectives for Suitable Young Growth by LUD, Distance Zone, and Alternative (percent)

	Scenery Integrity Objectives					
	High	**Moderate**	**Low**	**Very Low**	**Other[1]**	**Total**
Alternative 5						
Timber Production						
Foreground				14%		**14%**
Middleground				28%		**28%**
Background				+		**+**
Seldom Seen Areas				18%		**18%**
Unmapped Areas				+		**+**
Subtotal	**0%**	**0%**	**0%**	**61%**	**0%**	**61%**
Modified Landscape						
Foreground				9%		**9%**
Middleground				11%		**11%**
Background				+		**+**
Seldom Seen Areas				3%		**3%**
Unmapped Areas				+		**+**
Subtotal	**0%**	**0%**	**9%**	**24%**	**0%**	**24%**
Scenic Viewshed						
Foreground				3%		**3%**
Middleground				2%		**2%**
Background				+		**+**
Seldom Seen Areas						**0%**
Unmapped Areas				+		**+**
Subtotal	**0%**	**0%**	**0%**	**5%**	**0%**	**5%**
Non-Development LUDs (OG Habitat)						
Foreground	4%					**4%**
Middleground	4%					**4%**
Background	+					**+**
Seldom Seen Areas	2%					**2%**
Unmapped Areas	+					**+**
Subtotal	**10%**	**0%**	**0%**	**0%**	**0%**	**10%**
Total	**10%**	**0%**	**0%**	**90%**	**0%**	**100%**
Suitable Acres	**35,537**	**0**	**0**	**303,436**	**0**	**338,974**

[1] Consists of unmapped areas.
Note: Numbers are based on GIS estimates and are not exact due to rounding.

Table 3.16-4
SIO Changes in Estimated Suitable Young Growth Forest Land for Each Alternative

	Alternatives				
SIO	**1**	**2**	**3**	**4**	**5**
No Changes					
High	5,751			6,315	35,537
Moderate	29,773			35,015	
Low	73,382			75,540	
Very Low	154,970	234,285	168,043	146,763	170,995
Unmapped	30		75	75	38
Subtotal	**263,905**	**234,285**	**168,118**	**263,708**	**206,570**
Changes					
High to Moderate			50,313		
High to Very Low		9,611			8,781
Moderate to Low			47,398		
Moderate to Very Low		41,670			38,255
Low to Very Low		89,146	84,041		85,369
Subtotal	**0**	**140,427**	**181,752**	**0**	**132,405**
Total Suitable	**263,905**	**374,712**	**349,870**	**263,708**	**338,974**

Note: Numbers are based on GIS estimates and are not exact. Columns do not sum correctly due to rounding.

Alternative 1. Alternative 1 would result in the largest acreage of old-growth harvest. An estimated 38,527 acres would be harvested in the first 25 years and 62,851 acres would be harvested in 100 years. The 25-year harvest level is 62 percent more than the next highest old-growth harvest among the alternatives. Harvest of old growth would follow the SIOs under the 2008 Forest Plan so the SIOs would be met.

Young-growth harvest levels are estimated to be 9,669 acres in the first 25 years and 209,882 acres after 100 years. Both of these harvest levels are the lowest among the alternatives. Furthermore, young-growth harvest would follow the SIOs under the 2008 Forest Plan with this alternative. This alternative is ranked comparable to Alternative 4 and these two alternatives are expected to have the lowest visual impacts among the alternatives.

Alternative 2. Under Alternative 2, old-growth harvest levels would be lowest among the alternatives. An estimated 15,027 acres would be harvested in the first 25 years and 32,609 acres would be harvested in 100 years. This amounts to 39 and 52 percent of the Alternative 1 old-growth harvest, respectively. In addition, as in Alternative 1, harvest of old growth would follow the SIOs under the 2008 Forest Plan so the SIOs would be met after harvest.

In contrast, young-growth harvest levels are estimated to be 63,787 acres in the first 25 years and 335,344 acres after 100 years. Both of these harvest levels are the highest among the alternatives. In addition, young-growth harvest would be subject to the lowest SIOs among the alternatives – all SIOs would be Very Low. About 37 percent of the current SIO acreage covering these harvests would need to be reduced to achieve the Very Low SIO. Also, this alternative permits young-growth harvest in most non-development LUDs. Therefore, even though this alternative would result in the lowest old-growth harvest acreage, its visual impacts are likely to be the highest among the alternatives. It is likely that many areas across the Forest will not comply with the SIOs associated with their underlying LUDs, because of young-growth harvest under this alternative.

Alternative 3. Under Alternative 3, old-growth harvest levels would be almost as low as Alternative 2. An estimated 16,599 acres would be harvested in the first 25 years and 35,568 acres would be harvested in 100 years. This amounts to 43 and 57 percent of the Alternative 1 old-growth harvest, respectively. In addition, as in Alternative 1, harvest of old growth would follow the SIOs under the 2008 Forest Plan so the current SIOs would be met after harvest.

As in Alternative 2, young-growth harvest levels would be relatively high, estimated to be 53,734 acres in the first 25 years and 313,216 acres after 100 years. Both of these harvest levels are the second highest among the alternatives. Young-growth harvest would be subject to reductions in SIOs – all SIOs would be reduced one level except in the Timber Production LUD, which includes about 58 percent of the projected harvest. Therefore, the SIOs for about 52 percent of the projected harvest would be reduced by one level. This alternative would be similar to Alternative 5 in terms of overall visual impacts.

Alternative 4. Alternative 4 would have old-growth harvest levels lower than Alternatives 1, higher than Alternatives 2 and 3, and comparable to Alternative 5. An estimated 23,255 acres would be harvested in the first 25 years and 42,597 acres would be harvested in 100 years. This amounts to 60 and 68 percent of the Alternative 1 old-growth harvest, respectively. In addition, as in Alternative 1, harvest of old growth would follow the SIOs under the 2008 Forest Plan so the SIOs would be met after harvest.

Young-growth harvest levels would be second lowest among the alternatives; estimated to be 40,760 acres in the first 25 years and 234,885 acres after 100 years. Young-growth harvest would be subject to the SIOs of the 2008 Forest Plan, so the current SIOs would be met after harvest. As a result, this alternative, along with Alternative 1 would be likely to have the lowest visual impacts among the alternatives.

Alternative 5. Alternative 5 would have very similar old-growth harvest levels as Alternative 4. An estimated 23,813 acres would be harvested in the first 25 years and 42,479 acres would be harvested in 100 years. This amounts to 62 and 68 percent of the Alternative 1 old-growth harvest, respectively. As in Alternative 1, harvest of old growth would follow the SIOs under the 2008 Forest Plan so the SIOs would be met after harvest.

Young-growth harvest levels would also be very similar to Alternative 4; estimated to be 43,316 acres in the first 25 years and 284,144 acres after 100 years. Young-growth harvest would be subject to the SIOs of the current Forest Plan in the Old Growth Habitat LUD, but would be reduced to Very Low in the development LUDs. As a result, the SIOs on about 39 percent of the projected young-growth harvest would be reduced to the Very Low SIO level. This alternative would be similar to Alternative 3 in terms of overall visual impacts

Effects on Selected Viewsheds

To help focus the visual effects on more familiar areas, the alternatives were also analyzed by selected large viewsheds in the Tongass. These 23 viewsheds were selected for their popularity and intensity of public use and travel and are the same as those analyzed in the EIS associated with the 1997 Forest Plan Revision (USDA Forest Service 1997a) and in the EIS associated with the 2008 Forest Plan Amendment (USDA Forest Service 2008b). They technically represent a series of viewsheds along a travelway and take in entire Value Comparison Units (VCUs). Table 3.16-5 compares the percentage of land in each SIO on suitable young-growth acres under the five alternatives for each of the viewsheds. The table also includes the total suitable young-growth acres, the suitable acres potentially old enough to be harvested in the first decade, and the acreage of the viewshed. Acres that are seldom seen or unseen from any viewpoint along the travelway are excluded from each of these categories.

For two reasons, only the SIOs of young-growth acres are compared in this table in order to emphasize the differences among the alternatives. First, the SIOs for suitable young growth change in some alternatives while the SIOs for suitable old growth do not change. Secondly, the acres of young growth to be harvested over time are much higher than the acres of old growth and old-growth harvest over the next 100 years represents a small percentage (9 to 20 percent) of the suitable old growth.

While the previous section of this effects analysis summarized overall effects by alternative, this section is intended to be a viewshed-specific assessment of effects. As such, it takes into account past harvest and represents a cumulative assessment of scenery effects Listed below are some summary points that can be observed from the viewshed-specific assessment:

- Five of the 23 viewsheds (Hyder/Salmon River Highway, Icy Strait, Lynn Canal, Mendenhall Glacier, and Salmon Bay Lake) do not include any suitable young growth of harvestable age during the first decade, in any alternatives.

- Two of the 23 viewsheds (Hyder/Salmon River Highway and Mendenhall Glacier) do not include any suitable young growth in any alternatives.
- In most viewsheds, the highest effects on scenery would be associated with Alternative 2, followed by Alternative 5, followed by Alternative 3, followed by Alternative 1 or 4. This is based on the percentage of the viewshed that consists of suitable young growth and the changes in SIOs.
- Viewsheds with the highest potential for effects during the first decade include Behm Canal (West), Carroll Inlet, Clarence Strait, and Sumner Strait, based on the percentage of the viewshed consisting of suitable young growth that is harvestable in the first decade, the total amount of suitable young growth, and the extent of past harvest.

Behm Canal (West)

Alternatives 1 and 4 would have the fewest acres of suitable young growth in the viewshed. In addition, neither of these two alternatives would change SIOs relative to the 2008 Forest Plan (Table 3.16-5). Alternative 4 would have fewer suitable old-growth acres compared with Alternative 1, so it would likely have the lowest visual impact among all alternatives. Even though Alternative 1 would permit the highest level of old-growth harvest, this harvest level represents only 20 percent of the level allowed by the 2008 Forest Plan.

SIOs would change for young growth in Alternatives 2, 3, and 5. Alternative 2 would have the greatest effects on scenery in Behm Canal, because it would have the highest acreage with SIO changes (84 percent), the highest acreage in which the SIO would drop by two levels, and the highest level of young-growth harvest. Alternative 5 would have the second highest effects with 75 percent of the suitable acres with SIO changes and 15 percent dropping two levels. Alternative 3 would likely be in the middle in terms of scenery effects overall.

In some areas, particularly on the Revilla Island side of the west Canal, existing harvest is likely near the level allowed by the adopted SIOs. Additional harvest may need to be deferred in some areas in the coming decade depending on the SIO prescribed by the alternative; however, the number of young-growth acres of harvestable age within the next decade is limited, ranging from 866 to 2,485 acres (Table 3.16-5). A high portion of these acres are along the beach fringe in all alternatives except Alternative 1. Only commercial thinning is allowed in Alternatives 3 and 4. Thinning is expected to have little impact because it creates a fine patchwork of openings (less than 2 acres); this fine pattern would not be very noticeable and would become less noticeable after a short period. Clearcutting and patch cutting, with up to 10-acre openings, are allowed in Alternatives 2 and 5, respectively. A 200-foot shoreline buffer would be maintained in Alternative 5, which would help conceal the opening created by clearcuts. Therefore, Alternative 2 in particular, and Alternative 5 to a lesser degree, could have localized high effects during the first few decades. Overall harvest of old growth is expected to be much lower than under the existing Forest Plan with only 7 to 19 percent of the suitable old growth to be harvested under Alternatives 2 through 5.

Carroll Inlet

As with Behm Canal, Alternatives 1 and 4 would have the fewest acres of suitable young growth in the viewshed. In addition, neither of these two alternatives would change SIOs relative to the 2008 Forest Plan (Table 3.16-5). Alternative 4 would have fewer suitable old-growth acres compared with Alternative 1, so it would likely have the lowest visual impact among all

alternatives. Even though Alternative 1 would permit the highest level of old-growth harvest, it represents only 20 percent of the level allowed by the 2008 Forest Plan.

SIOs would change for young growth in Alternatives 2, 3, and 5. Alternative 2 would have the greatest effects on scenery in Carrol Inlet, because it would have the highest percentage of suitable young growth with SIO changes (73 percent), the highest percentage in which the SIO would drop by two levels (29 percent), and the highest young-growth harvest. Alternative 5 would have the second highest effects with 71 percent of the suitable acres having SIO changes and 25 percent dropping two levels. Alternative 3 would likely be in the middle in terms of scenery effects overall.

Carroll Inlet has experienced relatively heavy past harvest and existing harvest is likely near the level allowed by the adopted SIOs in some areas. Additional harvest may need to be deferred in localized areas in the coming decade depending on the SIO prescribed by the alternative; however, the number of young-growth acres of harvestable age within the next decade is limited, ranging from 109 to 592 acres (Table 3.16-5). A high portion of these acres are scattered along the beach fringe in all alternatives except Alternative 1. Only commercial thinning (low scenery impacts) is allowed in the beach fringe in Alternatives 3 and 4, but clearcutting and patch cutting, with up to 10 acre openings, are allowed in Alternatives 2 and 5, respectively (in addition, a 200-foot shoreline buffer would be maintained in Alternative 5). Therefore, Alternative 2 in particular, and Alternative 5 to a lesser degree, could have localized moderate effects during the first few decades. Overall harvest of old growth is expected to be much lower than under the existing Forest Plan with only 7 to 19 percent of the suitable old growth to be harvested under Alternatives 2 through 5

Chatham Strait (West side)

Alternatives 1 and 4 would have the fewest acres of suitable young growth in the viewshed. In addition, neither of these two alternatives would change SIOs relative to the 2008 Forest Plan (Table 3.16-5). Alternative 4 would have fewer suitable old-growth acres compared with Alternative 1, so it would likely have the lowest visual impact among all alternatives. Even though Alternative 1 would permit the highest level of old-growth harvest, this harvest level represents only 20 percent of the level allowed by the 2008 Forest Plan.

SIOs would change for young growth in Alternatives 2, 3, and 5. Alternative 2 would have the greatest effects on scenery in Chatham Strait, because it would have the highest percentage of suitable young growth with SIO changes (59 percent), the highest percentage in which the SIO would drop by two levels (34 percent), and the highest young-growth harvest. Alternative 5 would have the second highest effects with 29 percent of the suitable acres having SIO changes and 2 percent dropping two levels. Alternative 3 would likely be in the middle in terms of scenery effects overall.

Chatham Strait has experienced relatively high past harvest but much of it is in seldom seen areas. Further, the number of young-growth acres of harvestable age within the next decade is very limited, ranging from 0 to 34 acres (Table 3.16-5). Therefore, all of the alternatives are expected to have low effects during the first few decades. Overall harvest of old growth is expected to be much lower than under the existing Forest Plan with only 7 to 19 percent of the suitable old growth permitted to be harvested under Alternatives 2 through 5.

Table 3.16-5
SIO Changes and Suitable Young Growth Acres in Selected Viewsheds [1,2,3]

Scenic Integrity Objective	Alternative 1	2	3	4	5
Behm Canal (West)					
Percent of Suitable YG Acres with SIO Changes					
No Change	100%	16%	45%	100%	25%
High to Moderate			11%		2%
High to Very Low		10%			
Moderate to Low			15%		
Moderate to Very Low		15%			13%
Low to Very Low		59%	29%		60%
Suitable YG Acres of Harvestable Age in 1st Decade in Viewshed	**866**	**2,485**	**2,281**	**2,200**	**2,060**
Suitable YG Acres in Viewshed	**7,070**	**10,339**	**9,768**	**8,951**	**9,825**
Total Acres in Viewshed (2% of Total Acres are Non-NFS)	**49,276**	**49,276**	**49,276**	**49,276**	**49,276**
Carroll Inlet					
Percent of Suitable YG Acres with SIO Changes					
No Change	100%	27%	57%	100%	29%
High to Moderate			3%		
High to Very Low		2%			
Moderate to Low			27%		
Moderate to Very Low		27%			25%
Low to Very Low		44%	14%		46%
Suitable YG Acres of Harvestable Age in 1st Decade in Viewshed	**109**	**571**	**592**	**497**	**411**
Suitable YG Acres in Viewshed	**6,016**	**7,913**	**7,782**	**7,194**	**7,253**
Total Acres in Viewshed (6% of Total Acres are Non-NFS)	**52,281**	**52,281**	**52,281**	**52,281**	**52,281**
Chatham Strait					
Percent of Suitable YG Acres with SIO Changes					
No Change	100%	41%	64%	100%	71%
High to Moderate			32%		
High to Very Low		31%			
Moderate to Low			2%		
Moderate to Very Low		3%			2%
Low to Very Low		26%	2%		26%
Suitable YG Acres of Harvestable Age in 1st Decade in Viewshed	**0**	**34**	**33**	**0**	**14**
Suitable YG Acres in Viewshed	**4,456**	**7,466**	**6,887**	**4,686**	**7,198**
Total Acres in Viewshed (4% of Total Acres are Non-NFS)	**107,799**	**107,799**	**107,799**	**107,799**	**107,799**
Cholmondeley Sound					
Percent of Suitable YG Acres with SIO Changes					
No Change	100%	56%	83%	100%	77%
High to Moderate			12%		
High to Very Low		13%			
Moderate to Low			3%		
Moderate to Very Low		3%			
Low to Very Low		28%	2%		23%
Suitable YG Acres of Harvestable Age in 1st Decade in Viewshed	**0**	**112**	**97**	**0**	**75**
Suitable YG Acres in Viewshed	**574**	**944**	**895**	**744**	**789**
Total Acres in Viewshed (21% of Total Acres are Non-NFS)	**36,164**	**36,164**	**36,164**	**36,164**	**36,164**

Table 3.16-5 (continued)
SIO Changes and Suitable Young Growth Acres in Selected Viewsheds [1,2,3]

Scenic Integrity Objective	Alternative 1	2	3	4	5
Clarence Strait					
Percent of Suitable YG Acres with SIO Changes					
No Change	100%	27%	43%	100%	34%
High to Moderate			8%		
High to Very Low		7%			
Moderate to Low			31%		
Moderate to Very Low		32%			32%
Low to Very Low		33%	18%		34%
Suitable YG Acres of Harvestable Age in 1st Decade in Viewshed	**1,193**	**1,985**	**2,000**	**1,393**	**1,688**
Suitable YG Acres in Viewshed	**16,253**	**20,987**	**20,147**	**17,641**	**19,516**
Total Acres in Viewshed (11% of Total Acres are Non-NFS)	**201,376**	**201,376**	**201,376**	**201,376**	**201,376**
Duncan Canal					
Percent of Suitable YG Acres with SIO Changes					
No Change	100%	46%	46%	100%	49%
High to Moderate			13%		
High to Very Low		12%			
Moderate to Low			5%		
Moderate to Very Low		5%			3%
Low to Very Low		36%	36%		48%
Suitable YG Acres of Harvestable Age in 1st Decade in Viewshed	**0**	**253**	**251**	**0**	**130**
Suitable YG Acres in Viewshed	**2,025**	**3,105**	**3,074**	**1,904**	**2,354**
Total Acres in Viewshed (0% of Total Acres are Non-NFS)	**69,810**	**69,810**	**69,810**	**69,810**	**69,810**
Eastern Passage					
Percent of Suitable YG Acres with SIO Changes					
No Change	100%	22%	63%	100%	36%
High to Moderate			15%		
High to Very Low		14%			1%
Moderate to Low			21%		
Moderate to Very Low		23%			19%
Low to Very Low		41%	2%		44%
Suitable YG Acres of Harvestable Age in 1st Decade in Viewshed	**1**	**163**	**103**	**0**	**67**
Suitable YG Acres in Viewshed	**2,436**	**3,107**	**2,967**	**2,463**	**2,924**
Total Acres in Viewshed (9% of Total Acres are Non-NFS)	**135,765**	**135,765**	**135,765**	**135,765**	**135,765**
Ernest Sound					
Percent of Suitable YG Acres with SIO Changes					
No Change	100%	1%	4%	100%	4%
High to Moderate			18%		
High to Very Low		17%			6%
Moderate to Low			46%		
Moderate to Very Low		46%			40%
Low to Very Low		36%	32%		50%
Suitable YG Acres of Harvestable Age in 1st Decade in Viewshed	**15**	**431**	**433**	**0**	**193**
Suitable YG Acres in Viewshed	**147**	**789**	**784**	**351**	**521**
Total Acres in Viewshed (7% of Total Acres are Non-NFS)	**36,387**	**36,387**	**36,387**	**36,387**	**36,387**

Table 3.16-5 (continued)
SIO Changes and Suitable Young Growth Acres in Selected Viewsheds [1,2,3]

Scenic Integrity Objective	Alternative 1	2	3	4	5
Frederick Sound					
Percent of Suitable YG Acres with SIO Changes					
No Change	100%	36%	47%	100%	38%
High to Moderate			23%		
High to Very Low		25%			20%
Moderate to Low			19%		
Moderate to Very Low		20%			21%
Low to Very Low		20%	12%		21%
Suitable YG Acres of Harvestable Age in 1st Decade in Viewshed	**389**	**1,015**	**895**	**615**	**787**
Suitable YG Acres in Viewshed	**6,065**	**9,049**	**8,234**	**6,491**	**7,797**
Total Acres in Viewshed (2% of Total Acres are Non-NFS)	**163,049**	**163,049**	**163,049**	**163,049**	**163,049**
Hyder/Salmon River Hiqhway					
Percent of Suitable YG Acres with SIO Changes					
No Change					
High to Moderate					
High to Very Low					
Moderate to Low					
Moderate to Very Low					
Low to Very Low					
Suitable YG Acres of Harvestable Age in 1st Decade in Viewshed	**0**	**0**	**0**	**0**	**0**
Suitable YG Acres in Viewshed	**0**	**0**	**0**	**0**	**0**
Total Acres in Viewshed (2% of Total Acres are Non-NFS)	**22,603**	**22,603**	**22,603**	**22,603**	**22,603**
Icy Strait					
Percent of Suitable YG Acres with SIO Changes					
No Change	100%	46%	91%	100%	47%
High to Moderate			4%		
High to Very Low		4%			3%
Moderate to Low			4%		
Moderate to Very Low		4%			4%
Low to Very Low		46%			46%
Suitable YG Acres of Harvestable Age in 1st Decade in Viewshed	**0**	**0**	**0**	**0**	**0**
Suitable YG Acres in Viewshed	**2,223**	**2,519**	**2,273**	**2,241**	**2,519**
Total Acres in Viewshed (5% of Total Acres are Non-NFS)	**71,270**	**71,270**	**71,270**	**71,270**	**71,270**
Lynn Canal					
Percent of Suitable YG Acres with SIO Changes					
No Change	100%			100%	
High to Moderate					
High to Very					
Moderate to Low					
Moderate to Very Low		54%	95%		6%
Low to Very Low		46%	5%		94%
Suitable YG Acres of Harvestable Age in 1st Decade in Viewshed	**0**	**0**	**0**	**0**	**0**
Suitable YG Acres in Viewshed	**31**	**70**	**591**	**18**	**34**
Total Acres in Viewshed (15% of Total Acres are Non-NFS)	**233,520**	**233,520**	**233,520**	**233,520**	**233,520**

Table 3.16-5 (continued)
SIO Changes and Suitable Young Growth Acres in Selected Viewsheds [1]

Scenic Integrity Objective	Alternative 1	2	3	4	5
Mendenhall Glacier					
Percent of Suitable YG Acres with SIO Changes					
No Change					
High to Moderate					
High to Very Low					
Moderate to Low					
Moderate to Very Low					
Low to Very Low					
Suitable YG Acres of Harvestable Age in 1st Decade in Viewshed	**0**	**0**	**0**	**0**	**0**
Suitable YG Acres in Viewshed	**0**	**0**	**0**	**0**	**0**
Total Acres in Viewshed (3% of Total Acres are Non-NFS)	**55,266**	**55,266**	**55,266**	**55,266**	**55,266**
Peril Strait					
Percent of Suitable YG Acres with SIO Changes					
No Change	100%	29%	51%	100%	55%
High to Moderate			19%		
High to Very Low		24%			7%
Moderate to Low			29%		
Moderate to Very Low		28%			19%
Low to Very Low		19%	1%		19%
Suitable YG Acres of Harvestable Age in 1st Decade in Viewshed	**439**	**1,749**	**1,192**	**572**	**1,165**
Suitable YG Acres in Viewshed	**4,473**	**9,642**	**8,436**	**6,236**	**7,988**
Total Acres in Viewshed (7% of Total Acres are Non-NFS)	**190,244**	**190,244**	**190,244**	**190,244**	**190,244**
Salmon Bay Lake					
Percent of Suitable YG Acres with SIO Changes					
No Change	100%		5%	100%	19%
High to Moderate			29%		
High to Very Low		29%			11%
Moderate to Low			45%		
Moderate to Very Low		45%			45%
Low to Very Low		26%	20%		26%
Suitable YG Acres of Harvestable Age in 1st Decade in Viewshed	**0**	**0**	**0**	**0**	**0**
Suitable YG Acres in Viewshed	**1,083**	**1,371**	**1,349**	**0**	**1,352**
Total Acres in Viewshed (8% of Total Acres are Non-NFS)	**8,422**	**8,422**	**8,422**	**8,422**	**8,422**
Stephens Pass					
Percent of Suitable YG Acres with SIO Changes					
No Change	100%				
High to Moderate					
High to Very					
Moderate to Low			100%		
Moderate to Very Low		100%			100%
Low to Very Low					
Suitable YG Acres of Harvestable Age in 1st Decade in Viewshed	**15**	**113**	**427**	**0**	**67**
Suitable YG Acres in Viewshed	**15**	**113**	**427**	**0**	**67**
Total Acres in Viewshed (25% of Total Acres are Non-NFS)	**259,490**	**259,490**	**259,490**	**259,490**	**259,490**

Table 3.16-5 (continued)
SIO Changes and Suitable Young Growth Acres in Selected Viewsheds [1,2,3]

Scenic Integrity Objective	Alternative 1	2	3	4	5
Stikine Strait					
Percent of Suitable YG Acres with SIO Changes					
No Change	100%	7%	8%	100%	15%
High to Moderate			35%		
High to Very Low		35%			25%
Moderate to Low			25%		
Moderate to Very Low		25%			26%
Low to Very Low		33%	33%		35%
Suitable YG Acres of Harvestable Age in 1st Decade in Viewshed	**0**	**63**	**62**	**0**	**47**
Suitable YG Acres in Viewshed	**2,359**	**4,201**	**4,164**	**2,215**	**3,435**
Total Acres in Viewshed (0% of Total Acres are Non-NFS)	**60,823**	**60,823**	**60,823**	**60,823**	**60,823**
Sumner Strait					
Percent of Suitable YG Acres with SIO Changes					
No Change	100%	27%	37%	100%	35%
High to Moderate			13%		
High to Very Low		13%			7%
Moderate to Low			20%		
Moderate to Very Low		20%			14%
Low to Very Low		40%	30%		44%
Suitable YG Acres of Harvestable Age in 1st Decade in Viewshed	**1,588**	**2,878**	**2,837**	**2,436**	**2,482**
Suitable YG Acres in Viewshed	**16,333**	**23,605**	**23,041**	**19,300**	**20,246**
Total Acres in Viewshed (5% of Total Acres are Non-NFS)	**151,992**	**151,992**	**151,992**	**151,992**	**151,992**
Sweetwater Lake/Honker Divide					
Percent of Suitable YG Acres with SIO Changes					
No Change	100%	7%	11%	100%	35%
High to Moderate			29%		
High to Very Low		29%			1%
Moderate to Low			22%		
Moderate to Very Low		22%			22%
Low to Very Low		41%	38%		41%
Suitable YG Acres of Harvestable Age in 1st Decade in Viewshed	**16**	**29**	**26**	**16**	**18**
Suitable YG Acres in Viewshed	**6,681**	**9,734**	**9,370**	**4,630**	**9,636**
Total Acres in Viewshed (9% of Total Acres are Non-NFS)	**107,457**	**107,457**	**107,457**	**107,457**	**107,457**
Tennakee Inlet to Tenakee Springs					
Percent of Suitable YG Acres with SIO Changes					
No Change	100%	45%	53%	100%	77%
High to Moderate			30%		
High to Very		29%			1%
Moderate to Low			10%		
Moderate to Very Low		10%			9%
Low to Very Low		16%	8%		14%
Suitable YG Acres of Harvestable Age in 1st Decade in Viewshed	**64**	**490**	**334**	**71**	**150**
Suitable YG Acres in Viewshed	**2,104**	**4,035**	**3,476**	**2,233**	**3,638**
Total Acres in Viewshed (1% of Total Acres are Non-NFS)	**152,342**	**152,342**	**152,342**	**152,342**	**152,342**

Table 3.16-5 (continued)
SIO Changes and Suitable Young Growth Acres in Selected Viewsheds [1,2,3]

Scenic Integrity Objective	Alternative 1	2	3	4	5
West Coast Waterway -POW					
Percent of Suitable YG Acres with SIO Changes					
No Change	100%	47%	72%	100%	65%
High to Moderate			17%		
High to Very Low		17%			
Moderate to Low			6%		
Moderate to Very Low		7%			7%
Low to Very Low		29%	5%		29%
Suitable YG Acres of Harvestable Age in 1st Decade in Viewshed	**404**	**888**	**840**	**725**	**746**
Suitable YG Acres in Viewshed	**9,921**	**14,431**	**13,878**	**10,789**	**12,737**
Total Acres in Viewshed (1% of Total Acres are Non-NFS)	**140,773**	**140,773**	**140,773**	**140,773**	**140,773**
Wrangell Narrows					
Percent of Suitable YG Acres with SIO Changes					
No Change	100%	0%	0%	100%	19%
High to Moderate			29%		
High to Very Low		29%			8%
Moderate to Low			48%		
Moderate to Very Low		47%			48%
Low to Very Low		24%	23%		24%
Suitable YG Acres of Harvestable Age in 1st Decade in Viewshed	**0**	**49**	**50**	**0**	**43**
Suitable YG Acres in Viewshed	**2,495**	**3,489**	**3,369**	**2,507**	**3,260**
Total Acres in Viewshed (26% of Total Acres are Non-NFS)	**87,498**	**87,498**	**87,498**	**87,498**	**87,498**
Zimovia Strait					
Percent of Suitable YG Acres with SIO Changes					
No Change	100%	17%	35%	100%	37%
High to Moderate			18%		
High to Very Low		19%			1%
Moderate to Low			35%		
Moderate to Very Low		35%			36%
Low to Very Low		29%	11%		26%
Suitable YG Acres of Harvestable Age in 1st Decade in Viewshed	**71**	**233**	**225**	**74**	**193**
Suitable YG Acres in Viewshed	**2,725**	**3,934**	**3,997**	**2,835**	**3,637**
Total Acres in Viewshed (12% of Total Acres are Non-NFS)	**82,826**	**82,826**	**82,826**	**82,826**	**82,826**

Cholmondeley Sound

Alternatives 1 and 4 would have the fewest acres of suitable young growth in the viewshed. In addition, neither of these two alternatives would change SIOs relative to the 2008 Forest Plan (Table 3.16-5). Alternative 4 would have fewer suitable old-growth acres compared with Alternative 1, so it would likely have the lowest visual impact among all alternatives. Even though Alternative 1 would permit the highest level of old-growth harvest, this harvest level represents only 20 percent of the level allowed by the 2008 Forest Plan.

SIOs would change for young growth in Alternatives 2, 3, and 5. Alternative 2 would have the greatest effects on scenery in Cholmondeley Sound, because it would have the highest percentage of suitable young growth with SIO changes (44 percent), the highest percentage in which the SIO would drop by two levels

(16 percent), and the highest young-growth harvest. Alternative 5 would have the second highest effects with 23 percent of the suitable acres having SIO changes and 0 percent dropping two levels. Alternative 3 would likely be in the middle in terms of scenery effects overall.

Cholmondeley Sound has experienced limited past harvest on National Forest System (NFS) lands, but relatively high past harvest on non-NFS lands. About 21 percent of the Viewshed consists of non-NFS lands. Further, the number of young-growth acres of harvestable age within the next decade is very limited, ranging from 0 to 112 acres (Table 3.16-5). Therefore, all of the alternatives are expected to have low effects during the first few decades; however, additional harvest may need to be deferred in localized areas near non-NFS land, especially where harvest includes openings in the beach fringe, as in Alternatives 2 and 5. Overall harvest of old growth is expected to be much lower than under the existing Forest Plan with only 7 to 19 percent of the suitable old growth to be harvested under Alternatives 2 through 5.

Clarence Strait

Clarence Strait is a large viewshed (over 200,000 acres), extending along both sides of the strait from its northern end south to Gravina Island. The viewshed includes portions of the South Etolin Wilderness Area, which would have an SIO of High under all alternatives; however, a Very High SIO would likely be achieved.

Alternatives 1 and 4 would have the fewest acres of suitable young growth in the viewshed and neither of these two alternatives would change SIOs relative to the 2008 Forest Plan (Table 3.16-5). Alternative 4 would have fewer suitable old-growth acres compared with Alternative 1, so it would likely have the lowest visual impact among all alternatives. Even though Alternative 1 would permit the highest level of old-growth harvest, this harvest level represents only 20 percent of the level allowed by the 2008 Forest Plan.

SIOs would change for young growth in Alternatives 2, 3, and 5. Alternative 2 would have the greatest effects on scenery in Clarence Strait, because it would have the highest percentage of suitable young growth with SIO changes (73 percent), the highest percentage in which the SIO would drop by two levels (39 percent), and the highest young-growth harvest. Alternative 5 would have the second highest effects with 66 percent of the suitable acres having SIO changes and 32 percent dropping two levels. Alternative 3 would likely be in the middle in terms of scenery effects overall.

Clarence Strait has experienced considerable past harvest, but much of it is not readily visible from the Strait, so much of the viewshed appears relatively pristine. However, the number of young-growth acres of harvestable age within the next decade ranges from 1,393 to 2,000 acres (Table 3.16-5). A number of these acres are scattered along the beach fringe, especially along the Prince of Wales and adjacent islands in the northern portion of the Strait in all alternatives except Alternative 1. Only commercial thinning (generally low impact to scenery) is allowed in the beach fringe in Alternatives 3 and 4, but clearcutting and patch cutting, with up to 10 acre openings, are allowed in Alternatives 2 and 5, respectively. A 200-foot shoreline buffer would be maintained in Alternative 5, which would mitigate the visibility of openings. Therefore, Alternative 2 in particular, and Alternative 5 to a lesser degree, could have localized moderate effects during the first few decades. Overall harvest of old growth is expected to be much lower than under the existing Forest Plan with only 7 to 19 percent of the suitable old growth to be harvested under Alternatives 2 through 5.

Duncan Canal

Alternatives 1 and 4 would have the fewest acres of suitable young growth in the viewshed. In addition, neither of these two alternatives would change SIOs relative to the 2008 Forest Plan (Table 3.16-5). Alternative 4 would have fewer suitable old-growth acres compared with Alternative 1, so it would likely have the lowest visual impact among all alternatives. Even though Alternative 1 would permit the highest level of old-growth harvest, this harvest level represents only 20 percent of the level allowed by the 2008 Forest Plan.

SIOs would change for young growth in Alternatives 2, 3, and 5. Alternatives 2 and 3 would have the greatest effects on scenery in Duncan Canal, because they would have the highest percentage of suitable young growth with SIO changes (54 percent), the highest percentage in which the SIO would drop by two levels (17-18 percent), and the highest young-growth harvest. Alternative 5 would have the third highest effects with 51 percent of the suitable acres having SIO changes and 3 percent dropping two levels.

Duncan Canal has experienced considerable past harvest on the east side of the Canal, but much of it is not readily visible from the Strait. However, the number of young-growth acres of harvestable age within the next decade ranges from 0 to 253 acres (Table 3.16-5). A number of these acres are scattered along the beach fringe in all alternatives except Alternative 1. Only commercial thinning (generally low impact to scenery) is allowed in the beach fringe in Alternatives 3 and 4, but clearcutting and patch cutting, with up to 10 acre openings, are allowed in Alternatives 2 and 5, respectively (in addition, a 200- foot shoreline buffer would mitigate the visibility of openings in Alternative 5). Therefore, Alternative 2 in particular, and Alternative 5 to a lesser degree, could have local effects along the travelway during the first few decades. Overall harvest of old growth is expected to be much lower than under the existing Forest Plan with only 7 to 19 percent of the suitable old growth to be harvested under Alternatives 2 through 5.

Eastern Passage

Alternatives 1 and 4 would have the fewest acres of suitable young growth in the viewshed. In addition, neither of these two alternatives would change SIOs relative to the 2008 Forest Plan (Table 3.16-5). Alternative 4 would have fewer suitable old-growth acres compared with Alternative 1, so it would likely have the lowest visual impact among all alternatives. Even though Alternative 1 would permit the highest level of old-growth harvest, this harvest level represents only 20 percent of the level allowed by the 2008 Forest Plan.

SIOs would change for young growth in Alternatives 2, 3, and 5. Alternative 2 would have the greatest effects on scenery in Eastern Passage, because it would have the highest percentage of suitable young growth with SIO changes (78 percent), the highest percentage in which the SIO would drop by two levels (36 percent), and the highest young-growth harvest. Alternative 5 would have the second highest effects with 64 percent of the suitable acres having SIO changes and 20 percent dropping two levels. Alternative 3 would likely be in the middle in terms of scenery effects overall.

Eastern Passage has experienced considerable past harvest on the Wrangell Island side, but much of it is not readily visible from the Passage. The number of young-growth acres of harvestable age within the next decade ranges from 1 to 163 acres (Table 3.16-5). A few of these acres are scattered along the beach fringe in all alternatives except Alternative 1. Only commercial thinning (generally low impact to scenery) is allowed in the beach fringe in Alternatives 3 and 4, but clearcutting and patch cutting, with up to 10 acre openings, are

allowed in Alternatives 2 and 5, respectively (in addition, a 200-foot shoreline buffer would mitigate the visibility of openings in Alternative 5). Therefore, Alternative 2 in particular, and Alternative 5 to a lesser degree, could have small local effects along the travelway during the first few decades. Overall harvest of old growth is expected to be much lower than under the existing Forest Plan with only 7 to 19 percent of the suitable old growth to be harvested under Alternatives 2 through 5.

Ernest Sound

Alternatives 1 and 4 would have the fewest acres of suitable young growth in the viewshed. In addition, neither of these two alternatives would change SIOs relative to the 2008 Forest Plan (Table 3.16-5). Alternative 4 would have fewer suitable old-growth acres compared with Alternative 1, so it would likely have the lowest visual impact among all alternatives. Even though Alternative 1 would permit the highest level of old-growth harvest, this harvest level represents only 20 percent of the level allowed by the 2008 Forest Plan.

SIOs would change for young growth in Alternatives 2, 3, and 5. Alternative 2 would have the greatest effects on scenery in Ernest Sound, because it would have the highest percentage with SIO changes (99 percent), the highest percentage in which the SIO would drop by two levels (63 percent), and the highest young-growth harvest. Alternative 5 would have the second highest effects with 96 percent of the suitable acres having SIO changes and 46 percent dropping two levels. Alternative 3 would likely be in the middle in terms of scenery effects overall.

Ernest Sound has experienced considerable past harvest on Deer Island and along the beach to the north. The number of young-growth acres of harvestable age within the next decade ranges from 15 to 433 acres (Table 3.16-5). Most of these acres are along the beach fringe in all alternatives except Alternative 1. Only commercial thinning (generally low impact to scenery) is allowed in the beach fringe in Alternatives 3 and 4, but clearcutting and patch cutting, with up to 10 acre openings, are allowed in Alternatives 2 and 5, respectively (in addition, a 200-foot shoreline buffer would mitigate opening size in Alternative 5). Therefore, Alternative 2 in particular, and Alternative 5 to a lesser degree, could have localized effects during the first few decades. Overall harvest of old growth is expected to be much lower than under the existing Forest Plan with only 7 to 19 percent of the suitable old growth to be harvested under Alternatives 2 through 5.

Frederick Sound

Frederick Sound is a large viewshed (163,000 acres) along Kupreanof Island and the mainland. Alternatives 1 and 4 would have the fewest acres of suitable young growth in the viewshed. In addition, neither of these two alternatives would change SIOs relative to the 2008 Forest Plan (Table 3.16-5). Alternative 4 would have fewer suitable old-growth acres compared with Alternative 1, so it would likely have the lowest visual impact among all alternatives. Even though Alternative 1 would permit the highest level of old-growth harvest, this harvest level represents only 20 percent of the level allowed by the 2008 Forest Plan.

SIOs would change for young growth in Alternatives 2, 3, and 5. Alternative 2 would have the greatest effects on scenery in Frederick Sound, because it would have the highest percentage of suitable young growth with SIO changes (64 percent), the highest percentage in which the SIO would drop by two levels (45 percent), and the highest young-growth harvest. Alternative 5 would have the second highest effects with 62 percent of the suitable acres having SIO changes

and 41 percent dropping two levels. Alternative 3 would likely be in the middle in terms of scenery effects overall.

Frederick Sound has experienced considerable past harvest in local areas on Kupreanof Island and along the mainland. The number of young-growth acres of harvestable age within the next decade ranges from 389 to 1,015 acres (Table 3.16-5). Some of these acres are along the beach fringe in all alternatives except Alternative 1. Only commercial thinning (generally low impact to scenery) is allowed in the beach fringe in Alternatives 3 and 4, but clearcutting and patch cutting, with up to 10 acre openings, are allowed in Alternatives 2 and 5, respectively (in addition, a 200-foot shoreline buffer would mitigate opening size in Alternative 5). Therefore, Alternative 2 in particular, and Alternative 5 to a lesser degree, could have localized moderate effects during the first few decades. Overall harvest of old growth is expected to be much lower than under the existing Forest Plan with only 7 to 19 percent of the suitable old growth to be harvested under Alternatives 2 through 5.

Hyder/Salmon River

No suitable young growth acres occur in this viewshed under any of the alternatives. Therefore, no impacts related to young-growth harvest would occur. Limited harvest of old growth could occur, but this would be well within 2008 Forest Plan SIOs.

Icy Strait

Icy Strait would experience limited effects due partly to the Wilderness LUDs on Pleasant and Lemesurier Islands and the LUD II at Point Adolphus. Wilderness areas would have an SIO of High under all alternatives, but would likely achieve an SIO of Very High.

Alternatives 1 and 4 would have the fewest acres of suitable young growth in the viewshed. In addition, neither of these two alternatives would change SIOs relative to the 2008 Forest Plan (Table 3.16-5). Alternative 4 would have fewer suitable old-growth acres compared with Alternative 1, so it would likely have the lowest visual impact among all alternatives. Even though Alternative 1 would permit the highest level of old-growth harvest, this harvest level represents only 20 percent of the level allowed by the 2008 Forest Plan.

SIOs would change for young growth in Alternatives 2, 3, and 5. Alternative 2 would have the greatest effects on scenery in Icy Strait, because it would have the highest percentage of suitable young growth with SIO changes (54 percent), the highest percentage in which the SIO would drop by two levels (8 percent), and the highest young-growth harvest. Alternative 5 would have the second highest effects with 53 percent of the suitable acres having SIO changes and 7 percent dropping two levels. Alternative 3 would likely be in the middle in terms of scenery effects overall.

No young-growth acres of harvestable age within the next decade occur in the viewshed (Table 3.16-5). Therefore, little to no effects are expected to occur under any alternatives during the first few decades. Overall harvest of old growth is expected to be much lower than under the existing Forest Plan with only 7 to 19 percent of the suitable old growth to be harvested under Alternatives 2 through 5.

Lynn Canal

Scenic effects within the Lynn Canal Viewshed would be limited and would be very similar under all of the alternatives except Alternative 3 (Table 3.16-5). None of the alternatives would include only suitable young growth within the

viewshed that would be of harvestable age within the next decade. Alternative 3 would have 591 acres of suitable young growth of all ages, but none of the other alternatives would have more than 70 acres. None of these latter acres and few of the younger acres occur in the beach fringe. Therefore, effects of Alternative 3 are expected to be higher than under the existing Forest Plan, but relatively minor as well.

Mendenhall Glacier

No effects would occur on the Mendenhall Glacier Viewshed under any of the alternatives. No suitable young growth or old growth occurs within the viewshed.

Peril Strait/Neva-Olga Strait/Sitka

This viewshed is a large one (190,000 acres) that begins near Sitka and wraps around the northern end of Chichagof Island and the southern end of Baranof Island. Alternatives 1 and 4 would have the fewest acres of suitable young growth in the viewshed. In addition, neither of these two alternatives would change SIOs relative to the 2008 Forest Plan (Table 3.16-5). Alternative 4 would have fewer suitable old-growth acres compared with Alternative 1, so it would likely have the lowest visual impact among all alternatives. Even though Alternative 1 would permit the highest level of old-growth harvest, this harvest level represents only 20 percent of the level allowed by the 2008 Forest Plan.

SIOs would change for young growth in Alternatives 2, 3, and 5. Alternative 2 would have the greatest effects on scenery in the Peril Strait complex, because it would have the highest percentage of suitable young growth with SIO changes (71 percent), the highest percentage in which the SIO would drop by two levels (52 percent), and the highest young-growth harvest. Alternative 5 would have the second highest effects with 45 percent of the suitable acres having SIO changes and 26 percent dropping two levels. In this viewshed, Alternative 3 would likely be comparable to Alternative 5 in terms of scenery effects overall, with 49 percent of the suitable acres having SIO changes but none dropping two levels.

The Peril Strait complex has experienced considerable past harvest in local areas, mostly on Chichagof, Kruzof, and adjacent small islands. The number of young-growth acres of harvestable age within the next decade ranges from 439 to 1,749 acres (Table 3.16-5). Many of these acres are along the beach fringe in all alternatives except Alternative 1. Only commercial thinning (generally low impact to scenery) is allowed in the beach fringe in Alternatives 3 and 4, but clearcutting and patch cutting, with up to 10 acre openings, are allowed in Alternatives 2 and 5, respectively (in addition, a 200-foot shoreline buffer would mitigate opening size in Alternative 5). Therefore, Alternative 2 in particular, and Alternative 5 to a lesser degree, could have local moderate effects during the first few decades. Overall harvest of old growth is expected to be much lower than under the existing Forest Plan with only 7 to 19 percent of the suitable old growth to be harvested under Alternatives 2 through 5.

Salmon Bay Lake

In the Salmon Bay Lake Viewshed, Alternative 4 would have very minor to no effects on scenery because it has no suitable young-growth acres. The other four alternatives would have comparable suitable young-growth acres, ranging from 1,083 to 1,371 acres. However, none of the alternatives have any young-growth acres that would be of harvestable age within the next decade. Therefore, none of the alternatives are expected to have more than minor effects in the next few decades. In the long-term, Alternatives 2, 3, and 5 could have

higher effects; they all have SIOs changing on the majority of their suitable acres and Alternatives 2 and 5 would have 56 to 74 percent of their suitable acres with SIOs dropping by two levels. Overall harvest of old growth is expected to be much lower than under the existing Forest Plan with only 7 to 19 percent of the suitable old growth to be harvested under Alternatives 2 through 5.

Stephens Passage

Stephens Passage is a large viewshed (259,000 acres) running between Admiralty Island and the mainland. It excludes the majority of the wilderness portion of the Admiralty National Monument.

Alternatives 1 and 4 would have only 15 and 0 acres of suitable young growth in the viewshed (Table 3.16-5), respectively, so the effects resulting from young-growth harvest under these alternatives would be negligible to none. Alternative 4 would have fewer suitable old-growth acres compared with Alternative 1, so it would likely have the lowest visual impact among all alternatives. Even though Alternative 1 would permit the highest level of old-growth harvest, this harvest level represents only 20 percent of the level allowed by the 2008 Forest Plan.

All SIOs would change for suitable young growth in Alternatives 2, 3, and 5 and 100 percent of the SIOs in Alternatives 2 and 5 would drop by two levels. However, these alternatives would include only 113 and 67 acres of suitable young growth, which represents less than 0.1 percent of the large viewshed. Although the majority of these acres are older stands in the beach fringe, they are scattered throughout the viewshed. Only commercial thinning (generally low impact to scenery) is allowed in the beach fringe in Alternative 3, but clearcutting and patch cutting, with up to 10 acre openings, are allowed in Alternatives 2 and 5, respectively (in addition, a 200-foot shoreline buffer would mitigate opening size in Alternative 5). Therefore, effects would likely occur in the first few decades, but they would be minor and localized, especially under Alternative 5 with the smaller openings and 200-foot buffer and under Alternative 3 with the commercial thinning. Overall harvest of old growth is expected to be much lower than under the existing Forest Plan with only 7 to 19 percent of the suitable old growth to be harvested under Alternatives 2 through 5.

Stikine Strait

This viewshed covers the corridors between Etolin, Zarembo, and Woronkofski Islands. Alternatives 1 and 4 would have the fewest acres of suitable young growth in the viewshed. In addition, neither of these two alternatives would change SIOs relative to the 2008 Forest Plan (Table 3.16-5). Alternative 4 would have fewer suitable old-growth acres compared with Alternative 1, so it would likely have the lowest visual impact among all alternatives. Even though Alternative 1 would permit the highest level of old-growth harvest, this harvest level represents only 20 percent of the level allowed by the 2008 Forest Plan.

SIOs would change for young growth in Alternatives 2, 3, and 5. Alternative 2 would have the greatest effects on scenery in Stikine Strait, because it would have the highest percentage of suitable young growth with SIO changes (93 percent), the highest percentage in which the SIO would drop by two levels (60 percent), and the highest young-growth harvest. Alternative 5 would have the second highest effects with 85 percent of the suitable acres having SIO changes and 51 percent dropping two levels. In this viewshed, Alternative 3 would likely be almost comparable with Alternatives 2 and 5 in terms of scenery effects overall, with 92 percent of the suitable acres having SIO changes but none dropping two levels.

The Stikine Strait Viewshed has experienced considerable past harvest in most areas within the viewshed. The number of young-growth acres of harvestable age within the next decade ranges from 47 to 63 acres for Alternatives 2, 3, and 5 (Table 3.16-5). Many of these acres are along the beach fringe. No acres of suitable young growth would be of harvestable age in Alternatives 1 and 4 within the next decade. Only commercial thinning (generally low impact to scenery) is allowed in the beach fringe in Alternative 3, but clearcutting and patch cutting, with up to 10 acre openings, are allowed in Alternatives 2 and 5, respectively (in addition, a 200-foot shoreline buffer would mitigate opening size in Alternative 5). Therefore, Alternative 2 in particular, and Alternative 5 to a lesser degree, could have localized effects during the first few decades. Overall harvest of old growth is expected to be much lower than under the existing Forest Plan with only 7 to 19 percent of the suitable old growth to be harvested under Alternatives 2 through 5.

Sumner Strait

The Sumner Strait Viewshed is a large viewshed (152,000 acres) along northern Prince of Wales, Kosciusko, Kuiu, Kupreanof, Zarembo, and other islands. It includes portions of the Kuiu Wilderness and the Mt. Calder/Mt. Holbrook and Salmon Bay LUD II areas. These areas would have an SIO of High but would likely achieve an SIO of Very High.

Alternatives 1 and 4 would have the fewest acres of suitable young growth in the viewshed. In addition, neither of these two alternatives would change SIOs relative to the 2008 Forest Plan (Table 3.16-5). Alternative 4 would have fewer suitable old-growth acres compared with Alternative 1, so it would likely have the lowest visual impact among all alternatives. Even though Alternative 1 would permit the highest level of old-growth harvest, this harvest level represents only 20 percent of the level allowed by the 2008 Forest Plan.

SIOs would change for young growth in Alternatives 2, 3, and 5. Alternative 2 would have the greatest effects on scenery in Sumner Strait, because it would have the highest percentage of suitable young growth with SIO changes (73 percent), the highest percentage in which the SIO would drop by two levels (33 percent), and the highest young-growth harvest. Alternative 5 would have the second highest effects with 65 percent of the suitable acres having SIO changes and 21 percent dropping two levels. In this viewshed, Alternative 3 would likely be almost comparable with Alternative 5 in terms of scenery effects overall, with 63 percent of the suitable acres having SIO changes but none dropping two levels.

The Sumner Strait Viewshed has experienced extensive past harvest in many areas within the viewshed. The number of young-growth acres of harvestable age within the next decade ranges from 1,588 to 2,878 acres for Alternatives 2, 3, and 5 (Table 3.16-5). Many of these acres are along the beach fringe in all alternatives except Alternative 1. Only commercial thinning (generally low impact to scenery) is allowed in the beach fringe in Alternatives 3 and 4, but clearcutting and patch cutting, with up to 10 acre openings, are allowed in Alternatives 2 and 5, respectively (in addition, a 200-foot shoreline buffer would mitigate opening size in Alternative 5). Therefore, Alternative 2 in particular, and Alternative 5 to a lesser degree, could have relatively high effects during the first few decades. Overall harvest of old growth is expected to be much lower than under the existing Forest Plan with only 7 to 19 percent of the suitable old growth to be harvested under Alternatives 2 through 5.

Sweetwater Lake/Honker Divide

Alternatives 1 and 4 would have the fewest acres of suitable young growth in the viewshed. In addition, neither of these two alternatives would change SIOs relative to the 2008 Forest Plan (Table 3.16-5). Alternative 4 would have fewer suitable young-growth and old-growth acres compared with Alternative 1, so it would likely have the lowest visual impact among all alternatives. Even though Alternative 1 would permit the highest level of old-growth harvest, it represents only 20 percent of the level allowed by the 2008 Forest Plan.

SIOs would change for young growth in Alternatives 2, 3, and 5. Alternative 2 would have the greatest effects on scenery in the viewshed, because it would have the highest percentage of suitable young growth with SIO changes (93 percent), the highest percentage in which the SIO would drop by two levels (51 percent), and the highest young-growth harvest. Alternative 5 would have the second highest effects with 65 percent of the suitable acres having SIO changes and 23 percent dropping two levels. Alternative 3 would likely be in the middle in terms of scenery effects overall.

The Sweetwater Lake/Honker Divide Viewshed has experienced relatively heavy past harvest in some portions. Additional harvest may need to be deferred in localized areas in the coming decade depending on the SIO prescribed by the alternative; however, the number of young-growth acres of harvestable age within the next decade is very small, ranging from 16 to 29 acres (Table 3.16-5). Therefore, the alternatives would have only minor local effects during the first few decades. Overall harvest of old growth is expected to be much lower than under the existing Forest Plan with only 7 to 19 percent of the suitable old growth to be harvested under Alternatives 2 through 5.

Tenakee Inlet to Tenakee Springs

This is a large viewshed (152,000 acres), which contains the Trap Bay and Kadashan LUD II areas, which have an SIO of High under all alternatives (Table 3.16-5). The viewshed also contains land designated as Research Natural Area and Wild River LUDs, which also have a High SIO under all alternatives.

Alternatives 1 and 4 would have the fewest acres of suitable young growth in the viewshed. In addition, neither of these two alternatives would change SIOs relative to the 2008 Forest Plan (Table 3.16-5). Alternative 4 would have fewer suitable old-growth acres compared with Alternative 1, so it would likely have the lowest visual impact among all alternatives. Even though Alternative 1 would permit the highest level of old-growth harvest, this harvest level represents only 20 percent of the level allowed by the 2008 Forest Plan.

SIOs would change for young growth in Alternatives 2, 3, and 5. Alternative 2 would have the greatest effects on scenery in the viewshed, because it would have the highest percentage of suitable young growth with SIO changes (55 percent), the highest percentage in which the SIO would drop by two levels (39 percent), and the highest young-growth harvest. Alternative 5 would have the second highest effects with 23 percent of the suitable acres having SIO changes and 10 percent dropping two levels. In this viewshed, Alternative 3 would likely be almost comparable with Alternative 5 in terms of scenery effects overall, with 47 percent of the suitable acres having SIO changes but none dropping two levels.

The Tenakee Inlet to Tenakee Springs Viewshed has experienced considerable past harvest in many areas within the viewshed. The number of young-growth acres of harvestable age within the next decade ranges from 64 to 490 acres (Table 3.16-5). Many of these acres are along the beach fringe in all alternatives

except Alternative 1. Only commercial thinning (generally low impact to scenery) is allowed in the beach fringe in Alternatives 3 and 4, but clearcutting and patch cutting, with up to 10 acre openings, are allowed in Alternatives 2 and 5, respectively (in addition, a 200-foot shoreline buffer would mitigate opening size in Alternative 5). Therefore, Alternative 2 in particular, and Alternative 5 to a lesser degree, could have relatively high localized effects during the first few decades. Overall harvest of old growth is expected to be much lower than under the existing Forest Plan with only 7 to 19 percent of the suitable old growth to be harvested under Alternatives 2 through 5.

West Coast Waterway/Prince of Wales

This large viewshed (141,000 acres) contains the Mt. Calder/Mt. Holbrook LUD II area, which would have an SIO of High under all alternatives. Alternatives 1 and 4 would have the fewest acres of suitable young growth in the viewshed. In addition, neither of these two alternatives would change SIOs relative to the 2008 Forest Plan (Table 3.16-5). Alternative 4 would have fewer suitable old-growth acres compared with Alternative 1, so it would likely have the lowest visual impact among all alternatives. Even though Alternative 1 would permit the highest level of old-growth harvest, this harvest level represents only 20 percent of the level allowed by the 2008 Forest Plan.

SIOs would change for young growth in Alternatives 2, 3, and 5. Alternative 2 would have the greatest effects on scenery in the viewshed, because it would have the highest percentage of suitable young growth with SIO changes (53 percent), the highest percentage in which the SIO would drop by two levels (24 percent), and the highest young-growth harvest. Alternative 5 would have the second highest effects with 35 percent of the suitable acres having SIO changes and 7 percent dropping two levels. In this viewshed. Alternative 3 would likely be in the middle in terms of scenery effects overall.

The West Coast Waterway/Prince of Wales Viewshed has experienced relatively heavy past harvest in many areas within the viewshed. The number of young-growth acres of harvestable age within the next decade ranges from 404 to 888 acres (Table 3.16-5). Many of these acres are along the beach fringe in all alternatives except Alternative 1. Only commercial thinning (generally low impact to scenery) is allowed in the beach fringe in Alternatives 3 and 4, but clearcutting and patch cutting, with up to 10 acre openings, are allowed in Alternatives 2 and 5, respectively (in addition, a 200-foot shoreline buffer would mitigate opening size in Alternative 5). Therefore, Alternative 2 in particular, and Alternative 5 to a lesser degree, could have relatively high localized effects during the first few decades. Overall harvest of old growth is expected to be much lower than under the existing Forest Plan with only 7 to 19 percent of the suitable old growth to be harvested under Alternatives 2 through 5.

Wrangell Narrows

Alternatives 1 and 4 would have the fewest acres of suitable young growth in the viewshed. In addition, neither of these two alternatives would change SIOs relative to the 2008 Forest Plan (Table 3.16-5). Alternative 4 would have fewer suitable old-growth acres compared with Alternative 1, so it would likely have the lowest visual impact among all alternatives. Even though Alternative 1 would permit the highest level of old-growth harvest, this harvest level represents only 20 percent of the level allowed by the 2008 Forest Plan.

SIOs would change for young growth in Alternatives 2, 3, and 5. Alternative 2 would have the greatest effects on scenery in the viewshed, because it would have the highest percentage of suitable young growth with SIO changes (100 percent), the highest percentage in which the SIO would drop by two levels (76

percent), and the highest young-growth harvest. Alternative 5 would have the second highest effects with 81 percent of the suitable acres having SIO changes and 56 percent dropping two levels. In this viewshed, Alternative 3 would likely be almost comparable with Alternative 5 in terms of scenery effects overall, with 100 percent of the suitable acres having SIO changes but none dropping two levels.

The Wrangell Narrows Viewshed has experienced relatively high past harvest in many areas within the Viewshed and includes 26 percent non-NFS lands. However, the number of young-growth acres of harvestable age within the next decade ranges from 0 to 50 acres (Table 3.16-5). Most of these acres are along the beach fringe in all alternatives except Alternative 1. Only commercial thinning (generally low impact to scenery) is allowed in the beach fringe in Alternatives 3 and 4, but clearcutting and patch cutting

, with up to 10 acre openings, are allowed in Alternatives 2 and 5, respectively (in addition, a 200-foot shoreline buffer would mitigate opening size in Alternative 5). Therefore, Alternative 2 in particular, and Alternative 5 to a lesser degree, could have localized effects during the first few decades. Overall harvest of old growth is expected to be much lower than under the existing Forest Plan with only 7 to 16 percent of the suitable old growth to be harvested under Alternatives 2 through 5.

Zimovia Strait

The Zimovia Strait Viewshed runs between Etolin and Wrangell Islands. Alternatives 1 and 4 would have the fewest acres of suitable young growth in the viewshed. In addition, neither of these two alternatives would change SIOs relative to the 2008 Forest Plan (Table 3.16-5). Alternative 4 would have fewer suitable old-growth acres compared with Alternative 1, so it would likely have the lowest visual impact among all alternatives. Even though Alternative 1 would permit the highest level of old-growth harvest, this harvest level represents only 20 percent of the level allowed by the 2008 Forest Plan.

SIOs would change for young growth in Alternatives 2, 3, and 5. Alternative 2 would have the greatest effects on scenery in the viewshed, because it would have the highest percentage of suitable young growth with SIO changes (83 percent), the highest percentage in which the SIO would drop by two levels (54 percent), and the highest young-growth harvest. Alternative 5 would have the second highest effects with 63 percent of the suitable acres having SIO changes and 37 percent dropping two levels. In this viewshed, Alternative 3 would likely be almost comparable with Alternative 5 in terms of scenery effects overall, with 65 percent of the suitable acres having SIO changes but none dropping two levels.

The Zimovia Strait Viewshed has experienced relatively high past harvest in some areas within the viewshed. The number of young-growth acres of harvestable age within the next decade ranges from 71 to 233 acres (Table 3.16-5). Most of these acres are along the beach fringe in all alternatives except Alternative 1. Only commercial thinning (generally low impact to scenery) is allowed in the beach fringe in Alternatives 3 and 4, but clearcutting and patch cutting, with up to 10 acre openings, are allowed in Alternatives 2 and 5, respectively (in addition, a 200-foot shoreline buffer would mitigate opening size in Alternative 5). Therefore, Alternative 2 in particular, and Alternative 5 to a lesser degree, could have localized effects during the first few decades. Overall harvest of old growth is expected to be much lower than under the existing Forest Plan with only 7 to 19 percent of the suitable old growth to be harvested under Alternatives 2 through 5.

Renewable Energy Development

The Forest Plan identifies three types of area related to energy development on the Tongass based on the existing LUDs: windows, which represent areas potentially available for energy development; avoidance areas; and exclusion areas. Avoidance areas are those LUDs where development of energy projects are inconsistent with land use management objectives and desired future conditions. Alternative locations in other LUDs must be exhausted before facilities are considered in avoidance areas. LUDs classified as windows and avoidance areas make up 38 percent and 62 percent of the Forest, respectively. There are no exclusion areas on the Tongass due to special authorities provided in the Alaska National Interest Lands Conservation Act, Title XI. These classifications and the standards and guidelines in the 2008 Forest Plan would continue to apply under Alternative 1, which permits energy developments to "dominate the seen area" but meet a Low SIO. Under Alternatives 2 through 5, renewable energy sites would be managed under the new Renewable Energy Plan Components identified in Chapter 5 of the Forest Plan amendment. Although the new components are likely to result in more energy project development over the long term, the scenery requirements for Alternatives 3 through 5 are similar to those in the existing Forest Plan. Under Alternative 2, scenery standards would be relaxed to Very Low for renewable energy development so effects on scenery would likely be greater. The new components are discussed in more detail in the *Renewable Energy* section of this EIS.

The Forest Service has identified 11 proposed renewable energy projects in Southeast Alaska that are currently active (Table 3.12b-3). Nine of the projects are hydroelectric projects, one is a wave project, and one is a geothermal project. Five of these proposed projects would be located in important recreation places. The proposed renewable energy projects are further discussed in in the *Renewable Energy* section of this EIS.

Effects from the proposed projects on scenery would heavily depend on site-specific plans. In general, project activities that would impact scenery could include new access road construction; forest clearing and ground disturbance; dam, powerhouse, and penstock construction; and transmission line construction. There is a wide range of types and sizes for these disturbances and facilities and the eventual impacts to scenery will depend on the location and design features. All potential impacts to scenery resources would be addressed during the permitting and licensing of the projects, and would include National Environmental Policy Act assessment.

The impacts to scenery associated with Alternatives 2 through 5 are expected to be similar, as these alternatives would follow the same renewable energy-related plan components except that Alternative 2 would reduce the SIO to Very Low, whereas Alternatives 3, 4, and 5 would have an SIO of Low. Impacts associated with Alternative 1 are expected to be slightly lower because of the development of fewer projects over the long term; however, the Alternative 1 standards and guidelines for scenery related to renewable energy projects are similar to the plan components of Alternatives 2 through 5. Although on a site-specific basis differences would occur, on a Forest-wide basis the scenery effects associated with all of the alternatives would show little differences because of the small number of projects likely to be developed.

Cumulative Effects

This section considers the incremental effects of the alternatives when added to other past, present, and reasonably foreseeable actions. The effects of past and present actions on scenery are included in the Affected Environment portion of

this section, which discusses the level of scenic quality on the Tongass. Past actions include past timber harvest and road building, as well as the development of facilities and mines, which have resulted in reduced ESIs in many areas. Present actions include the impacts of current management policies on scenery; these have resulted in modifications to SIOs.

Reasonably foreseeable actions on NFS lands include the projected levels of future timber harvest and renewable energy development that are used in the preceding analysis to assess the potential impacts of the alternatives on the scenic quality. Other reasonably foreseeable actions include regional transportation development as defined by the State Transportation Plan and the Forest Service Alaska Region Long Range Transportation Plan, as well as road paving on Prince of Wales Island, the closing of roads, and construction of the Angoon Airport. In addition, the expansion of cities like Juneau and Ketchikan, recreational cabin development, land auctions by the State, and land exchanges could include additional road construction, timber harvest, and facility construction.

It is not possible at this time to predict exactly which roads, energy projects, or other projects would be developed or their likely impact on future scenic integrity. Human settlement expansion is expected to occur around the region's larger cities, such as Juneau and Sitka, with residential expansion also expected as a result of state land auctions. These developments would likely result in increased impacts on scenery. Mining activities are expected to expand at existing sites, including Greens Creek on Admiralty Island and Kensington Gold Mine north of Juneau, as well as possible future sites, including the Bokan Mountain and Niblack sites on the southern end of Prince of Wales Island. Mining projects are for the most part expected to have a negative local effect on scenery. Overall, the cumulative effects of past, present, and future actions on scenery are expected to be negative, but are not expected to be substantially different than the effects associated with the actions addressed under direct and indirect effects.

Subsistence

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Affected Environment

Subsistence hunting, fishing, trapping, and gathering activities are a major part of life for many Southeast Alaska residents. Some individuals participate in subsistence activities to supplement personal income and provide needed food. Nearly all rural Alaska communities depend on subsistence resources to meet some portion of their nutritional needs (Fall 2014). Others pursue subsistence activities to perpetuate cultural customs and traditions. Still others participate in subsistence activities for reasons unconnected with income or tradition. For all these individuals, subsistence is a lifestyle reflecting deeply held attitudes, values, and beliefs.

Within the context of Southeast Alaska's seasonal and cyclical resource-based employment, subsistence harvest of fish and wildlife resources takes on special importance. The use of these resources may play a major role in supplementing cash incomes during periods when the opportunity to participate in the wage economy is either marginal or nonexistent. Because of high prices of commercial products provided through the retail sector of the cash economy, especially in remote communities, the economic role of locally available fish and game takes on added importance.

Native and non-Native communities both have high subsistence participation rates and rely heavily on wild foods, with approximately 86 percent of rural Alaska households using wild game and 95 percent using fish (Fall 2014). The opportunity to participate in subsistence activities reinforces a variety of cultural and related values in both Native and non-Native communities. For example, the distribution of harvested fish and wildlife contributes to the cohesion of kinship groups and community stability through the sharing of resources. Subsistence resources provide the foundation for Native culture, forming the basis for different clans and potlatch ceremonies, as well as reinforcing basic values of respect for the earth and its resources. Participating in subsistence activities contributes to the self-reliance, independence, and ability to provide for oneself; values that social surveys indicate are important reasons why many non-Native people move to or remain in Southeast Alaska (USDA Forest Service 1997a).

The Legal Context for Subsistence Use

While there are a variety of cultural, popular, and sociological definitions and interpretations of subsistence, Congress addressed this subject in Title VIII of the 1980 Alaska National Interest Lands Conservation Act (ANILCA). Section 803 of ANILCA defines subsistence use as:

> "the customary and traditional uses by rural Alaska residents of wild renewable resources for direct, personal, or family consumption as food, shelter, fuel, clothing, tools, or transportation; for the making and selling of handicraft articles out of non-edible byproducts of fish and wildlife resources taken for personal or family consumption; for barter, or sharing for personal or family consumption; and for customary trade."

ANILCA provides for "the continuation of the opportunity for subsistence uses by rural residents of Alaska, including both Natives and non-Natives, on the public lands." It also states, in part, that "subsistence uses of fish and wildlife and other renewable resources shall be the priority consumptive uses of all such resources on the public lands of Alaska when it is necessary to restrict taking."

The provisions in ANILCA established a harvest priority for rural residents in an attempt to protect subsistence resource harvest. Under ANILCA, in times of resource scarcity or when demand exceeds biologically sound harvest levels, subsistence harvests have priority over other consumptive use of resources. In practice, this meant that commercial, sport, or other harvests were to be curtailed by state or federal fish and wildlife management authorities before subsistence harvests were limited. The Alaska legislature subsequently passed a regulation to comply with ANILCA, but in 1989, the Alaska Supreme Court ruled in McDowell v. State of Alaska that a harvest priority for rural residents conflicted with the state constitution, which guarantees all Alaskans equal access to the state's natural resources. This ruling took the state out of compliance with ANILCA and the federal government has managed subsistence resources on federal lands in Alaska since 1990. As a result, federal subsistence harvests of fish and wildlife on the Tongass National Forest are presently managed by the Forest Service (Schroeder and Mazza 2005).

ANILCA requires the analysis of the potential effects on subsistence uses of all actions on federal lands in Alaska. This analysis typically focuses on those food-related resources most likely to be affected by habitat degradation associated with land management activities. Three factors related to subsistence uses are specifically identified by ANILCA: 1) resource distribution and abundance, 2) access to resources, and 3) competition for the use of resources. These factors are discussed in general terms in the following paragraphs.

Abundance and Distribution

Southeast Alaska subsistence resources include terrestrial wildlife (including deer, moose, mountain goat, black and brown bear, furbearers, and small game), waterfowl (including ducks, geese, and seabirds), marine mammals (harbor seal), salmon, other finfish, marine invertebrates, plants, and firewood. The abundance and distribution of these resources on the Tongass is described in the 1997 Land Management Plan Revision Final Environmental Impact Statement (FEIS), as well as in other sections of this EIS.

Access

Road building, a byproduct of timber harvesting and, to a much lesser extent, mining, is an important agent of change in Southeast Alaska. New road networks often provide greater access to previously unconnected areas and can affect subsistence both positively and negatively by providing access, dispersing

hunting and fishing pressure, and creating the potential for increased competition. On Prince of Wales Island, for example, areas that have become connected by road are now more easily reached by local residents and other nearby communities. Road systems tend to bring more people into an area and also give subsistence hunters access to previously remote regions and provide a greater opportunity for subsistence harvest.

Southeast Alaska is comprised of isolated islands unconnected by road systems; however, with the transportation means available (floatplanes, ferry systems, automobiles, and boats), Southeast Alaska residents are very mobile in their subsistence resource use activities. Wrangell, the fifth largest community in Southeast Alaska, for example, has documented their subsistence gathering from the southern tip of Prince of Wales Island to Yakutat, covering most of the islands in between (Kruse and Muth 1990).

Competition

The Tongass National Forest, with nearly 17 million acres of largely undeveloped land, includes extensive subsistence resources. These resources are not, however, distributed or used evenly across the Forest. Where the resources are confined to island groups or river systems and access is costly or nonexistent, use of the resources is low. Where the resource is abundant, and a community is present but access by other communities is costly, the resource tends to be used primarily by the community that resides in the area. Where resources are abundant and access is readily available to local and other communities of Southeast Alaska, competition for resources may exist.

Increased competition may result when less expensive access to the area or within the area is provided. Such is the case when road systems are established to local communities. When areas historically not used for subsistence purposes are made available because of easier, more cost-effective access, the new area then tends to be used. When communities with road access to abundant resources are connected to a ferry system or to commercial air services, competition for the resources may be generated from outside communities with lower abundance of the same resource.

Examples of the effect of ease of access are readily available in Southeast Alaska. Chichagof Island, Prince of Wales Island, and the Yakutat Forelands at one time were isolated portions of the Tongass with limited use from communities in the vicinity. Today, road construction, primarily a result of timber harvest activities, has created relatively large areas that are easily accessed from local communities. Access provided by ferry systems and small commuter planes to Chichagof and Prince of Wales Islands allows relatively easy access from off-island communities. Access to the Yakutat Forelands has been made easier because of commercial jet service and ferry service to the community of Yakutat.

Subsistence Users

Under ANILCA, only rural Alaska residents qualify for subsistence hunting and fishing on federal lands. Alaska residents living in urban areas can harvest under sport, personal use, or commercial regulations, but not under subsistence regulations. Following the Alaska Supreme Court's 1989 ruling in *McDowell v. State of Alaska*, all Alaska residents qualify as subsistence users on state lands with federal lands continuing to be managed under ANILCA.

In 2013, Southeast Alaska had an estimated population of 74,382, with the majority (about 92 percent) living in established communities (either incorporated cities or Census Designated Places [CDP]) (Alaska Department of Labor [DOL] 2014a). Almost two-thirds (63 percent) of the area's population lived in the city

and borough of Juneau (44 percent) or Ketchikan Gateway Borough (19 percent), the only two communities considered as urban areas for subsistence purposes. An additional 23 percent of the area's population resided in the communities of Sitka, Petersburg, Wrangell, Haines, and Craig. The remaining 13 percent of the population lived in communities ranging in size from Excursion Inlet with 8 people to Metlakatla with 1,471 people (Alaska DOL 2014a).

In addition to permanent communities, there are a small number of logging camps across the Tongass National Forest that, in the past, were large enough and existed long enough to have had an effect on local uses of fish and wildlife. Currently, the remaining camps have few residents and do not have much effect on competition for resources.

A relatively small number of Southeast Alaska residents live at remote isolated locations. These include people living at home sites throughout Southeast Alaska, at summer fishing sites along the outer coast, tree thinners camped near areas where they have Forest Service contracts, trappers, and people living on floathouses and fishing boats. This diverse group is typically transient, generally has very low cash income, and is closely tied to non-commercial harvest of fish, game, and other renewable natural resources.

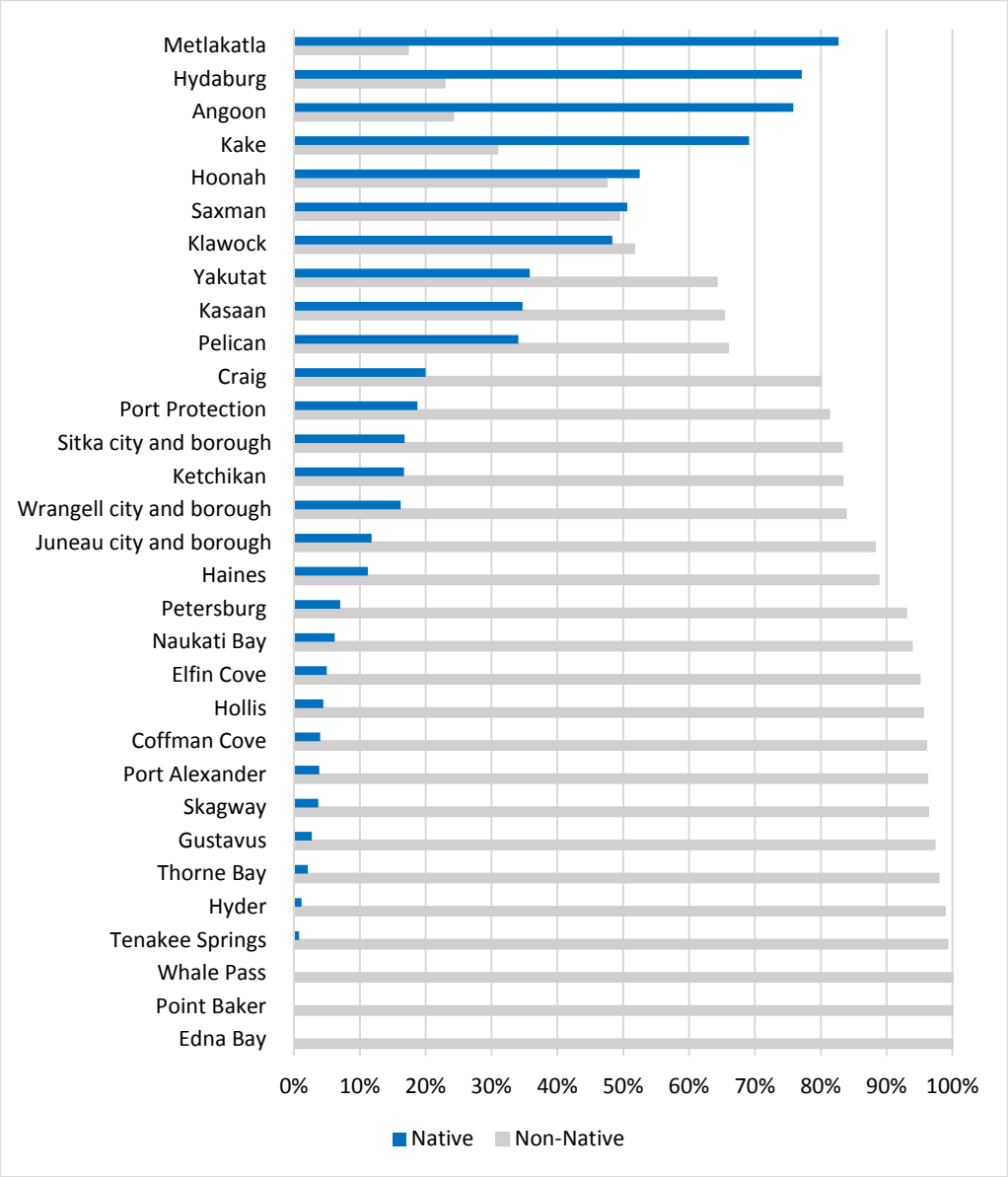
Alaska Natives made up about 12 percent of the region's population in 2010 and comprised about 24 percent of the total population of Southeast Alaska's 30 rural communities in 2010 (Alaska DOL 2014b, 2014c) (Figure 3.17-1). These rural communities include: places that are predominately Native, such as Metlakatla, Hydaburg, and Angoon, where Alaska Natives made up 83 percent, 77 percent, and 76 percent of the population, respectively; other communities that are predominately non-Native, like Edna Bay, Point Baker, and Whale Pass; and places with more mixed ethnicity where Alaska Natives range from about one-third to two-thirds of the population (Figure 3.17-1).

The Bureau of Indian Affairs identifies 17 localized Indian tribes in the region, including the Metlakatla of the Annette Island Reserve. At the time of contact, tribes occupied seasonal camps and temporary villages throughout traditional territories. In the late 1800s, the individual tribes of the region coalesced at what had been their winter villages. The area's extant tribes live within their earlier territories and use a similar set of subsistence resources and in this way maintain long standing ties to place. For Native people, this tie to place and the harvest and use of traditional foods are key elements in fostering Native cultural identity (Alaska Native Heritage Center 2014).

Economy

Subsistence use of fish and wildlife has been and continues to be an important component of the economies of Southeast Alaska communities. In Native communities, harvest and use of wild resources supported the subsistence-based economy that predated the introduction of cash income. In the modern era, beginning in the late-1700s, the economies of Native communities have undergone a progressive transformation, incorporating cash income into the subsistence-based system. Southeast Alaska communities that were settled primarily by non-Native immigrants have also depended on a mix of subsistence use of wild resources and cash income.

Figure 3.17-1
Native/Non-Native Components of Southeast Communities, 2010



Source: Alaska DOL (2014c).

Cash income in most Southeast Alaska rural communities is limited and intermittent, and frequently supports the purchase of fuel and equipment that are part of subsistence harvest technology. Subsistence harvests have been found to fill essential food needs in most rural communities in the region. These harvests are also customarily shared among community residents and between members of different communities. Some subsistence products are traded and bartered within the region. Subsistence harvests are not geared toward market sale or commercial profit. A mixed subsistence-market economy in which subsistence harvests and cash income are complementary characterizes the economies of most of the region's rural communities (Wolfe 2004).

Subsistence research conducted in Southeast Alaska over the past two decades has included detailed community studies, use area mapping, household surveys,

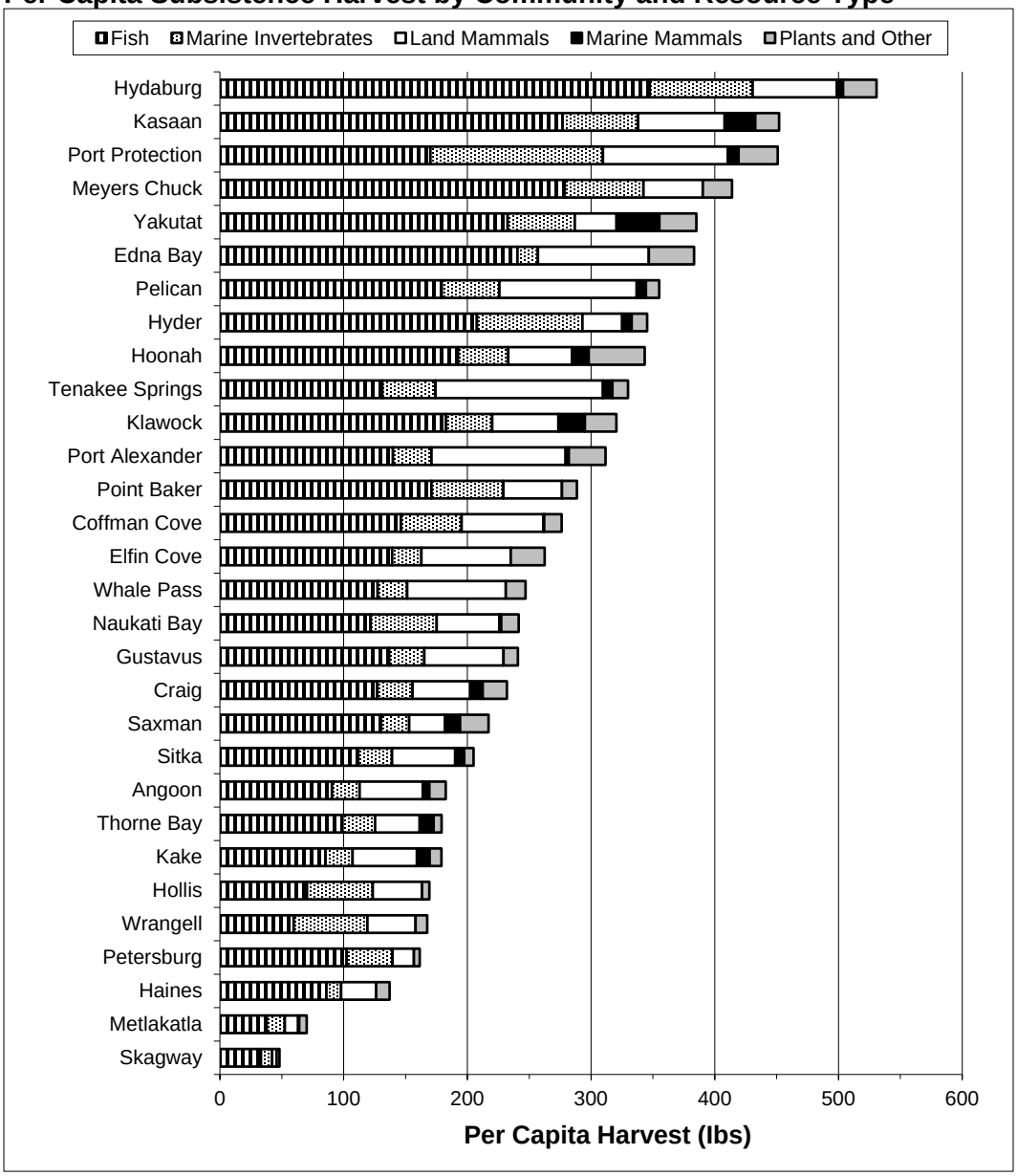
and studies of specific subsistence harvests. During the 1980s, the Forest Service supported research that examined the impacts of timber harvests in the Tongass National Forest on subsistence resources in the area. The Tongass Resource Use Cooperative Survey (TRUCS) was completed in 1988. Data from TRUCS are summarized in the 1997 Tongass Land Management Plan Revision FEIS.

From 1987 to 2001, interviews were conducted with 1,064 households in 24 Southeast Alaska communities as part of the Tongass Land and Resource Management Plan (Forest Plan) subsistence administrative studies. This fieldwork was conducted cooperatively with the Forest Service, Alaska Department of Fish and Game (ADF&G), and the area's tribes and communities all participating. Summary data from this and past community harvest assessments were compiled from the ADF&G Subsistence Community Profile Database (www.state.ak.us) and harvest levels are presented by community and species in Figure 3.17-2. The data presented in Figure 3.17-2 are the most recent available in the ADF&G database. The year these data were collected does, however, vary by community and the data summarized in Figure 3.17-2 should be considered a general overview of harvest patterns rather than an exact representation of current harvest activities.

The findings of this research are summarized in an unpublished paper by Schroeder and Mazza (2005) who identify a number of key subsistence characteristics that are evident in these data and generally consistent with the following past findings:

- Wild foods account for a large share of the diet for residents of the studied communities, ranging from 48 pounds per capita for Skagway in 1987 to over 500 pounds per capita for Hydaburg in 2012 (see Figure 3.17-2). The average American diet includes about 225 pounds of meat, fish, and poultry on a per capita basis. In more than half of the identified communities, wild foods came close to, or exceeded, this national average (Figure 3.17-2). Although residents of subsistence communities purchase food, most could meet their entire protein need from wild sources.
- Marine resources, including fish, mammals, and plants, comprise the majority of subsistence harvests in all communities when measured by food weight. Marine resources account for more than half of total per capita harvest in all Southeast Alaska communities, ranging from 55 percent in Tenakee Springs to 88 percent in Skagway (Figure 3.17-2). As a result, management activities that restrict access for subsistence harvest of land mammals have had a relatively small effect on overall subsistence harvest by weight.
- More recent subsistence harvest levels in the main Native communities and the larger non-Native communities appear very similar to harvest levels estimated in the late 1980s or before. Harvest levels identified in the recent assessments conducted in Angoon, Hoonah, Hydaburg, Kake, Petersburg, Wrangell, and Yakutat, for example, are very similar to those identified in earlier studies. In a few communities, such as Coffman Cove, Kasaan, Klawock, and Port Protection, there are larger differences in harvest levels over time. However, these differences seem to be more influenced by special events or small community sizes than by patterned changes in subsistence harvests.

Figure 3.17-2
Per Capita Subsistence Harvest by Community and Resource Type



Note:
The year these data were collected varies by community, as follows:
1987: Elfin Cove, Gustavus, Hyder, Metlakatla, Meyers Chuck, Pelican, Port Alexander, Skagway, and Tenakee Springs
1996: Kake, Point Baker, Port Protection, and Sitka
1997: Craig, Hydaburg, and Klawock
1998: Coffman Cove, Edna Bay, Hollis, Kasaan, Naukati Bay, and Thorne Bay
1999: Saxman
2000: Petersburg, Wrangell, and Yakutat
2012: Angoon, Haines, Hoonah, Hydaburg, and Whale Pass
Source: ADF&G (2006, 2014)

- Subsistence harvest levels vary considerably from community to community. Recent research and other data suggest that intercommunity variability may not be fully explained by ethnicity, income, community size, or access to resources. Other factors, such as community demographic composition, cultural traditions and orientations, and community history, may have a larger influence on harvest levels than more easily analyzed standard socioeconomic variables.
- Subsistence harvesters use a wide variety of species, but use tends to be concentrated on a relatively small number of species. In Yakutat, for example, individual subsistence harvesters use as many as 65 of the 150 different species that are harvested in the community, but 84 percent of overall community harvest (in food weight) involves just 10 species. That said, the contribution of a particular species to the total subsistence harvest generally appears to vary from year to year, although the overall total harvest in food weight may remain nearly constant.
- A small number of high harvesting households account for a disproportionate share of the total community harvest and tend to harvest more fish and wildlife than their family members can consume. The surplus is distributed to other subsistence users through a kinship network and through barter and trade. These networks are also used to distribute specialty subsistence products such as herring roe and hooligan oil, which are produced in large quantities in only a few communities. In Yakutat, for example, just 25 percent of subsistence households account for about 75 percent of total community subsistence harvest (in terms of food weight), with the lowest harvesting 50 percent of households taking just 8 percent of the total community harvest.

Subsistence Use Areas

Historically, subsistence use occurred where access to the resources cost less in energy than the resources gathered. Many of the gathering activities occurred in easily accessible areas. These activities occurred close to settlements where they could be accessed by foot or boat. Over time, as new technology developed, ease of access meant a movement outward into new resource use areas. The advent of motorized boats and the development of road systems associated with timber harvest activities have had a substantial influence on subsistence gathering activity in Southeast Alaska. Today, all communities use motorized boats and many are tied to nearby lands by road systems.

The distribution of subsistence harvest activity is described in further detail in the 1997 Tongass Land Management Plan Revision FEIS, with traditional household deer hunting areas mapped in Appendix H. These areas were identified based on the 1987 TRUCS (Kruse and Muth 1990). The traditional household deer hunting areas mapped in Appendix H show that the road systems are extensively used. This is particularly true on Prince of Wales Island. These maps also show that subsistence use tends to be concentrated in close proximity to individual communities and along beaches.

Each of the communities in Southeast Alaska has a distinct home range where concentrated use occurs, with a wide range of use typically occurring on a less concentrated scale outside the normal home range. More than half (54 percent) of all households surveyed in rural Southeast Alaska in 1987 traveled a minimum of 11 miles by boat to reach the one reliable deer hunting area that they chose to describe in TRUCS (Kruse and Muth 1990). An additional 18 percent of all households also used boats to reach their reliable deer hunting area, but traveled shorter distances (10 miles or less). Only 15 percent of all households used cars or trucks to travel to their most reliable areas. Thirteen percent used some other

form of transportation, such as airplanes, walking, all-terrain vehicles, and the Alaska Marine Highway System (Kruse and Muth 1990).

While the majority of use occurs within about a 15-mile radius of rural communities, nearly all of the forested lands of the Tongass are used to some degree for subsistence deer hunting (USDA Forest Service 1997a). Appendix H in the 1997 Tongass Land Management Plan Revision FEIS also displays, by community, the individual Wildlife Analysis Areas (WAAs) where approximately 75 percent of the average annual deer harvest occurred.

Kruse and Muth (1990) found that nearly one-half of the households harvesting deer mentioned the existence of clearcuts of various ages occurring in presently reliable areas (44 percent), most-often-used areas (48 percent), and areas no longer used (55 percent). They also reported that old-growth forests were mentioned as most reliable by 90 percent of households harvesting deer, were most-often-used areas by 91 percent of households, and were areas no longer used by 90 percent of those households harvesting deer.

Many of the fish and wildlife resource values of Southeast Alaska watersheds, based on the Value Comparison Unit (VCU) classification of the Tongass, are summarized in the 1998 Tongass Fish and Wildlife Resource Assessment (ADF&G 1998). This report shows the relative value of areas for black bear, brown bear, deer, sport fishing, salmon production, and subsistence use. This resource assessment also included a ranking of the VCUs that have the highest community use values.

Environmental Consequences

The analysis of the likely effects of the EIS alternatives on subsistence resources and uses is presented in two parts. Effects on subsistence resources and uses important to each rural community are discussed individually by community in the *Subregional Overview and Communities* section. This section provides a Forest-wide evaluation that assesses the three factors related to subsistence uses identified by ANILCA: abundance and distribution, access, and competition. This general analysis relies on the community discussions and also on the Forest-wide effects analyses from the related resource sections (primarily *Fish* and *Wildlife*) where abundance and distribution are of concern.

Section 810 of ANILCA requires the Forest Service, in determining whether to withdraw, reserve, lease, or otherwise permit the use, occupancy, or disposition of NFS lands in Alaska, to evaluate the potential effects on subsistence uses and needs, followed by specific notice and determination procedures should there be a significant possibility of a significant restriction of subsistence uses. The Alaska Land Use Council's definition of "significantly restrict subsistence use" is one guideline used in the evaluation:

> "A proposed action shall be considered to significantly restrict subsistence uses, if after any modification warranted by consideration of alternatives, conditions, or stipulations, it can be expected to result in a substantial reduction in the opportunity to continue subsistence uses of renewable resources."

Considerations of abundance and distribution, access, and competition (by non-rural residents) are mentioned.

It should be noted that the term "significant" as used in this context does not have the same definition as used in the implementing regulations for the National

Environmental Policy Act (NEPA). See 40 Code of Federal Regulations (CFR) Section 1508.27 for definitions of "significant" in a NEPA context.

The U.S. District Court Decision of Record in *Kunaknana v. Watt* provided additional clarification. In part it states:

> "restrictions for subsistence uses would be significant if there were large reductions in abundance or major redistribution of these resources, substantial interference with harvestable access to active subsistence-use sites, or major increases in non-rural resident hunting."

Direct and Indirect Effects

Abundance and Distribution

Based on the 1987 survey information compiled as part of TRUCS, 61 percent of subsistence resources (by weight) are fish or marine invertebrates, 21 percent are deer, 4 percent are other land mammals, and another 3 percent are marine mammals. More recent community data compiled by ADF&G (2014) indicate that fish and marine invertebrates still comprise the majority of subsistence harvest per capita (in pounds). As shown in Figure 3.17-2, the share of total subsistence harvest that consists of fish and marine invertebrates ranges from 55 percent in Tenakee Springs to 88 percent in Skagway.

The subsistence analysis conducted for the 1997 Forest Plan Revision FEIS found that the primary subsistence resource likely to be significantly affected by the alternatives was Sitka black-tailed deer. Some effects to fish habitat may also result from land management activities, but the magnitude of the effects could not be calculated. Alternatives with more roads and timber production within riparian management areas and/or beach and estuary fringe would generally have the highest potential for adverse effects to fish and wildlife resources in the Tongass.

As a result of their association with old-growth forest habitat, which is the main terrestrial habitat type affected by the alternatives, deer are considered the "indicator" for potential subsistence resource consequences concerning the abundance and distribution of the resources. The community-based subsistence analysis (see the *Subregional Overview and Communities* section) focuses largely on deer, which is, in most cases, by far the largest terrestrial component of subsistence food resources.

Both the 1997 Forest Plan Revision FEIS and 2008 Forest Plan Amendment FEIS concluded that deer habitat capabilities in several portions of the Tongass may not be adequate to sustain the current levels of deer harvests, and that implementation of any of the 1997 and 2008 alternatives could, therefore, be accompanied by a significant possibility of a significant restriction on the abundance and/or distribution of subsistence uses of deer. This possibility was largely due to the continuation of reduced habitat capabilities resulting from past habitat alterations, which is why it applied to all alternatives.

The possibility of a significant restriction, resulting from a change in abundance or distribution, would be less than the possibility under the 1997 Forest Plan or 2008 Forest Plan for all of the alternatives considered in this EIS because of the lower anticipated rates of timber harvest. Further, although the harvest of old growth is likely to have negative effects on deer habitat, the vast majority of the harvest proposed under the alternatives in this EIS represents the harvest of young-growth stands that are currently in the stem exclusion stage of plant succession. Harvesting these stands would convert them to the stand initiation stage or open them up to provide more light to forage, which is generally of much higher value to deer. As a result, the harvest under the alternatives in this EIS

would have both adverse and beneficial effects on deer habitat, depending on the stand (see *Wildlife* section).

Management of energy projects under the new Renewable Energy Plan Components identified in Chapter 5 of the amended Forest Plan under Alternatives 2 through 5 would not affect this conclusion. This would also be the case under Alternative 1 where the current Transportation and Utility System classifications and the standards and guidelines in the current Forest Plan would continue to apply to energy projects.

In the short term, the risk of a significant restriction would be about the same under any of the alternatives because the effects of past harvest would override the effects of new harvest during the next 10 years. In the long term, those alternatives that limit the areas available for future harvesting of old growth the most would result in the largest reduction in risk. Total maximum harvest over 100 years would range from about 273,000 acres under Alternative 1 to about 368,000 acres under Alternative 2 (Table 3.4-3).

Access

Subsistence users typically hunt and fish in traditional areas surrounding their communities. Many of the communities in Southeast Alaska are compact, centralized places surrounded by undeveloped land with limited infrastructure. Most subsistence food production is supported by a central or core use area surrounding a community. Traditional household deer hunting areas are identified for 32 communities in Southeast Alaska in Appendix H to the 1997 Forest Plan EIS. Access to and use of surrounding areas for subsistence activities may be guided by local customary rules, as well as federal and state regulation and economic considerations, with traditional use areas for different communities often overlapping at their margins. Customary rules guiding subsistence harvest may be related to local histories and social customs of clans and communities (Wolfe 2004).

Forest plans are programmatic, meaning that they establish direction and allowable activities for broad land areas, rather than schedule specific activities in specific locations. This makes it difficult to evaluate the effects of the alternatives on particular groups of subsistence users or resources. The following discussion addresses potential impacts at the programmatic or forest scale and assesses relative potential impacts in terms of overall proposed road construction and timber management activities.

Viewed at this scale, none of the alternatives would directly limit the use of public lands for the purposes of subsistence gathering activities. Traditional access methods would remain available under all the alternatives for present and foreseeable future activities. Access methods differ by Game Management Unit (GMU). Those subsistence users who use a boat as their primary method of access may have temporary and localized disruptions under the alternatives that propose the most young-growth harvest in the beach fringe.

Data on documented deer harvest by transportation type are available at the GMU level. Data from the 2013 Deer Management Report are presented by transportation type and GMU in Table 3.17-1. GMU 4, the ABC Islands (Admiralty, Baranof, and Chicagof Islands), accounted for two-thirds (66 percent) of deer harvested in Southeast Alaska in 2011 (8,665 deer), with GMU 2, Prince of Wales Island, accounted for one-quarter (25 percent) (3,251 deer). Hunters accessing hunting areas by boat accounted for 63 percent of total deer harvest in 2011. Hunters accessing the area by highway vehicle accounted for 23 percent of total deer harvest. The relative share of harvest by transportation type varies

by GMU, with boat access, for example, accounting for 84 percent of harvest in GMU 4, but just 23 percent in GMU 2. Highway vehicle was the most frequently used method of access in GMU 2, Prince of Wales Island, accounting for 58 percent of deer harvest in 2011 (Table 3.17-1). This relatively high share reflects the more densely roaded nature of Prince of Wales Island and may be considered generally indicative of the effects of timber harvest and associated road building in areas connected to communities and the marine highway system. Most of the lands suitable for young-growth harvest in the beach fringe are within GMUs 1A, 2, and 3.

Table 3.17-1
Deer Harvest by Game Management Unit and Transportation Type, 2011

			Percent of Deer Harvested by Transportation Type[2]					
GMU Number[1]	Area	Deer Harvested	Airplane	Boat	3- or 4-Wheeler	Highway Vehicle	Foot	Un-known
1A	Ketchikan[3]	176	NA	NA	NA	NA	NA	NA
1B	Petersburg[4]	83	1	84	3	4	7	2
1C	Juneau	388	0	30	0	45	20	2
2[5]	Prince of Wales Island	3,251	3	23	NA	58	8	8
3	Central Islands	514	1	45	12	26	5	11
4	ABC Islands[5]	8,665	6	84	2	3	3	3
	Total	**13,077**	**883**	**6,938**	**329**	**2,529**	**240**	**139**
	Percent of Total	100	8	63	3	23	2	1

Notes:
ABC Islands = Admiralty, Baranof, and Chichagof Islands
[1] Game Management Units (GMUs) are a geographic unit of measurement established and used by ADF&G.
[2] These data were compiled as part of ADF&G's mandatory hunt report cards issued in conjunction with deer harvest tickets. Hunters report transportation method for traveling to their hunting areas. Numbers may not sum to 100 percent due to rounding.
[3] Airplane data are not available for this GMU.
[4] The foot category for this GMU includes 1 percent of hunters that used a horse/dog team to access their hunting area.
[5] In GMU 2, 3- or 4- Wheelers were accounted for in the Highway Vehicle category.
Source: ADF&G (2013).

New road construction is likely to result in the development of new use patterns around some communities, but these changes are not likely to lead to a significant possibility of a significant restriction of subsistence access to the resources. New use patterns may, however, favor some subsistence groups and disadvantage others. Subsistence access may be via a number of different transportation types and often involves more than one form of transportation. Subsistence users may, for example, access an area via boat followed by road (and on-foot) or via boat and on-foot, with types of access varying by location and user. Some hunters may access specific areas using more than one form of transportation, but others may favor one form of transportation over another, say highway vehicle over foot.

While there would be some new road access under all alternatives in the long run, nearly all new roads constructed under the alternatives would be closed following harvest. These roads would, therefore, not be available for use by highway vehicles or high-clearance vehicles. They may, however, be available for access by other methods and would, as a result, have the potential to affect existing subsistence patterns.

Based on the miles of new road construction projected under each alternative and viewed at a programmatic level, Alternative 1 would involve the construction of most new roads over 25 years: 281 miles of new roads versus the next highest maximum of 267 miles under Alternative 5. However, Alternative 1 would require much less road construction on decommissioned roadbeds and road

reconstruction over this period than the other alternatives, with a maximum combined total length of 224 miles versus 306 miles (Alternative 4) to 381 miles (Alternative 2) under the other alternatives. Viewed over 100 years, new road construction would range from 871 miles (Alternative 4) to 1,056 miles (Alternative 2), with road construction on decommissioned roadbeds and road reconstruction miles ranging from 1,315 miles (Alternative 1) to 1,791 miles (Alternative 2). Harvest would be limited to areas outside Inventoried Roadless Areas (IRAs) under Alternatives 1, 4, and 5 and would, therefore, tend to increase road density in already roaded areas rather than provide new access to presently undeveloped areas.

Renewable energy development is not expected to substantially increase road density on the Forest under any of the alternatives.

Some subsistence users have a preference for unroaded areas. Viewed at a programmatic level, Alternatives 1, 4, and 5 would likely have the lowest impact on subsistence users who prefer unroaded areas because timber management would be primarily limited to areas outside the existing IRAs on the Tongass.

Another potential access impact relates to the effects of clearcut harvesting on the landscape. Subsistence hunters have varying opinions on the effects of clearcut harvest on hunting success. Some hunters say that timber harvest clearcuts are productive for some years after harvest, while others prefer not to use clearcuts. Hunters interviewed on Prince of Wales Island, for example, reported that the best hunting in clearcut areas begins approximately 2 years after an area is logged, with hunt quality typically starting to decline 9 years after the area was cut (Brinkman 2006). Concern has been expressed by hunters that clearcuts in the process of regrowth become impassable to hunters after a period of time (Galginaitis 2004). Young-growth harvest would likely improve hunting in many previously harvested areas.

In addition to long-term access effects, timber management activities may also have short-term, temporary displacement effects for subsistence users because it is standard practice to close logging roads to outside traffic when logging is taking place. Subsistence users who use existing roads for access would be preempted from using those roads for the duration of logging activity in the affected area. These types of effects would, however, be short term and temporary, and would not be likely to lead to a significant possibility of a significant restriction of subsistence access to the resources. In addition, as previously noted, most or all new roads would be closed following harvest.

Competition

Almost two-thirds (63 percent) of the population in Southeast Alaska in 2014 resided in Juneau (44 percent) or Ketchikan (19 percent) and is, therefore, considered non-rural from a subsistence perspective (Alaska DOL 2014a). Residents in the remaining communities are considered rural. Competition for the more abundant wildlife and fisheries resources near rural communities is affected by a number of factors, including fish and game regulations, the mobility of community residents, the Forest-wide distribution of game species, decreases in resource populations as a result of habitat reductions and/or over-harvest, and types of community access, such as roads, ferries, and commercial air services.

The following assumptions were made for the purposes of evaluating potential impacts to competition:

- New road construction adjacent to communities with ferry access will result in increased competition from outside communities.

- New road construction adjacent to existing road systems where interties between communities exist will result in increased competition from surrounding communities associated with the interconnected roads.
- Habitat reductions will result in increased competition if regulations allow sport use to remain constant, with the same number of users seeking fewer huntable resources.
- The demand for resources will remain constant or increase slightly as the habitat capability remains the same or declines over time.

Given these assumptions, the 1997 Forest Plan Revision FEIS concluded that implementation of Alternative 11 (the Selected Alternative) would result in a significant possibility of a significant restriction of subsistence use of deer by increasing competition for some subsistence resources by non-rural, as well as rural residents. This was judged most likely to occur on Chichagof, Baranof, and/or Prince of Wales Islands, where competition for deer and some other land mammals was identified as heavy, and habitat capability had already been reduced as a result of timber harvest.

Cumulative Effects

The significant possibility of a significant restriction, resulting from a change in competition, would still exist but be less than the possibility under Alternative 11 (the Selected Alternative) of the 1997 Forest Plan Revision FEIS for all of the alternatives considered in this EIS because of the much lower anticipated rates of timber harvest and road construction.

Cumulative effects are discussed in four categories.

1. **Effects Resulting from Timber Harvesting of Private Lands**. Native corporation lands adjacent to the Tongass National Forest support extensive timber harvest operations and old-growth forest wildlife habitat capability on Native corporation lands (especially that for deer) has declined. This decline has occurred primarily on North Chichagof, Kupreanof, Admiralty (localized), and Prince of Wales Islands, as well as in some mainland areas. The resulting lower habitat capabilities on these private lands are likely to increase hunting demands in adjacent National Forest areas, increasing competition and potentially leading to reduced hunter success, reduced or eliminated sport seasons, and in some places reduced or eliminated subsistence seasons.
2. **Effects from Past Activities**. Timber harvest has been more influential in changing the landscape than any other use of the resources of the Tongass National Forest. Timber harvest has historically been accompanied by road building, log transfer facility development, and reductions in old-growth forest habitat.
3. **Effects of Present Activities**. Implementation of the current Forest Plan allowed an annual maximum timber harvest of approximately 267 million board feet (MMBF) (based on the Allowable Sale Quantity [ASQ]), with an annual conversion of up to 8,900 acres of old-growth habitat to young growth (although a much lower volume and acreage of old growth has been harvested in recent years). This timber harvest involved the projected construction of up to 106 miles of system roads each year. In reality, less than 25 miles of new system roads has been built each year since the plan was implemented. Two mining operations, the Greens Creek Mine on Admiralty Island and Kensington Mine north of Juneau, are currently operating.
4. **Effects of Reasonably Foreseeable Future Activities**. Timber harvest activities have typically been accompanied by new access and often

increased use of subsistence resources by rural and non-rural residents. The effects of timber harvest on deer habitat capability would be reduced over time as harvest areas transition from old-growth to young-growth under all alternatives.

Counting all lands in Southeast Alaska, an estimated 86 percent of the original old growth remains today. After 100 years of implementing any of the alternatives, it is estimated that the percentage of the original old growth remaining would be 82 percent, due to combined harvest on NFS and non-NFS lands, assuming maximum rates of harvest. Although the percentage reduction would not be high overall, areas of concentrated harvest could have higher effects on subsistence. Areas of concentrated harvest are described in the *Biodiversity* section, which quantifies the estimated effects of cumulative future harvest on the amount of old growth by biogeographic province for all of Southeast Alaska (see Tables 3.9-16, 3.9-17, and 3.9-18).

Timber harvest of Native corporation lands is anticipated to continue at a relatively low but constant level over the next decade. New land conveyances under Public Law 113-291 could result in some previously unharvested areas being logged. Actual mineral development is difficult to predict, but effects to subsistence resources would be highly localized where it does occur. Appendix C provides a full list of all the projects considered in the cumulative effects analysis.

ANILCA Determination

An ANILCA Section 810 evaluation and determination is not required for approval of a Forest Plan amendment, which is a programmatic level decision and not a determination whether to “withdraw, reserve, lease, or otherwise permit the use, occupancy, or disposition” of National Forest land. This EIS is part of the Forest Plan Amendment process and, therefore, does not require an ANILCA Section 810 evaluation and determination. However, public hearings on subsistence issues for the proposed Forest Plan Amendment were held in several communities between the Draft and Final versions of this EIS.

Subsistence testimony during these hearings did not provide specific examples of how the proposed action would affect the commenter’s subsistence use in terms of access or increasing competition. Some commenters were concerned in general that the proposed Forest Plan could impact subsistence and cultural heritage resources in RMAs, particularly in the beach and estuary fringe, or that by not improving forest and water ecosystems there could be a reduction in abundance and distribution of subsistence resources. The alternatives consider various levels of young-growth treatment in the RMAs and beach fringe. Alternatives 3 and 4 propose commercial thinning only in beach fringe and do not allow harvest in RMAs. Alternative 2 allows for even-aged management within the beach fringe for 15 years followed by commercial thinning for the life of the Forest Plan and allows commercial thinning up to 33 percent in the RMAs. Alternative 5 allows for up to 10-acre openings and/or up to 35 percent of the acres to be removed in the first 15 years in both RMAs and the beach fringe.

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Heritage Resources and Sacred Sites

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Affected Environment

Heritage Resources

The Tongass National Forest has a rich and varied history. Its early history is represented by the Tsimshian and Haida in southern Southeast Alaska, and the Tlingit who occupy areas from southern Southeast Alaska all the way to Yakutat and the Copper River area. Tribal groups—or Kwáan within the Tlingit—have associated tribal boundaries; for example, the Stikine Tlingit (Stax'heen Kwáan), the Sitka Tlingit (Sheet'ka Kwáan), and the Hoonah Tlingit (Xuna Káawu) all claim traditional use areas.

Important historic properties and other cultural resources located throughout the Forest that represent Alaska Native migration into the area thousands of years ago and continued occupation of the area are exemplified by the well documented and publicized Ground Hog Bay, Hidden Falls, and On Your Knees Cave sites. In addition, there are pictograph and petroglyph sites, forts, and seasonal hunting and fishing sites. Oral histories and ethnographies provide evidence for sacred lands, battle sites, transportation and trade corridors, and traditional subsistence use areas.

Early contact with Europeans, and the subsequent exploitation and colonization of Southeast Alaska, resulted in historic properties representing early Russian occupation, fur farming, gold mining, large-scale fishing and canning operations, and the timber industry. Historic properties and other cultural resources representing these different uses and periods in history are present within the Forest and are managed as part of the Heritage Program. Cultural resources are broadly defined in the National Environmental Policy Act (NEPA) and can include prehistoric and historic sites, cultural landscapes, artifacts, and sacred sites that may or may not be eligible for the National Register of Historic Places (NRHP). Historic properties, on the other hand, are defined in the National Historic Preservation Act (NHPA) and specifically refer to sites that either have the potential to be eligible or are eligible to be listed on the National Register. Historic properties that are identified, but have not yet had a "determination of eligibility" are treated as "eligible" properties for the purposes of Section 106 of the NHPA. Properties identified as not eligible are managed in accordance with Forest Service policy, but still are analyzed as a cultural resource for NEPA purposes.

National Register–eligible historic properties within the Tongass National Forest have met one or more of the four primary criteria to deem them significant enough for national recognition: they have been associated with events that made a significant contribution to the broad patterns of our history; were associated with the lives of significant persons in our past; embodied a distinctive characteristics of a type, period, or method of construction; or have yielded or may be likely to yield, information important in history or prehistory. It is within this context that historic properties are discussed and the potential adverse effects are analyzed.

The terms “cultural resources” and “historic properties” are generally used interchangeably even though they have different meanings within NEPA and NHPA. They may also be lumped under the broader category of “heritage resources.”

As of the end of June 2015, approximately 145,330 acres of Tongass National Forest lands have been inventoried for heritage resources. A total of 3,399 heritage resource sites have been identified, 46 of which have been listed on the NRHP, while 666 have been determined eligible for listing either through concurrence with the Alaska State Historic Preservation Office (SHPO) or by a decision of the Keeper of the National Register. Of the remaining known sites, 2,354 are currently unevaluated for National Register eligibility.

Of the known sites, 1,436 represent the historic period beginning with the early contact period and include World War II sites, Civilian Conservation Corps–era shelters, historic canneries, trappers’ cabins, fox farms, shipwrecks, military installations, and early logging and recreational sites. Prehistoric sites total 1,699 and are represented by pictographs, petroglyphs, Native villages, fish traps and weirs, lithic scatters, fortifications, burials sites, and rockshelters. The remaining known sites have not yet been classified as to associated time period. These known sites are distributed throughout the Forest and, with their associated features that enable their eligibility to the NRHP (such as integrity of location and sense of place), make up the “affected environment” for cultural resources. They are located throughout the Forest, in all ecosystems, from shoreline to alpine, along streams and rivers, in caves and in the open.

The majority of the known sites occur in close proximity to food and fresh water sources, normally below 100 feet in elevation and near the shoreline. These areas are described as “high sensitivity areas” in the current predictive model for locating sites. Other types of heritage resources such as mineral resource areas, or rock cairns of unknown use, may occur in higher elevations, but in general they are less abundant and more sparsely dispersed, and are considered to be in “low sensitivity” areas.

Because a small percentage of the total acreage of the Forest has been surveyed for cultural resources, the heritage staff rely on a predictive model to understand and evaluate potential impacts in areas that have not benefitted from a current field survey. The current model predicts that most sites will be below 100 feet in elevation and/or in areas of animal, plant, or mineral resource abundance was based on the assumption that the shorelines were static and had not changed through time. These are considered “high sensitivity areas.” Because of a new understanding of elevation and sea level changes, both raising and lowering, after deglaciation, this model is no longer appropriate for some portions of the Forest and in particular for locating prehistoric sites. The model is still useful in predicting the locations of more recent human occupation, however.

A new model for locating historic properties looks at the changing landscapes of both emergent and submerging shorelines, and predicts sites both at higher elevations and lower elevations. The changing landscape situation is complex, and is not uniform across Southeast Alaska. It is difficult to predict where cultural resources, in particular archaeological resources, are located without having a good understanding of geomorphology, and in particular glacial geomorphology. It also should be noted that this model is for archaeological sites, only one type of historic property or cultural resource found throughout the Forest.

Recent research has demonstrated the validity of a model that predicts the oldest, and potentially most important, sites for understanding the early prehistory of the Tongass may expect to be found between modern day sea level

and higher elevation relict beaches that are 60 or more feet above present-day sea level, depending on the geomorphology.

Identification and evaluation of heritage resources is an ongoing process. Historic research, literature reviews, oral interviews, and field surveys all provide information about the location or potential location of resources and insight into resource distribution and the sensitivity of sites to damage. Further scientific study will increase knowledge about early human migration, later exploration and development of the region, and human behavior in response to social and environmental change. Overall only a small portion of the Tongass National Forest has been surveyed; therefore, additional heritage sites are expected to be located within the Forest in the future. As heritage resources are located the Forest has the responsibility to evaluate the recovered data and to make determinations regarding eligibility to the NRHP. In addition, the Forest has the responsibility to curate collected artifacts and conserve records, photographs, and other data specific to heritage resource projects and sites within an appropriate environment under 36 Code of Federal Regulations (CFR) 79 and in accordance with federal Records Management requirements.

Sacred Sites

Numerous sacred sites have been identified throughout the Tongass National Forest. Sacred sites are defined by the persons who believe they are sacred. Generally, the authoritative voice is a tribal representative, but Traditional Cultural Practitioners and tribal members may also define what is sacred. Sacred sites and their definition can and do change through time. Sacred sites have both tangible and intangible qualities. They can include old village sites, pictographs, petroglyphs, burials, traditional hunting and gathering areas, traditional areas for collection of minerals or source materials for artifacts, as well as places that are visited for their “spiritual” qualities.

Many sacred sites are also considered cultural resources or historic properties. Those sites are managed as heritage resources subject to Section 106 review should they have the potential to be affected by a federal undertaking.

In December 2014, Congress passed legislation that included the Sealaska Land Entitlement Finalization which conveys the remaining 70,075 acres on the Tongass specified in 1971 under the Alaska Native Claims Settlement Act (ANCSA). The conveyance includes 18 parcels of land totaling 69,585 acres and 490 acres of land containing not more than 76 cemetery and historic sites. The conveyed parcels contain 15 heritage resource sites that will be deducted from the above total once conveyance is complete. All of the cemetery sites being conveyed are considered to be sacred sites. While these properties will be conveyed out of federal ownership, they may still be surrounded by Forest lands and developmental activities and will need to be considered in planning.

Other sacred sites might include places where traditional cultural practices occur such as healing ceremonies, certain subsistence practices, or places of spiritual qualities that cannot be measured or pointed to on a map. In order to protect and preserve Alaska Native religious practices, Executive Order 13007 and other laws and Executive Orders of the U.S. Government require the Forest Service, to the extent practicable, permitted by law, and not clearly inconsistent with essential agency functions to:

- Accommodate access to, and ceremonial use of, Alaska Native sacred sites by Alaska Native religious practitioners,
- Avoid adversely affecting the physical integrity of sacred sites, and
- Maintain the confidentiality of sacred sites.

Alaska Native groups or an appropriately authoritative representative of an Alaska Native religion shall be responsible for identifying such sites to the Forest Service as the managing agency.

Further, the Culture and Heritage Cooperation Authority (25 United States Code [USC] 32a) provides for reburial of human remains on Forest lands. These sites are treated as sacred sites.

Burial sites are also considered sacred, and are generally discovered during ground-disturbing activities. The Native American Graves Protection and Repatriation Act covers inadvertent discoveries of Alaska Native remains and affords protection to these sites.

Environmental Consequences

Direct and Indirect Effects

Direct effects to heritage sites include damage or destruction caused inadvertently or by intent. Inadvertent damage to archaeological sites can result from access and use around the site that causes soil compaction, or from other ground-disturbing activities. Other historic properties and cultural resources may be inadvertently damaged by careless behavior. Intentional damage includes looting and vandalism, relic collecting, theft, and defacement and is a violation of the Archaeological Resources Protection Act. Damage or destruction of historic properties and cultural resources can result in the loss of information and change the eligibility of the property for National Register purposes and may cause a property to be delisted if the factors that contributed to listing no longer remain.

While multiple-use activities have benefited heritage resources by providing opportunities for inventory, evaluation, and interpretation in remote areas of the Forest, ground-disturbing activities have the most potential to adversely affect these resources and their environmental settings. The amount of impact an activity has is determined largely by the location and nature of the activity, the characteristics of the soils, the degree of use, and the nature of the historic property or cultural resource.

Under all of the alternatives, the preferred management of heritage resource sites eligible for, nominated to, or listed in the National Register is avoidance and protection in accordance with the Forest-wide Standards and Guidelines. If avoidance and protection are not possible, and a determination of “Adverse Effect to Historic Properties” is made, a Memorandum of Agreement (MOA) with the State Historic Preservation Officer is required in order to mitigate the effects. If the historic properties are listed on the National Register of Historic Places, the ACHP must also be invited to consult. Alaska Native tribes and other potential stakeholders also may be invited to be signatories on the MOA depending on the historic property or cultural resource in question. The potential for adverse effects, and therefore the need for mitigation, is diminished when the physical settings around significant heritage resources are allowed to retain their integrity of place (i.e., original location and setting, whether in a natural setting or a cultural landscape).

Direct effects are mostly likely to occur under Land Use Designations allowing timber harvesting, mining, and road construction. Existing standards and guidelines (e.g., those for riparian and beach and estuary buffer zones) result in the protection of many of the Forest’s heritage resources by eliminating or minimizing ground disturbing activities in those locales. However, all action alternatives would allow some harvest in Beach Fringe and Alternatives 2 and 5 would allow harvest in Riparian Management Areas (Alternative 2 more than Alternative 5).

Indirect effects are mostly like to occur as a result of recreation and special uses simply because people want to recreate and use the forest in the same places people have for thousands of years. In many instances, retention of an historic property's original setting, or cultural landscape, is crucial to imparting and protecting the values that qualify a heritage resource for National Register status.

Except for those sacred sites that are also considered archaeological sites or historic properties, the potential effects to sacred sites are difficult to evaluate because the 'sacred' nature of a site is determined by the tribes or their religious practitioners, and may or may not be obvious to a casual observer. Development on or near sacred sites with intangible or "spiritual" qualities may be considered a direct effect if the landscape or the qualities of that site are impaired.

An indirect effect common to all alternatives and prescriptions is that the discovery of new sites can lead to vandalism if locations become known to the public.

In applying the current model that predicts the majority of significant heritage resources located below 100 feet elevation, Alternative 3 has the least impact to old-growth areas below 100 feet (Table 3.18-1). Conversely, Alternative 1 would have the least impact to areas below 100 feet in young growth areas. Presumably, previous harvests have impacted areas now considered young growth; therefore, less harvest of old growth in Alternative 3 would be preferable from the standpoint of potential effects on heritage resources. While this is a presentation of the potential effects to heritage resources using the current quantifiable model, consideration will need to be given to the location of relict beaches and other refinements to the model in relation to future proposed sales.

Table 3.18-1
Approximate Suitable Acres Under 100 Feet Elevation Likely to be Harvested over 25 Years

Alternative	Old-Growth Harvest (Acres)	Young-Growth Harvest (Acres)
1	692	243
2	255	4,797
3	169	3,421
4	338	1,931
5	350	2,387

In addition, Alternative 1 does not include any entry into beach or estuary fringes or riparian buffers. Therefore, heritage resources in those locations should be less subjected to impacts related to logging. Table 3.18-2 identifies the maximum estimated acres of old growth and young growth that can be harvested and miles of road likely to be constructed and reconstructed under each alternative over 25 years, and Table 3.18-3 presents harvest acreages and road miles over 100 years. These acreages and mileages provide relative indicators of potential adverse effects, with the alternatives having the most acreage and mileage likely to produce the highest risk of effects. Under this scenario, Alternatives 2 and 3 have the highest risk of effects because they include more area where development would be permitted. They would be followed by Alternatives 5, 4, and 1, in decreasing order of risk level. However, because project areas are inventoried for ancient and historic heritage resource sites and tribal consultation for sacred sites should occur prior to implementation and avoidance of impacts is the preferred option for resource protection, the levels of risk are considered relatively low for all alternatives. In addition, existing standards and guidelines should result in the protection of most heritage resources and sacred sites in those areas.

While it is true that increased project activity might accelerate the loss of heritage resources, primarily by improving public access and increasing the probability for looting and vandalism of heritage resource sites, there are potential positive effects as well. Over time, decay, neglect, and natural landscape changes threaten the preservation of significant heritage resources. By expanding the Forest's inventory of its heritage resources, development projects result in identification of many sites that might otherwise decay unnoticed. Once sites are known, the Forest has the opportunity to better protect them and encourage collection of information from a greater number of them.

Table 3.18-2
Approximate Maximum Acres Likely to be Harvested and Maximum Road Miles to be Constructed/Reconstructed over 25 Years

Alternative	Old-Growth Harvest (Acres)	Young-Growth Harvest (Acres)	New Road Construction (Miles)	Road Reconstruction & Roads Constructed on Decom. Roadbeds (Miles)
1	38,527	9,669	281	224
2	15,027	63,787	260	381
3	16,599	53,734	245	339
4	23,255	40,760	257	306
5	23,813	43,316	267	321

Table 3.18-3
Approximate Maximum Acres Likely to be Harvested and Maximum Road Miles to be Constructed/Reconstructed over 100 Years

Alternative	Old-Growth Harvest (Acres)	Young-Growth Harvest (Acres)	New Road Construction (Miles)	Road Reconstruction & Roads Constructed on Decom. Roadbeds (Miles)
1	62,851	209,882	944	1,315
2	32,609	335,344	1,056	1,790
3	35,568	313,216	1,020	1,696
4	42,597	234,885	871	1,344
5	42,479	284,144	994	1,585

Cumulative Effects

The vast majority of Southeast Alaska is occupied by the Tongass National Forest (16.7 million acres), so the disturbances described above for the Tongass are the major disturbances affecting heritage resources. However, Glacier Bay and Haines/Skagway National Park areas, Haines State Forest, and other ownerships in the Haines/Skagway area occupy 3.6 million acres, while state, Native corporations, and other ownerships inside the Forest boundary occupy a combined 1.1 million acres. Therefore, activities on these lands contribute to Southeast Alaska cumulative effects. However, extensive timber harvest, road construction, and renewable energy, mining, and infrastructure development for tourism-related activities occur on these ownerships, which have the potential to affect cultural resources.

If Forest Service policy of avoidance and protection is followed, cumulative effects would be minimal with the implementation of this plan. However, if mitigation becomes the primary strategy for responding to potential adverse effects to historic properties, then the cumulative effects could be significant. Mitigation does not nullify cumulative effects. At present, there is no reason to

believe that the policy of avoidance and protection will not be followed, and cumulative effects are expected to be minimal.

Extensive landscape changes and ground disturbance have occurred and will continue to occur on many non-federal lands in Southeast Alaska. Projects that are on non-federal lands, and not funded or authorized by the federal government are not subject to the same protections for heritage resources. Heritage resources are nonrenewable, and once disturbed they are permanently damaged or destroyed; their information and values are lost and cannot be recovered. Preservation of these resources and values on federal lands is critical so that future generations can continue to enjoy the heritage and knowledge about our past that we enjoy today.

Appendix C of this Environmental Impact Statement provides a full list of all the projects considered in the cumulative effects analysis.

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Inventoried Roadless Areas

Affected Environment **3-441**
Current Situation 3-441
Environmental Consequences **3-445**
Direct, Indirect, and Cumulative Effects 3-445
Cumulative Effects 3-447

This section provides an overview of the existing conditions related to Inventoried Roadless Areas (IRAs) as defined in the Roadless Area Conservation Rule (2001 Roadless Rule; USDA Forest Service 2000) and assesses the potential direct, indirect, and cumulative effects of the alternatives on these areas.

The Ninth Circuit Court of Appeals recently upheld the United States District Court for District of Alaska's 2011 reinstatement of the Roadless Rule on the Tongass National Forest. Consequently, the Roadless Rule remains in effect in Alaska and the Forest Service continues to apply the Rule to the Tongass National Forest. A second case involving the Roadless Rule is currently being adjudicated in the United States District Court for the District of Columbia. The Forest Service will comply with all court orders.

Affected Environment

IRAs in the Alaska Region include 9.2 million acres (57 percent) of the Tongass National Forest. Including Wilderness, Land Use Designation (LUD) II designated areas, and National Monument areas, the Tongass National Forest is currently more than 90 percent undeveloped and unavailable for timber harvest and road building. In some locations short-term "boom and bust" developments including fox farming, salmon canneries, mining, and military activity resulted in the temporary development and occupation of small areas mostly near the shoreline. Many of these areas have since been largely reclaimed by nature. Developed areas cover about 1.3 million acres, or about 8 percent, of the Tongass. Southeast Alaska residents (approximately 74,000) are, for the most part, surrounded by land that has many of the characteristics of wilderness. Routine travel and ordinary outdoor recreation activities typically require a higher degree of skill, risk-taking, and self-reliance than is usually required of adventurous backcountry visitors on other National Forests.

Several characteristics of IRAs on the Tongass are unique relative to other areas in the National Forest System (NFS). The Tongass has very large undeveloped land areas that could potentially be managed as wilderness or in an unroaded condition. Several portions of the Forest constitute contiguous IRAs exceeding 1 million acres, and thus represent large, unfragmented wildlife habitats and exceptional opportunities for solitude.

Many of the Tongass IRAs represent wildlife habitats, ecosystems, and visual character, such as coastal islands facing the open Pacific, extensive beaches on inland saltwater, old-growth temperate rain forests, ice fields, and glaciers that exist nowhere else in the NFS. Many of these areas are remote and difficult to access for primitive recreation and many contain other important resources, such as timber, minerals, and salmon-producing streams.

Current Situation

IRAs are defined as undeveloped areas typically exceeding 5,000 acres that meet the minimum criteria for wilderness consideration under the Wilderness Act and were inventoried during the Forest Service's Roadless Area Review and

Evaluation (RARE) II process and subsequent updates and forest planning analyses. The Tongass is using the IRA boundaries associated with the 2001 Roadless Rule (USDA Forest Service 2000), which are identified in a set of maps, associated with the Forest Service Roadless Area Conservation, Final Environmental Impact Statement (FEIS), Volume 2, dated November 2000. These maps identify 9.2 million acres in IRAs on the Tongass and correspond closely with the 1996 roadless area inventory that was prepared for the 1997 Forest Plan Revision (USDA Forest Service 1997c). The current acreage represents an approximately 292,000-acre reduction compared to the 2008 Forest Plan due to land adjustments, refinements to boundaries, additional road construction, and mapping corrections.

Roadless characteristics (i.e., values or features that make the area meet the minimum criteria for wilderness consideration under the Wilderness Act) are described in the Roadless Area Conservation FEIS (USDA Forest Service 2000, Vol. 1, pp. 3-3 to 3-7).

Detailed descriptions of the IRAs are included in Appendix C to the Tongass Land Management Plan Revision, Final Supplemental EIS (SEIS), Roadless Area Evaluation for Wilderness Recommendations (USDA Forest Service 2003b). These characteristics are also discussed in detail in the individual resource sections in this FEIS.

Table 3.19-1 summarizes the roadless characteristics considered and the section in this chapter where potential effects are discussed.

Table 3.19-1
Roadless Characteristics and Discussion Sections

2001 Roadless Rule Characteristics	Chapter 3 Section
Biological Values	
Diversity of plant and animal communities	Wildlife, Biodiversity, Plants, Fish
Habitat for threatened, endangered, proposed, candidate, and sensitive species, and for those species dependent on large, undisturbed areas of land	Wildlife, Biodiversity, Plants, Fish
Physical Values	
High quality or undisturbed soil, water, and air	Soils, Geology, Karst and Caves, Water, Climate and Air
Sources of public drinking water	Water
Social Values	
Primitive, Semi-Primitive Non-Motorized, and Semi-Primitive Motorized classes of dispersed recreation opportunities	Recreation and Tourism
Reference landscapes	Scenery
Natural appearing landscapes with high scenic quality	Scenery
Traditional cultural properties and sacred sites	Heritage Resources and Sacred Sites
Other locally identified unique characteristics	Recreation and Tourism; Heritage Resources and Sacred Sites

Source: USDA Forest Service 2000

The roadless area inventory displays the extent of the roadless resource and provides data for use by managers, legislators, and others to formulate land management proposals. Roadless areas may retain their roadless character by being managed in a way that emphasizes relatively large undeveloped or natural areas, such as areas usually required for old-growth habitat, scenic backdrops, or primitive recreation. Roadless areas identified in the inventory that are outside of the Wilderness LUD may be considered for wilderness recommendation, or managed for a wide range of other resource management activities.

Table 3.19-2 provides an overview of the IRAs identified in the 2001 Roadless Rule. These areas consist of approximately 9.2 million acres spread over 110 separate IRAs ranging in size from just 466 acres (Fake Pass #532) to 1.19 million acres (Juneau-Skagway Icefield #301). All but 5 of the 110 IRAs identified in the 2001 Roadless Rule are larger than 5,000 acres (Table 3.19-2). Table 3.19-2 also includes the amount of each area that is productive old growth (POG). If the additional 5.8 million acres of the Tongass in Wilderness and Wilderness National Monument are combined with the IRA acreage, the resulting total (15.0 million acres) represents about 90 percent of the Tongass.

Table 3.19-2
Tongass National Forest Inventoried Roadless Areas Covered by the 2001 Roadless Area Conservation Rule

Roadless Area Number	Roadless Area Name	Roadless Rule National Forest Acres	Productive Old-Growth Forest (Acres)
201	Fanshaw	48,118	29,247
202	Spires	533,366	65,442
204	Madan	67,878	32,357
205	Aaron	78,598	16,889
206	Cone	127,869	10,706
207	Harding	173,344	54,497
208	Bradfield	197,826	20,018
209	Anan	36,646	15,878
210	Frosty	37,369	17,511
211	North Kupreanof	114,318	25,083
212	Missionary	16,661	8,256
213	Five Mile	18,822	8,114
214	South Kupreanof	216,579	84,620
215	Castle	49,194	19,247
216	Lindenberg	25,797	11,419
217	Green Rocks	10,578	4,589
218	Woewodski	10,052	5,570
220	East Mitkof	7,922	2,973
223	Manzanita	8,385	4,781
224	Crystal	18,324	7,789
225	Kadin	2,023	1,979
227	North Wrangell	7,829	4,375
229	South Wrangell	14,193	6,096
231	Woronkofski	11,098	5,961
232	North Etolin	40,909	19,683
233	Mosman	53,118	24,718
234	South Etolin	26,230	9,740
235	West Zarembo	6,781	3,064
236	East Zarembo	10,845	5,084
237	South Zarembo	36,228	14,618
238	Kashevarof Islands	4,630	3,281
239	Keku	9,019	4,956
240	Security	31,370	20,491
241	North Kuiu	6,352	5,625
242	Camden	36,676	18,068
243	Rocky Pass	77,674	37,946
244	Bay of Pillars	27,083	19,177
245	East Kuiu	27,215	17,009
246	South Kuiu	61,906	36,408

Table 3.19-2 (continued)
Tongass National Forest Inventoried Roadless Areas Covered by the 2001 Roadless Area Conservation Rule

Roadless Area Number	Roadless Area Name	Roadless Rule National Forest Acres	Productive Old-Growth Forest (Acres)
247	East Wrangell	7,269	4,689
288	West Wrangell	8,849	4,042
289	Central Wrangell	13,097	5,899
290	Southeast Wrangell	18,340	7,661
301	Juneau-Skagway Icefield	1,186,714	57,950
302	Taku-Snettisham	661,162	95,065
303	Sullivan	67,114	13,422
304	Chilkat-West Lynn Canal	194,888	45,554
305	Juneau Urban	100,412	39,212
306	Mansfield Peninsula	52,730	27,189
307	Greens Creek	26,965	16,648
308	Windham-Port Houghton	160,445	105,861
310	Douglas Island	24,382	13,234
311	Chichagof	552,423	176,502
312	Trap Bay	13,217	6,664
313	Rhine	22,830	6,779
314	Point Craven	10,726	6,706
317	Point Augusta	15,439	10,240
318	Whitestone	5,616	2,794
319	Pavlof-East Point	4,886	3,935
321	Tenakee Ridge	20,512	5,757
323	Game Creek	49,839	18,053
325	Freshwater Bay	43,132	15,924
326	North Kruzof	32,006	15,339
327	Middle Kruzof	14,698	7,643
328	Hoonah Sound	79,524	24,776
329	South Kruzof	54,639	16,340
330	North Baranof	311,224	75,786
331	Sitka Urban	110,803	12,942
332	Sitka Sound	13,270	5,970
333	Redoubt	67,652	28,392
334	Port Alexander	120,181	31,064
338	Brabazon Addition	498,364	0
339	Yakutat Forelands	320,932	75,272
341	Upper Situk	16,397	10,946
342	Neka Mountain	6,103	1,950
343	Neka Bay	7,056	3,729
501	Dall Island	103,861	61,050
502	Suemez Island	19,862	11,244
503	Outer Islands	98,303	51,366
504	Sukkwan	43,901	16,303
505	Soda Bay	63,371	20,559
507	Eudora	190,697	84,718
508	Christoval	9,079	6,867
509	Kogish	63,608	23,470
510	Karta	51,177	17,781
511	Thorne River	72,971	38,017
512	Ratz	5,322	2,444
514	Sarkar	51,876	25,141
515	Kosciusko	63,655	36,544
516	Calder	8,693	6,517
517	El Capitan	26,081	13,316
518	Salmon Bay	22,628	9,318
519	McKenzie	76,054	26,015

Table 3.19-2 (continued)
Tongass National Forest Inventoried Roadless Areas Covered by the 2001 Roadless Area Conservation Rule

Roadless Area Number	Roadless Area Name	Roadless Rule National Forest Acres	Productive Old-Growth Forest (Acres)
520	Kasaan	7,576	3,060
521	Duke	44,650	6,152
522	Gravina	37,183	18,478
523	South Revilla	51,834	20,862
524	Revilla	29,049	9,962
525	Behm Islands	4,349	2,746
526	North Revilla	212,772	95,720
528	Cleveland	185,741	95,547
529	North Cleveland	105,132	46,154
530	Hyder	121,521	14,180
531	Nutkwa	40,810	21,894
532	Fake Pass	466	396
533	Hydaburg	11,021	6,382
534	Twelvemile	37,914	12,631
535	Carroll	11,268	4,421
536	Kasaan Bay	6,210	1,045
577	Quartz	142,889	46,978
Total Acres		**9,224,182**	**2,560,474**

Within IRAs, there are areas where roads were constructed that were either grandfathered in (i.e., constructed prior to the 2001 Roadless Rule) or constructed during the period following the December 30, 2003, Tongass Exemption (68 Federal Register [FR] 75136). These areas are referred to as "roaded roadless" in this FEIS. In total, 80,251 acres (0.9 percent) of current IRAs are considered roaded roadless.

Environmental Consequences

Direct, Indirect, and Cumulative Effects

There are currently 9,224,182 acres in IRAs on the Tongass (Table 3.19-2). Not all lands that are identified as suitable for timber production would actually be harvested. Some of the road construction associated with timber harvest or renewable energy sites would occur in areas already roaded. Some of the road construction would fragment existing IRAs, either creating new roadless areas (if more than 5,000 acres remains) or simply resulting in small blocks of undeveloped land surrounded by roads and harvest areas. In addition, not all of the effects of the alternatives would occur at once.

For these activities to take place there would need to be a change in the Roadless Rule (rule making). Under current regulations, commercial timber harvest in IRAs is inconsistent with the 2001 Roadless Rule; therefore, harvest activities in IRAs would be postponed until there was a change in the Roadless Rule or the Tongass Roadless Rule Exemption were reinstated.

Effects of Alternatives

Timber Harvest

Estimated acres of old-growth harvest and young-growth harvest after 100 years within current IRAs are presented in Table 3.19-3 by alternative. Only Alternatives 2 and 3 would allow harvest within IRAs, butharvest would be deferred until agency rulemaking modifies 36 CFR 294.13(b)(4) (2001). Under Alternative 2, 100 percent of the proposed old-growth harvest within IRAs is located within roaded roadless areas (areas that were roaded before the 2001

Roadless Rule and during the 2001 Roadless Rule exemption period). This alternative would harvest an estimated 2,171 acres of old-growth forest, and 9,118 acres of young-growth, which is equivalent to 0.02 and 0.1 percent of total IRA acres, respectively (Table 3.19-3). If this alternative were selected, no harvest could occur in IRAs until agency rulemaking modifies 36 CFR 294.13(b)(4) (2001).

Alternative 3 would allow young-growth and old-growth harvest in 2001 Roadless Rule areas and includes almost eight times more old-growth harvest within IRAs than Alternative 2 (Table 3.19-3). An estimated total of 17,037 acres of old-growth would be harvested under Alternative 3 (0.2 percent of total IRA acres), with just 9 percent of this total located in roaded roadless. Alternative 3 includes an estimated 11,810 acres of young-growth harvest (0.1 percent of total IRA acres), about 2,700 acres more than Alternative 2 (Table 3.19-3). Approximately 77 percent of this estimated young-growth harvest would occur in roaded roadless areas (Table 3.19-3). If this alternative were selected, harvest in IRAs would be deferred until agency rulemaking modifies 36 CFR 294.13(b)(4) (2001).

Table 3.19-3
Estimated Old-Growth and Young-Growth Harvest After 100 Years within Current Inventoried Roadless Areas by Alternative

	Estimated Old-Growth Harvest Acres			Estimated Young-Growth Harvest Acres		
Alternative	Acres	Percent of IRA Acres	Percent in "Roaded Roadless"	Acres	Percent of IRA Acres	Percent in "Roaded Roadless"
1	0	0	0	0	0	0
2	2,171	0.02	100	9,118	0.1	100
3	17,037	0.2	9	11,810	0.1	77
4	0	0	0	0	0	0
5	0	0	0	0	0	0

[1] IRAs do not include Wilderness and Wilderness National Monument, even though they are roadless. Commercial timber harvest in IRAs is inconsistent with the 2001 Roadless Rule; harvest activities in IRAs would not be possible unless there was a change in the Roadless Rule or the Tongass Roadless Rule Exemption were reinstated.

Renewable Energy

All renewable energy sites have to meet detailed local, state and, in most cases, federal laws, regulations, and requirements. Projects are also subject to Tongass National Forest Plan standards and guidelines. The 2008 Forest Plan identifies three types of areas related to energy development on the Tongass based on the existing LUDs: windows, which represent areas potentially available for energy development; avoidance areas; and exclusion areas. Avoidance areas are those LUDs where development of energy projects is not allowed unless there is no feasible alternative. Exclusion areas preclude Transportation and Utility Systems. There are no exclusion areas on the Forest due to special authorities provided in the Alaska National Interest Lands Conservation Act, Title XI. These classifications and the standards and guidelines in the 2008 Forest Plan would continue to apply under Alternative 1. Under Alternatives 2 through 5, energy projects would be managed under the Renewable Energy Plan Components identified in Chapter 5 of the Forest Plan. This is discussed in more detail in the *Renewable Energy* section of this FEIS.

The Forest Service has identified 11 proposed renewable energy projects that are on or considered likely to affect NFS lands and are currently active (Table 3.12b-3). These projects consist of nine hydroelectric projects, one geothermal project, and one wave project.

Eight of the 11 proposed renewable energy projects on or likely to affect NFS lands are located in IRAs. These projects include seven hydroelectric projects and one geothermal project. Effects from the proposed projects would depend on site-specific plans. In general, project activities that would impact IRAs could include new access road construction (temporary and permanent), forest clearing, ground disturbance, temporary construction noise, and visual impacts depending on the location and design features. Any associated transmission lines would also impact the IRAs crossed through forest clearing and potential additional road construction.

All potential impacts to IRAs would be addressed during the permitting and licensing of these projects, with most requiring project-specific National Environmental Policy Act (NEPA) assessment. Potential impacts would be mitigated, but some impacts, like the presence of a road in an IRA, would be unavoidable. Implementation of the Renewable Energy Plan Components under Alternatives 2 through 5 would simplify the development process for some projects, but would not necessarily result in an increase in the number of projects developed. The greatest effect may be in making the permitting process for developers less burdensome, resulting in more rapid development of sites rather than a substantial increase in the number of sites developed. Current existing and proposed renewable energy projects are widely distributed across the Forest, with 11 identified proposed renewable energy projects spread across six ranger districts. This would reduce the cumulative effects of these activities on any specific IRA. Overall, Alternatives 2 through 5 would likely have little additional adverse effects to IRAs relative to current conditions (Alternative 1).

Cumulative Effects

This section considers the incremental effects of the alternatives when added to other past, present, and reasonably foreseeable actions. The effects of past and present actions on IRAs are included in the affected environment portion of this section, which discusses the existing IRAs on the Tongass. IRAs are identified based on past actions—specifically, timber harvest and road development, with all areas on the Forest within 1,200 feet of an existing road or within 600 feet of an existing harvest unit generally considered developed. Present actions include the impacts of current management policies on IRAs.

Reasonably foreseeable actions on NFS lands include the projected levels of future timber harvest, road construction, and renewable energy project development. The direct and indirect effects of these actions on IRAs are discussed above. The contribution to the timber program for the proposed alternatives would be largest under Alternative 3, followed by Alternative 2, as these alternatives include old-growth and young-growth suitable acres in IRAs. No suitable acres are identified in IRAs under Alternatives 1, 4, and 5. Harvest in IRAs would be deferred under Alternatives 2 and 3 until agency rulemaking modifies 36 CFR 294.13(b)(4) (2001).

Other reasonably foreseeable actions include regional transportation development as defined by the State Transportation Plan and Forest Service Alaska Region Long Range Transportation Plan, as well as road paving on Prince of Wales Island, the closing of roads, and construction of the Angoon Airport. In addition, the expansion of cities like Juneau and Ketchikan, recreational cabin development, and land auctions by the State could include additional road construction.

If one or more of these actions crossed IRAs, the overall effect would be a reduction in the size of existing IRAs. It is not possible at this time to predict exactly which roads would be developed. None of the alternatives are expected to affect this type of future development, which would be expected to go or not go

forward regardless of the selected alternative. The overall cumulative effect of these regional activities viewed in conjunction with the Forest Plan alternatives would be a reduction in existing IRAs.

New utility line projects, if they were to go forward, would have similar effects. The 2010 Region 10 Energy Program Overview (USDA Forest Service 2010b) indicated that at least 20 new transmission line corridors being considered for Southeast Alaska would cross NFS lands, noting, however, that many of these are still in the early conceptual planning stage and applications have not been submitted to the Forest Service. Several organizations in Southeast Alaska have planned interconnected transmission lines and or interties that would connect multiple power projects and allow power sales and sharing throughout the region (USDA Forest Service 2010b). These include the Swan Lake-Lake Tyee Intertie Project, completed in 2009, and the Kake to Petersburg Transmission Line Intertie Project, which is currently undergoing NEPA review; the DEIS was released in November 2014 and a FEIS and Draft Record of Decision is anticipated in July 2016. None of the alternatives would affect these developments, which would be expected to go or not go forward regardless of the selected alternative. The overall cumulative effects if one or more of the utility projects that cross IRAs were developed would be a reduction in the size of existing IRAs, which could occur under any of the alternatives. The potential reduction in existing IRA acres would be greatest under Alternatives 3 and 2, as described above.

The Tongass National Forest comprises about 78 percent of the land area of Southeast Alaska. Over 90 percent of the Tongass is currently roadless or wilderness. The other major land ownership in Southeast Alaska is Glacier Bay Park and Preserve (12.5 percent of Southeast Alaska), the vast majority of which is managed as wilderness by the National Park Service. In addition, the State of Alaska and the Bureau of Land Management manage another 6 percent of Southeast Alaska, a large portion of which is roadless. Combining all ownerships, approximately 90 percent of Southeast Alaska is currently roadless. At least 97 percent of all existing IRAs would remain roadless under any of the alternatives. As a result, the vast majority of existing wilderness and IRAs in Southeast Alaska would remain in wilderness or roadless after 100+ years, and the potential for cumulative effects is considered low.

Appendix C in this FEIS lists and describes the past, present, and reasonably foreseeable future actions considered in the cumulative effects analysis.

Wilderness

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Affected Environment

Introduction

This section provides a general overview of wilderness, describes existing wilderness in Alaska and on the Tongass National Forest, discusses the relative contribution of Tongass wilderness to the National Wilderness Preservation System, and addresses wilderness management direction in Alaska. The only other National Forest in Alaska, the Chugach National Forest, currently has no designated wilderness, but includes 2 million acres of wilderness study area. None of the alternatives evaluated in this Environmental Impact Statement (EIS) include new Wilderness recommendations.

Wilderness Overview

The Wilderness Act of 1964 defines wilderness "as an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain." The Act further elaborates on the definition to mean:

> "an area of undeveloped federal land retaining its primeval character and influence, without permanent improvements or human habitation, which is protected and managed so as to preserve its natural conditions and which 1) generally appears to have been affected primarily by the forces of nature, with the imprint of man's work substantially unnoticeable; 2) has outstanding opportunities for solitude or a primitive and unconfined type of recreation; 3) has at least five thousand acres of land or is of sufficient size as to make practicable its preservation and use in an unimpaired condition; and 4) may also contain ecological, geological, or other features of scientific, educational, scenic, or historical value."

Wilderness Character

The Wilderness Act does not define wilderness *character*, but according to Landres et al. (2005), wilderness character may be described as the "combination of biophysical, experiential, and symbolic ideals that distinguish wilderness from all other lands." Landres et al. identify four qualities of wilderness that may be used to approximate wilderness character for the purposes of monitoring changes to wilderness character over time. These qualities, which were identified based on the Definition of Wilderness, Section 2(c) from the 1964 Wilderness Act, and are described below, are equally important and reinforce one another. A fifth category, other features of value, has also been identified and is described below.

Untrammeled—The Wilderness Act states that wilderness is "an area where the earth and its community of life are untrammeled by man" and "generally appears to have been affected primarily by the forces of nature." This quality refers to

wilderness being essentially unhindered and free from modern human control or manipulation.

Natural—The Wilderness Act states that wilderness is "protected and managed so as to preserve its natural conditions." This quality refers to the intended and unintended effects of modern people on ecological systems inside wilderness since the time of designation.

Undeveloped—The Wilderness Act states that wilderness is "an area of undeveloped federal land retaining its primeval character and influence, without permanent improvements or human habitation." The undeveloped quality refers to the absence of structures, construction, habitations, and other evidence of modern human presence or occupation, including the development level of trails and campsites.

The undeveloped quality also refers to the absence of mechanical transport and motorized equipment. Wilderness was partly established "in order to assure that…growing mechanization, does not occupy and modify all areas within the United States…" (Wilderness Act, Section 2a).

Outstanding opportunities for solitude or a primitive and unconfined type of recreation—The Wilderness Act states that wilderness has "outstanding opportunities for solitude or a primitive and unconfined type of recreation." This quality includes the values of inspiration and physical and mental challenge. Primitive recreation in wilderness has largely been interpreted as travel by nonmotorized and nonmechanical means. It also encompasses reliance on personal skills to travel and camp in an area. Unconfined encompasses attributes such as self-discovery, exploration, and freedom from societal and managerial controls.

Other features of value—Wilderness preserves other tangible features that are of scientific, educational, scenic, or historical value. This quality is based on the last clause of section 2(c) of the Wilderness Act which states that a wilderness "may also contain ecological, geological, or other features of scientific, educational, scenic, or historic value." This quality captures important elements of the wilderness that may not be covered in the other four qualities, such as cultural or paleontological resources. This quality is preserved or improved when these resources are preserved; the loss of or impacts to such features degrades this quality of wilderness character.

The existing wilderness on the Tongass was established under the 1980 Alaska National Interest Lands Conservation Act (ANILCA) and the 1990 Tongass Timber Reform Act (TTRA), which amended ANILCA. In ANILCA, Congress reaffirmed and expanded upon the purposes of wilderness as stated in the 1964 Wilderness Act, specifically for wilderness established in Alaska. Except as otherwise expressly provided for in ANILCA, wilderness designated by this Act shall be administered in accordance with applicable provisions of the Wilderness Act. In recognition of unique situations and established uses in Alaska, ANILCA provided a number of important specific exceptions to the prohibitions of the Wilderness Act. These included exceptions related to subsistence, access, and public use cabins among others. These exceptions are addressed in detail in the final part of this Affected Environment section.

Wilderness Values

People value wilderness for a variety of reasons, but most reasons involve three central themes: the *experiential* value, the *scientific* and *ecological resource* value, and the *symbolic* and *spiritual* values (slightly modified from Hendee and Dawson 2002). The *experiential* value is the direct value of the wilderness

experience. The experience is seen as valuable in its own right because of its primitive recreation, aesthetic, closeness to nature, education, freedom, solitude, simplicity, spiritual, and mystical dimensions. The value of wilderness as a *scientific* and *ecological resource* includes the importance of wilderness to science, including its importance in preservation of fauna and flora, particularly those species requiring large tracts of unmodified habitats. Finally, the *symbolic* and *spiritual* values of wilderness are represented by the high values some people place on the knowledge that wilderness exists, whether they use it or not. In a world characterized by rapid change and complexity, wilderness symbolizes comforting stability and simplicity to many.

Wilderness in Alaska and the Tongass

Congress has the sole authority for designating additions to the National Wilderness Preservation System. Fourteen wildernesses totaling 5.5 million acres were established under ANILCA. Two of these wilderness areas on Admiralty Island and within Misty Fiords are encompassed by designated National Monuments.[1] Prior to ANILCA, there was no designated wilderness on the Tongass. The TTRA amended ANILCA and designated five new wildernesses and one wilderness addition totaling 296,080 acres. As a result of these two pieces of legislation, there are currently 5.8 million acres of wilderness on the Tongass in 19 separate wildernesses (Table 3.20-1).

Table 3.20-1
Existing Wildernesses on the Tongass National Forest

Name	Total Acres	Non-National Forest Acres	National Forest Acres
Wildernesses Established December 2, 1980, by ANILCA			
Kootznoowoo Wilderness (Admiralty Island National Monument)	988,050[1]	32,129	955,858[1]
Coronation Island Wilderness	19,232	0	19,232
Endicott River Wilderness	98,729	0	98,729
Maurelle Islands Wilderness	4,937	0	4,937
Misty Fiords National Monument Wilderness	2,142,907	600	2,142,307
Petersburg Creek-Duncan Salt Chuck Wilderness	46,849	0	46,849
Russell Fiord Wilderness	348,701	0	348,701
South Baranof Wilderness	319,568	0	319,568
South Prince of Wales Wilderness	91,018	50	90,968
Stikine-LeConte Wilderness	449,951	1,025	448,926
Tebenkof Bay Wilderness	66,839	27	66,812
Tracy Arm-Fords Terror Wilderness	653,179	0	653,179
Warren Island Wilderness	11,181	0	11,181
West Chichagof-Yakobi Wilderness	265,529	1,038	264,491
Wildernesses Established November 28, 1990, by the TTRA			
Chuck River Wilderness	74,990	692	74,298
Karta Wilderness	39,894	5	39,889
Kuiu Wilderness	60,581	0	60,581
Pleasant-Lemusurier-Inian Islands Wilderness	23,151	55	23,096
South Etolin Wilderness	83,371	752	82,619
Total Acreage	**5,788,657**	**36,436**	**5,752,221**

[1] Kootznoowoo Wilderness includes 18,486 acres, including 24 acres of Non-National Forest System lands in the Young Lake Addition established by the Tongass Timber Reform Act (TTRA), November 28, 1990.
Source: Total acreages are as reported to Congress with official boundary maps. These wildernesses include only the public lands above mean high tide.

Wilderness recommendations were not considered in the 1997 Land and Resource Management Plan (Forest Plan) Final Environmental Impact Statement

[1] Note that the Admiralty Island National Monument Wilderness was renamed the Kootznoowoo Wilderness by separate legislation in 1990.

(FEIS) and Record of Decision (ROD) because additional wilderness had been created under the TTRA. In March 2001, the U.S. District Court of Alaska ruled in response to a lawsuit filed by the Sierra Club (*Sierra Club v. Lyons*) and other environmental groups that the 1997 FEIS should have considered making additional wilderness recommendations and ordered the Forest Service to prepare a Supplemental EIS (SEIS) to evaluate wilderness recommendations and update the Analysis of the Management Situation (AMS) relative to roadless areas and their relative contribution to the National Wilderness Preservation System. The Forest Service subsequently updated the AMS and determined the eligibility of each of the inventoried roadless areas for wilderness recommendation. Eight alternatives that identified roadless areas within the Tongass for recommendation as potential wilderness were evaluated in a Final SEIS to the 1997 Forest Plan FEIS in 2003 (USDA Forest Service 2003b). The ROD for the Final SEIS concluded that it was not "the appropriate time for significantly changing land use designations on the Tongass National Forest" and did not recommend any additional wilderness on the Tongass at that time (USDA Forest Service 2003b).

Relative Contribution of Tongass Wilderness

Overview

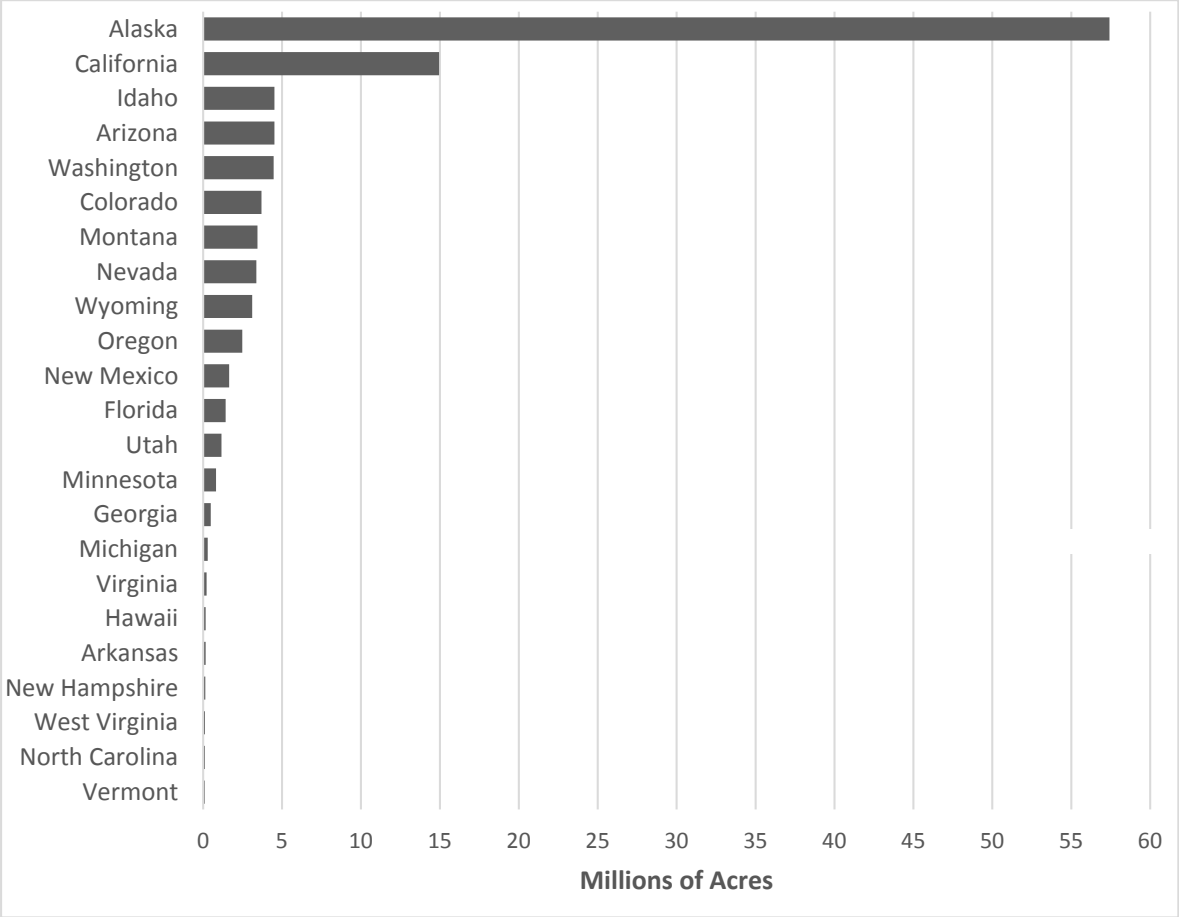
The National Wilderness Preservation System includes almost 110 million acres, with more than half of this total (57 million acres) in Alaska (Figures 3.20-1 and 3.20-2). In addition to having the largest total land area in wilderness, Alaska also has the highest proportion of its land area in wilderness (15.4 percent), followed closely by California (13.8 percent) (Figure 3.20-3). The states with both the greatest land area and highest percent land area in wilderness are Alaska, California, Washington, Idaho, Arizona, and Colorado (Wilderness.net 2014).

Alaska also has the highest number of wilderness acres per resident, with almost 90 acres per resident. This ratio increases to slightly more than 120 acres per resident when only Southeast Alaska is considered. The next closest state is Wyoming with about 6 acres of wilderness per resident.

Existing wilderness on the Tongass, approximately 5.8 million acres, represents about 34 percent of the forest land base and 28 percent of the land in Southeast Alaska. Viewed on a national basis, existing wilderness on the Tongass represents 16 percent of all wilderness on NFS lands and 5.3 percent of all lands in the National Wilderness Preservation System (Wilderness.net 2014).

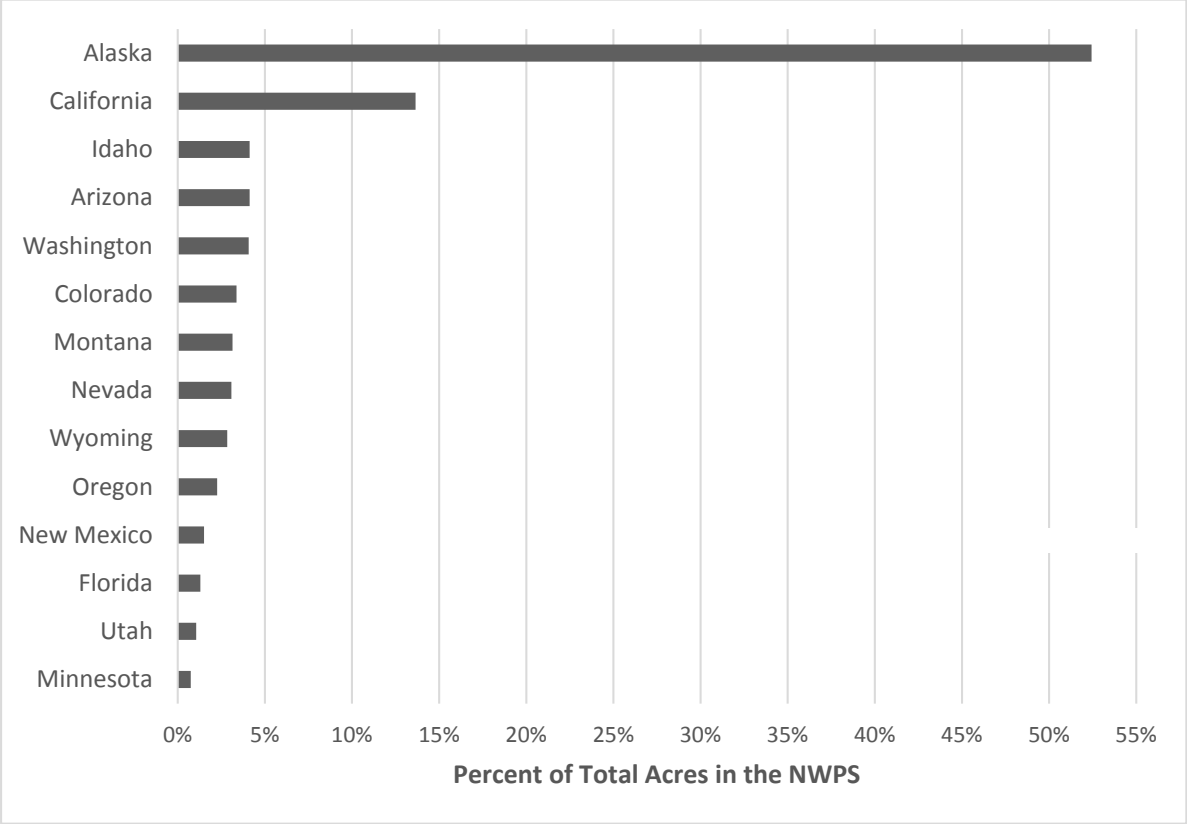
Two of the largest wildernesses on the Tongass, Misty Fiords National Monument Wilderness (2.1 million acres) and Kootznoowoo (Admiralty Island) Wilderness (almost 1 million acres), contain vast, intact ecosystems. Five other wildernesses are each more than 250,000 acres. The wildernesses of the Tongass are mostly in a pristine condition, with the imprint of humans generally not noticeable. They offer outstanding opportunities for solitude and primitive recreation.

Figure 3.20-1
Acres of Wilderness by State



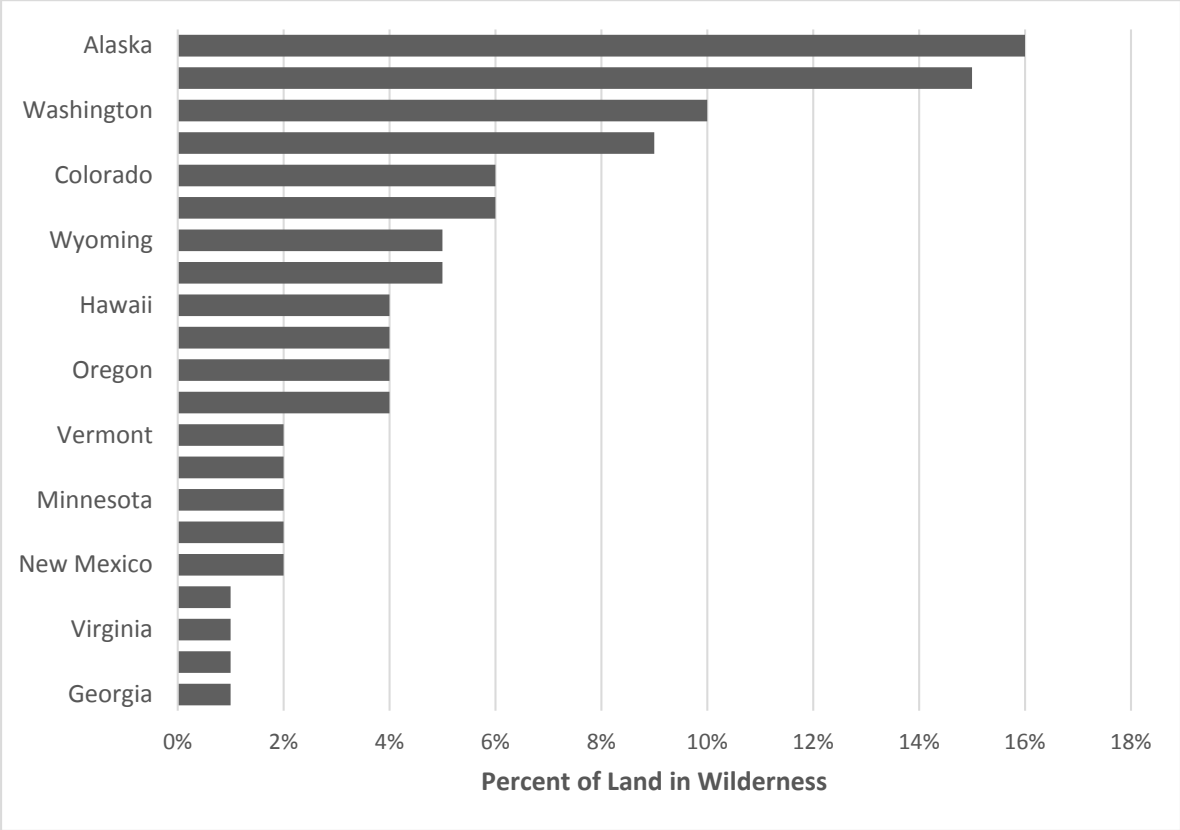
Source: Wilderness.net (2014)

Figure 3.20-2
Percent of Total Acres in the National Wilderness Preservation System by State



Source: Wilderness.net (2014)

Figure 3.20-3
Percentage of Land Area in Wilderness by State



Source: Wilderness.net (2014)

In the remainder of this section, the Tongass National Forest is evaluated in terms of how well its landforms and ecosystems are represented in existing wilderness.

Ecoregions

DeVelice and Martin (2001) provide a national summary of acreage in National Forest roadless areas versus designated wilderness, National Parks, and other areas primarily managed to maintain natural values (i.e., conservation reserves or reserves). In Alaska, all but 1 of 15 ecoregions (as defined by Ricketts et al. 1999) have greater than 12 percent of their area in reserves. No other region in the country surpasses Alaska in ecological representation in reserves.

Two ecoregions cover the Tongass National Forest: the Northern Pacific Coastal Forest and the Pacific Coastal Mountain Tundra and Ice Fields (Ricketts et al. 1999). These two ecoregions extend from eastern Kodiak Island to the southern end of the Alaska panhandle. Approximately 19 percent of the Northern Pacific Coastal Forest and 37 percent of the Pacific Coastal Mountain Tundra and Ice Fields ecoregions are in reserves (DeVelice and Martin 2001). The portions of both of these areas protected in wilderness are above the 12 percent threshold considered by some authorities (e.g., World Commission on Environment and Development 1987) as the minimum area for representation (DeVelice and Martin 2001).

When the acreage of inventoried roadless areas is added to the acreage of conservation reserves in the two ecoregions, the percentage increases to 64 percent for the Northern Pacific Coastal Forest and 66 percent for the Pacific Coastal Mountain Tundra and Ice Fields ecoregions (DeVelice and Martin 2001). These values are in the 25 to 75 percent range that Noss and Cooperrider (1994) argue is required to achieve representation and are higher than the 12 percent threshold.

When one considers only NFS lands, the percentage of NFS lands area in wilderness in these ecoregions is 25 percent for the Northern Pacific Coastal Forest and 21 percent for the Pacific Coastal Mountain Tundra and Ice Fields. If all inventoried roadless areas are counted along with wilderness, the total area of wilderness plus inventoried roadless areas on the Tongass in these ecoregions increases to 69 percent and 79 percent, respectively (DeVelice and Martin 2001).

Land Cover Classes

The various ecosystems of Southeast Alaska are generally represented within the Tongass' wilderness. These areas include glaciers and ice fields, off-shore islands and seacoasts facing both the open Pacific Ocean and inland passages, major river systems, and 1.5 million acres of old-growth temperate rain forests. Viewed in terms of broad National Forest land cover classes, designated Wilderness on the Tongass exceeds 12 percent of the area in five land cover classes that are prevalent in Southeast Alaska. These five classes are: 1) Evergreen Forest (23 percent), 2) Tundra (15 percent), 3) Barren Land (37 percent), 4) Water (23 percent), and 5) Glaciers-Snow (15 percent). Designated Wilderness does not exceed 12 percent of the area for Deciduous Forest (0 percent), Mixed Forest (0 percent), and Shrub-Brush (9 percent) (Martin et al. 2000). However, these latter three land cover types are not prevalent in Southeast Alaska.

Biogeographic Provinces

The extent to which identifiable landform types and ecosystems are represented in the wildernesses (and other natural setting Land Use Designations [LUDs]) of the Tongass National Forest may be evaluated based on the extent to which the biogeographic provinces of Southeast Alaska are represented. The Tongass can be subdivided into 21 biogeographic provinces characterized by similar species composition, similar patterns in distribution for many species, similar geologic barriers and historic events (such as glaciation), and similar climatic conditions. These provinces are discussed in the Biodiversity section of this chapter. Table 3.20-2 identifies the percentage of each biogeographic province that is included in existing wilderness. It also includes the percentage of each biogeographic province in other natural setting LUDs.

Twelve of the 21 biogeographic provinces on the Tongass have 20 percent or more of their lands within the National Forest boundary in Wilderness or National Monument; 16 of the 21 have 15 percent or more. Five provinces (Dall Island and Vicinity, Kupreanof/Mitkof Island, and North Central Prince of Wales) have from 1 to 6 percent in Wilderness or National Monument. However, these areas have from 37 to 80 percent of their land areas within wilderness or natural setting LUDs. Overall, 18 of the 21 provinces have more than 50 percent of their land areas in either wilderness or natural setting LUDs. The remaining three have 37 to 42 percent.

Table 3.20-2
Percentage of Biogeographic Province in Existing Wilderness or Natural Setting LUDs

	Province	Percent in Wilderness or National Monument	Percent in Other Natural Setting LUDs[1]	Total Percent in Wilderness or Natural Setting LUDs[1]
1	Yakutat Forelands	1	78	79
2	Yakutat Uplands	37	63	100
3	East Chichagof Island	6	50	56
4	West Chichagof Island	82	18	100
5	East Baranof Island	24	52	75
6	West Baranof Island	29	57	86
7	Admiralty Island	93	6	99
8	Lynn Canal	17	64	81
9	North Coast Range	23	56	78
10	Kupreanof/Mitkof Island	6	34	40
11	Kuiu Island	26	40	66
12	Central Coast Range	39	38	77
13	Etolin Island	16	26	42
14	North Central Prince of Wales	3	34	37
15	Revilla Island/Cleveland	18	42	60
16	South Outer Islands	16	57	73
17	Dall Island and Vicinity	3	77	80
18	South Prince of Wales	24	41	64
19	North Misty Fiords	82	14	95
20	South Misty Fiords	100	0	100
21	Ice Fields	33	62	95
	Total	**33**	**43**	**76**

Wilderness Management in Alaska

Management under the Wilderness Act

The Wilderness Act of 1964 mandates that designated "wilderness areas … shall be administered for the use and enjoyment of the American people in such a manner as will leave them unimpaired for future use and enjoyment as wilderness, and so as to provide for the protection of these areas, the preservation of their wilderness character, and for the gathering and dissemination of information regarding their use and enjoyment as wilderness."

Subject to existing private rights, the Act prohibits permanent roads and, except as necessary for realizing the recreation and other wilderness purposes of the area, commercial enterprises. Temporary roads, the use of motor vehicles, motorized equipment, other mechanized equipment, motorboats, the landing of aircraft, and structures and installations are prohibited except as necessary to meet minimum requirements for the administration of the area as wilderness. The Act provides that the use of aircraft or motorboats, where these uses were established prior to designation, may be permitted to continue subject to restrictions by the Secretary of Agriculture. In 1997, the Regional Forester decided to maintain a prohibition on recreational helicopter use within wilderness. Wildernesses were withdrawn from mineral entry as of December 31, 1983, and patenting of valid claims is limited to subsurface mineral rights.

Management under the Alaska National Interest Lands Conservation Act

In ANILCA, Congress reaffirmed and expanded upon the purposes of wilderness as stated in the Wilderness Act of 1964, specifically for wilderness established in Alaska. In recognition of unique situations and established uses in Alaska, ANILCA also provided a number of exceptions to the requirements of the Wilderness Act.

Subsistence Policy (Applies to All Federal Lands)
Section 811 mandates that the Secretary "shall ensure that rural residents engaged in subsistence uses shall have reasonable access to subsistence resources on public lands." This section further directs that, other laws (including the Wilderness Act) notwithstanding, the Secretary "shall permit on the public lands appropriate use for subsistence purposes of snowmobiles, motorboats, and other means of surface transportation traditionally employed for such purposes by local residents, subject to reasonable regulation."

Transportation and Utility Systems
In Section 1101, Congress finds that:

> "(a) Alaska's transportation and utility network is largely undeveloped and the future needs for transportation and utility systems in Alaska would best be identified and provided for through an orderly, continuous decisionmaking process involving the State and Federal Governments and the public."

Section 1105 provides that in any case in which there is no applicable law with respect to a transportation or utility system, the head of the federal agency concerned shall make recommendations to authorize the system within the Conservation Unit concerned (including Wilderness) if it is determined that the system would be compatible with the purposes for which the unit was established, and there is no economically feasible and prudent alternative route for the system (see Section 1104 regarding National Environmental Policy Act [NEPA] procedural requirements). Section 1106(b) requires that following federal agency review and decision recommendation, the President has the authority to review and either approve or disapprove the application. If the application is approved by the President, Congress must issue a joint resolution approving the application by the transportation or utility system for the project to move forward (Section 1106(c)). ANILCA (Section 506) includes specific exceptions for Admiralty Island National Monument Wilderness regarding the right to develop hydroelectric resources and public access and use.

Special Access
Section 1110(a) requires that the Secretary "shall permit" on Conservation Units, which include Wilderness, "the use of snowmachines (during periods of adequate snow cover or frozen river conditions, in the case of Wild or Scenic rivers), motorboats, airplanes, and nonmotorized surface transportation methods for traditional activities (where such activities are permitted by this Act or other law) and travel to and from villages and homesites." Such use is subject to reasonable regulation, but shall not be prohibited unless after notice and hearing the Secretary finds that such use would be detrimental to the resource values of the area.

Inholding Access
Section 1110(b) assures adequate and feasible access to state and private land and to valid occupancies, including valid mining claims.

Navigation Aids and Facilities
Section 1310(a) provides that reasonable access to, and operation and maintenance of, existing air and water navigation aids, communication sites, facilities for national defense, and related facilities and existing facilities for weather, climate and fisheries research, and monitoring shall be permitted. “Nothing in the Wilderness Act shall be deemed to prohibit such access, operation and maintenance within wilderness areas designated by this Act.” Section 1310(b) provides that the establishment, operation, and maintenance of new such facilities shall be permitted within wilderness after consultation with the Secretary and in accordance with mutually agreed upon terms and conditions to minimize the adverse effects within the unit.

Aquaculture
Section 1315(b) provides that the Secretary may permit fishery research, management, enhancement, and rehabilitation activities within National Forest System Wilderness, in a manner that adequately assures protection, preservation, enhancement, and rehabilitation of the wilderness resource. Subject to reasonable regulations, permanent improvements and facilities such as fishways, fish weirs, fish ladders, fish hatcheries, spawning channels, stream clearance, egg planting, and other accepted means of maintaining, enhancing, and rehabilitating fish stocks may be permitted.

Public Use Cabins
Section 1315(c) provides for the continued use, maintenance, and replacement of existing public use cabins within wilderness. Section 1315(d) authorizes the construction and maintenance of a limited number of new public use cabins and shelters, if necessary, for public health and safety, and also requires the Secretary to notify Congress of his intention to remove an existing or construct a new public use cabin or shelter.

Beach Log Salvage
Section 1315(f) allows the Secretary to permit or otherwise regulate the recovery and salvage of logs from the coastlines of National Forest Wilderness and National Monuments. Agency policy further defines the salvage of logs to include only the recovery of logs that were harvested and then lost in transport. Downed trees resulting from natural forces, such as blow down, and stream bank or shore erosion shall not be sold or removed under this authority. Removal where allowed will normally be accomplished by the use of "pull boats" (boats that pull logs off the beach by long cable usually at high tides) without use of other mechanical devices on the beach.

Temporary Hunting and Fishing Facilities
Section 1316(a) provides that the Secretary shall permit, subject to reasonable regulation to ensure compatibility, the continuation of existing uses and future establishment and use of temporary campsites, tent platforms, shelters, and other temporary facilities and equipment directly and necessarily related to the taking of fish and game. Facilities and equipment shall be constructed, used, and maintained in a manner consistent with the protection of the area where they are located. New facilities shall be constructed of materials that blend with and are compatible with the surrounding landscape. Section 1316(b) allows the Secretary to deny new facilities and equipment upon making a determination, after public notice, that the establishment and use of new facilities or equipment would constitute a significant expansion of existing facilities or uses that would be detrimental to the purposes for which the unit was established, including “wilderness character.”

Other Forest Plan Restrictions

ANILCA defines "wilderness" as having the same meaning as when it is used in the Wilderness Act (Sec. 102(13)). Section 707 states that, except as expressly provided in ANILCA, wilderness designated by ANILCA "shall be administered in accordance with applicable provisions of the Wilderness Act governing areas designated by that Act as Wilderness." Some of the restrictions identified for Tongass wilderness by the 2008 Forest Plan include the following:

- New roads, motorized trails, and airstrips are not permitted, except where authorized by ANILCA and to access state and private inholdings and valid mining claims, subject to stipulations for protection of natural and other values of the land.
- The landing of helicopters for access by the general public is prohibited. The administrative use of helicopters may be allowed on a case-by-case basis after evaluation of the need and full consideration of all alternative options for access.
- There is a group size limitation of no more than 12 persons for commercial or general public use, unless otherwise approved by the appropriate line officer.
- No new permanent administrative facilities are allowed, except as consistent with ANILCA.

Environmental Consequences

None of the alternatives include lands suitable for timber production. Therefore, there would be no direct effects to Wilderness from timber harvest. Potential indirect effects from timber harvest and direct and indirect effects from renewable energy development to Wilderness are discussed below.

Direct and Indirect Effects

Existing wilderness on the Tongass, which encompasses approximately 5.7 million acres and represents about 34 percent of the forest land base and 28 percent of the land in Southeast Alaska, would remain unchanged under all of the alternatives. The 19 wildernesses on the Tongass are identified in Table 3.20-1. The acres of each biogeographic province presently in Wilderness areas on the Tongass would also remain unchanged (see Table 3.20-2).

Wilderness areas may be indirectly affected if old-growth or young-growth harvest, including associated road construction, takes place in an adjacent area. Depending on the actual location and extent of harvest, there could be edge-related effects, increasing the potential for impacts to portions of Wilderness boundary areas. Such impacts could include introduced non-native or invasive plant species, vulnerability to windthrow events, noise from harvest activities, reduced scenic quality, and unauthorized recreation access. The effects of individual proposed harvest projects on Wilderness would be analyzed in a site-specific NEPA analysis.

All renewable energy projects built and operated in Southeast Alaska have to meet local, state and, in most cases, federal laws, regulations, and requirements. Projects are also subject to Forest Plan direction (e.g., standards and guidelines). The 2008 Forest Plan identifies three types of areas related to Transportation and Utility Systems, including hydroelectric power projects on the Tongass based on the LUD windows, which represent areas potentially available for transportation and utility development; avoidance areas; and exclusion areas. Avoidance areas are those LUDs where development of energy projects is only allowed if no feasible alternative exists outside of that LUD. Exclusion areas

preclude Transportation and Utility Systems. There are no exclusion areas on the Forest due to special authorities provided in ANILCA, Title XI. The Wilderness, Wilderness National Monument, and Non-Wilderness National Monument LUDs are identified as avoidance areas in the 2008 Forest Plan. These classifications and the standards and guidelines in the 2008 Forest Plan would continue to apply under Alternative 1.

Under Alternatives 2 through 5, renewable energy direction in Chapter 5 of the Forest Plan would be applied to the LUDs, similar to how the forest-wide standards and guidelines in Chapter 4 of the Forest Plan are applied to the LUDs. Renewable energy direction in Chapter 5 identifies the following with respect to the suitability of lands: "SUIT-RE-01**:** All NFS lands may be suitable for renewable energy sites on a case-by-case basis in consideration of the LUD, ecological and social values, and benefit to Southeast Alaska communities." This direction also states that "(i)dentifying renewable energy sites as suitable is not a commitment but only an indication that the use might be appropriate."

Implementation of the renewable energy direction under Alternatives 2 through 5 may simplify the administrative process for projects; however, the change would not likely result in an increase in the number of projects developed due to the ANILCA Title XI requirements for Forest Service assessment of alternatives and the requirement for Presidential and Congressional approval. All proposed projects would continue to be evaluated in accordance with applicable local, state, and federal regulations and requirements.

The Forest Service has identified 12 proposed renewable energy projects that are currently active (Table 3.12b-3). One of the identified projects is located in Wilderness. The Angoon Hydroelectric project is exempted from the requirements of the Wilderness Act through ANILCA Section 506 (a)(3)(D).

Cumulative Effects

There would be no direct effects and minimal indirect effects to Wilderness from timber harvest under any of the alternatives. One of the 12 proposed renewable energy projects is located in Wilderness: the Angoon Hydroelectric project. The Angoon Hydroelectric project is exempted from the requirements of the Wilderness Act through ANILCA section 506 (a)(3)(D). Given the current regulatory protections in place for Wilderness, the potential for cumulative effects associated with timber harvest or renewable energy development is low. Appendix C provides a list and description of the past, present, and reasonably foreseeable future projects considered in the cumulative effects analysis.

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Other Special Land Use Designations

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A number of areas on the Tongass National Forest have been allocated to special Land Use Designations (LUDs) because they possess outstanding resources, research opportunities, or other factors of special interest. These areas include LUD II management areas, Experimental Forests, Research Natural Areas (RNAs), Special Interest Areas, and Wild and Scenic Rivers. Each of these is described in this section, as are the effects of the alternatives on these areas.

Affected Environment

Land Use Designation II Management Areas

The Tongass Timber Reform Act of 1990 (TTRA) amended the Alaska National Interest Lands Conservation Act (ANILCA), and designated 12 areas encompassing 726,862 acres to LUD II management areas (Table 3.21-1). On December 19, 2014, the National Defense Authorization Act for Fiscal Year 2015[1] designated eight LUD II management areas (Table 3.21-1), encompassing 151,832 acres for a combined total of 878,694 acres (Table 3.21-1). The goal for LUD II areas is to manage them in a roadless state to retain their wildland character. Minor developments may be compatible with LUD II objectives depending on the specific proposal. Also, access by boats, aircraft, and snowmachines is permitted so long as such uses do not become excessive.

Table 3.21-1
National Forest System Land and Non-National Forest System Land within LUD II Areas

LUD II Area	Acres
LUD II Areas Established by the Tongass Timber Reform Act	
Yakutat Forelands	137,477
Berners Bay	46,314
Anan Creek	38,326
Kadashan	34,124
Lisianski River/Upper Hoonah Sound	147,114
Mt. Calder/Mt. Holbrook	60,066
Nutkwa	21,445
Outside Islands	75,218
Trap Bay	6,471
Point Adolphus/Mud Bay	117,427
Naha	31,546
Salmon Bay	11,334
Subtotal	***726,862***

[1] Public Law No. 113-291, December 19, 2014, 128 Stat. 3729, section 3720(e)(4).

Table 3.21-1 (continued)
National Forest System Land and Non-National Forest System Land within LUD II Management Areas

LUD II Area	Acres
LUD II Areas Established by Public Law 113-291	
Bay of Pillars	20,836
Kushneahin Creek	33,515
Northern Prince of Wales	8,724
Western Kosciusko	8,023
Eastern Kosciusko	1,657
Sarkar Lakes	24,509
Honker Divide	19,809
Eek Lake and Sukkwan Island	34,759
Subtotal	***151,832***
Grand Total	**878,694**

Experimental Forests

Experimental forests provide areas for conducting forest management-related research. Natural resources in experimental forests are used or altered under controlled scientific studies. The Tongass has two experimental forests, Maybeso and Héen Latinee, with a combined area of about 36,264 acres.

Maybeso

The Maybeso Experimental Forest (10,644 acres) was established in the early 1950s as a part of an intensive research program to document the effects of large-scale harvesting on hydrology, fisheries, and timber productivity. The forest is located in a large steep-sided alluvial valley with a south to southeast-facing aspect near the central-eastern coast of Prince of Wales Island. By the early 1960s, most of the suitable forest land on the experimental area had been harvested. Permanent research plots were established and monitored to study hillslope erosion, movement of large woody debris in and through streams, forest regeneration, and silvicultural responses to precommercial thinning. Most of these plots are still monitored. The upper slopes of the Maybeso watershed are included in the Karta Inventoried Roadless Area (IRA) (IRA # 510).

Because nearly all of the old-growth timber on the Maybeso Experimental Forest has been harvested for research, the timber in the area is now primarily young growth. Consequently, while there are limited opportunities to design new old-growth harvest-related experiments, there exists the potential for experiments concerning young-growth timber which is now up to 45 years in age. Several recent young-growth studies have taken place in this area.

Héen Latinee

Héen Latinee Experimental Forest (25,621 acres) was established on June 25, 2009, as a site for coastal temperate rainforest research (USDA Forest Service 2009c). Located 37 miles north of Juneau, the forest extends from temperate rain forests on the shores of Lynn Canal to alpine tundra bordering the Juneau Icefield. The area represents a nearly undeveloped watershed that is readily accessible and provides opportunities to study ecological systems ranging from glacier to marine environments. The Héen Latinee Experimental Forest was established to provide:

1. Lands for conducting scientific research that serves as a basis for the management of temperate rainforests in the Alaska Region of the Forest Service;

2. Opportunities and facilities for the general public, Forest Service staff, and other cooperating organizations such as universities to pursue scientific inquiry and education; and
3. Monitoring data to inform society about the trajectory and speed of climate change.

This Experimental Forest consists of Cowee and Davies Watersheds and is referred to as the Cowee-Davies Experimental Forest in the 2008 Tongass National Forest Land and Resource Management Plan (Forest Plan), Appendix L (USDA Forest Service 2008a).

Young Bay (de-established)

The Young Bay Experimental Forest (6,660 acres) was de-established in 2009 in the Record of Decision (ROD) that established the Héen Latinee Experimental Forest (USDA Forest Service 2009c). The Young Bay Experimental Forest was located just south of Juneau on northern Admiralty Island. Originally selected for long-term hydrologic and fisheries monitoring with a paired comparison between streams, this site was used extensively for fisheries and hydrology research in the 1960s and 1970s. The area is currently managed as Semi-Remote Recreation LUD.

Research Natural Areas

RNAs are part of a national network of ecological areas designated for research and education and/or to maintain biological diversity of representative ecosystems on NFS lands. RNAs are used for non-manipulative research, observation, and study. These areas also may serve to carry out provisions of special acts, such as the Endangered Species Act and the monitoring provisions of the National Forest Management Act.

Current Situation

Six RNAs were established within the Tongass National Forest prior to 1996. One of the six, Pack Creek, was declassified in the ROD for the 1997 Tongass Forest Plan due to a long history of human presence related to viewing brown bears. At the same time, Pack Creek was re-designated as a zoological area to be managed under the Special Interest Area LUD. Seven additional areas were classified as RNAs by the 1997 ROD. That action resulted in the current total of 12 Tongass RNAs incorporating a total area of 66,998 acres. Brief descriptions of each follow below.

Cape Fanshaw RNA

Established in 1965, this 573-acre RNA is located at the junction of Frederick Sound and the Stephens Passage in Roadless Area 201. This area was established to represent undisturbed old-growth yellow-cedar and western hemlock forests. It represents a good example of cedar decline on the mainland, and has been used for long-term monitoring of changes in species composition and stand dynamics.

Dog Island RNA

Established in 1976, this 705-acre RNA is located on Dog Island in Roadless Area 521. The area represents a small island ecosystem containing the northern limit of Pacific yew (*Taxus brevifolia*), associated scrub timber, and low-volume, mixed-conifer sites of southern Southeast Alaska.

Kadin Island RNA

Established in 1997, this 1,630-acre RNA is located just north of Wrangell in Roadless Area 225. Kadin Island experiences high winds blowing down through the Stikine River corridor. The high winds pick up silt from the unvegetated glacial river floodplain and cause the deposition of loess on the island at the river's mouth. The continuing rain of loess onto the upper soil layers provides a supply of unleached, nutrient-rich soil material to the forests of the island. The loess deposition overcomes the process of acid bog formation (paludification) that overtakes most stable sites of moderate topographic relief on the Tongass National Forest. Few areas in the world have a combination of high rainfall and recent loess deposition, so the properties of the soils here are of special interest. The fringe of the island is subject to tidal influence and changes in water level because of shifts of the river. Wetland marsh communities are included in this area. The bald eagle nest concentration on Kadin Island is second only to parts of Admiralty Island, according to the U.S. Fish and Wildlife Service (USFWS).

Marten River RNA

Established in 1997, this 7,459-acre RNA is located within the Misty Fiords National Monument Wilderness adjacent to the Red River RNA. The Marten River RNA contains riparian spruce stands and has excellent habitat for brown bears along its major mainland streams.

Limestone Inlet RNA

Established in 1951 and expanded in 1971, this 8,964-acre RNA is located in Stephens Passage in Roadless Area 302. The area represents typical vegetation types common to the Juneau mainland, including many avalanche chutes and a mainland stream. In 1951, Limestone Inlet was considered the most pristine drainage in the northern mainland coast, making it an excellent area for documenting baseline conditions on the mainland. The Alaska Department of Fish and Game (ADF&G) has altered the native salmon runs since 1980 by operating a hatchery in nearby Snettisham Lake; however, upland areas remain intact.

Old Tom Creek RNA

Established in 1951, this RNA, 4,544 acres in size prior to Public Law 113-291, has been reduced to 1,335 acres or about 30 percent of its original size. Located on central Prince of Wales Island in Roadless Area 519, this RNA is situated in a low-site, cedar-dominated watershed. Established as an example of cedar-hemlock old-growth forest, the RNA also includes some examples of riparian spruce forest, extensive tidal meadows, and dense bald eagle and black bear populations. The RNA also included a U.S. Geological Survey (USGS) gauging station. Prior to the reduction in size, this RNA was functioning as part of a medium old-growth reserve (OGR). Following the reduction, there is no longer a medium OGR. As a result, this area was one of the areas re-evaluated by an interagency team of biologists (Forest Service, USFWS, and ADF&G). The new location for a medium OGR in this area as proposed by this interagency team is discussed in detail in Appendix E.

Red River RNA

Established in 1980, this 8,004-acre RNA is located in Misty Fiords National Monument Wilderness. This RNA represents the northern range of Pacific silver fir (*Abies amabilis).*

Rio Roberts RNA

Established in 1997, this 1,621-acre RNA is located on central Prince of Wales Island in Roadless Area 511. This area contains riparian flood plain spruce stands, upland old-growth and natural young-growth stands, and upland hemlock on drumlin fields. A high level of recreation use occurs in the area, including hiking, camping, boating, and fishing in the Thorne River near this RNA. As a result of Public Law 113-291, the Rio Roberts RNA is now included within the Honker Divide LUD II area.

Robinson Lake RNA

Established in 1997, this 6,473-acre RNA is located in the Misty Fiords National Monument Wilderness. This RNA focuses on a natural slump lake, forest types typical of the southern portion of mainland Southeast Alaska, and some uncommon plants of restricted distribution in Alaska. Robinson Lake formed when a natural earthslide dammed Robinson Creek. The area extends to the shore of Behm Canal to include habitat diversity associated with the shoreline and proximity to deep water.

Tonalite Creek RNA

Established in 1997, this 10,037-acre RNA is located south of Tenakee Springs across Tenakee Inlet in Roadless Area 311. This RNA includes pristine examples of Sitka spruce, western and mountain hemlock, and yellow cedar forest types. The Tonalite drainage is a narrow glacial valley that supports runs of pink, chum, and coho salmon. The drainage is prime brown bear, Sitka black-tailed deer, and beaver habitat.

Warm Pass Valley RNA

Established in 1997, this 8,401-acre RNA is located along the U.S.-Canada border between the Taku River and Chilkat Pass in Roadless Area 301; the valley includes the northernmost example of subalpine fir in Alaska. The valley is also an important area for interior vegetation species that mix with the coastal forest and tundra. The Warm Pass Valley RNA has a unique climate caused by a pronounced rain shadow effect. The valley supports a moose population that uses both the alpine shrub belt and riparian shrubs at lower elevation.

West Gambier Bay RNA

Established in 1997 to replace the Pack Creek RNA, this 11,976-acre RNA is located at the head of the west arm of Gambier Bay in Admiralty Island National Monument-Kootznoowoo Wilderness. The area includes long, narrow Pybus Lake and several smaller lakes; productive wildlife habitat; an anadromous fish stream; and a variety of geological features, including karst. West Gambier Bay contains forest and nonforest vegetation types typically found on the islands of northern Southeast Alaska.

Special Interest Areas

Special Interest Areas are areas possessing unique or unusual scenic, historic, prehistoric, scientific, natural, or other characteristics. The objective of designating and managing such areas is to protect their unique values and, foster public use and enjoyment of these areas. Special Interest Areas may be designated as scenic, recreation, historic, archaeological, geological, botanical, zoological, or paleontological areas. Special Interest Areas differ from RNAs in that management may promote public use as well as scientific study.

Special Interest Area designations are intended to maintain natural to near-natural conditions in most cases; the Recreation Area designation may include developed facilities within a natural or near-natural setting. The resources contained within these areas are not available for development, except for public facilities designed to allow recreation use while protecting the values of the area, or for interpretation and scientific study. Each area may require unique management direction determined through individualized study and planning. Special Interest Areas may be withdrawn from mineral entry. The LUD for Special Interest Areas applies to all the designated areas.

Current Situation

Thirty-four Special Interest Areas have been designated within the Tongass National Forest. Eight of the 34 areas were designated prior to the 1997 Forest Plan:

- Mendenhall Glacier Recreation Area (5,791 acres)
- Ward Lake Recreation Area (440 acres)
- Walker Cove-Rudyerd Bay Scenic Area (93,540 acres)
- Admiralty Lakes Recreation Area (8,710 acres)
- New Eddystone Rock Geological Area (1 acre)
- Hubbard Glacier Geological Area (46,000 acres)
- Tracy Arm-Fords Terror Scenic Area (283,000 acres)
- Naha Recreation Area (2,363 acres)

A further 16 Special Interest Areas, plus one expansion, were identified and designated with the 1997 Forest Plan as follows:

- Arena Cove/Cape Felix Geological Area (9,465 acres)
- Bailey Bay Hot Springs Recreation Area (3,510 acres)
- Blind Slough Scenic and Zoological Area (8,150 acres)
- Blue River Lava Flow Geological Area (13,520 acres)
- Clear River Zoological Area (11,530 acres)
- Duke Island Zoological Area (44,650 acres)
- Falls Creek Windthrow Botanical Area (820 acres)
- Fish Creek Hot Springs Recreation Area (100 acres)
- Karst Areas Geological Areas (multiple areas totaling 13,635 acres)
- Keku Islets Geological and Scenic Area (2,300 acres)
- Mount Edgecumbe Geological Area (49,050 acres)
- North Hamilton River Redcedar Cultural and Botanical Area (80 acres)
- Pack Creek Zoological Area (5,837 acres)
- Patterson Glacier Geological and Botanical Area (13,900 acres)
- Pike Lakes Recreation Area (2,340 acres)
- Soda Springs Geological Area (3,515 acres)
- Ward Lake Recreation Area Expansion (7,535 acres)

The remaining 10 Special Interest Areas were identified and designated in the 2008 Forest Plan. These areas are all geologic areas and most of them contain unique karst features. The 10 geologic areas are described in Appendix L to the 2008 Forest Plan (USDA Forest Service 2008a).

- Big Creek Geological Area (2,000 acres)
- Blake Channel Geological Area (700 acres)
- Calamity Creek Caves Geological Area (200 acres)
- Dall Island Geological Area (13,600 acres)
- Eastern Chichagof Geological Area (23,900 acres)
- Heceta Geological Area (4,100 acres)
- Kosciusko Geological Area (8,700 acres; reduced by 700 acres by Public Law 113-291)
- Northern Prince of Wales Geological Area (2,400 acres; reduced by 400 acres by Public Law 113-291)
- North-Central Prince of Wales Geological Area (700 acres)
- Suemez Island Volcanics Geological Area (7,100 acres)

Eight of the Special Interest Areas are within Wildernesses, National Monuments, or LUD II areas. These areas are managed in a way that accounts for the Wilderness, National Monument, or LUD II area surrounding them. They include the following:

- Admiralty Lakes Recreation Area (Admiralty Island National Monument and Kootznoowoo Wilderness)
- Blue River Lava Flow Geological Area (Misty Fiords National Monument and Wilderness)
- Hubbard Glacier Geological Area (Russell Fiord Wilderness)
- Naha Recreation Area (Naha LUD II)
- New Eddystone Rock Geological Area (Misty Fiords National Monument and Wilderness)
- Pack Creek Zoological Area (Admiralty Island National Monument and Kootznoowoo Wilderness)
- Tracy Arm-Fords Terror Scenic Area (Tracy Arm-Fords Terror Wilderness)
- Walker Cove-Rudyerd Bay Scenic Area (Misty Fiords National Monument and Wilderness)

The Tongass also contains a portion of the 5-acre Fort Durham National Historic Landmark (most of which is on private land).

Special Interest Areas are not considered suitable for timber production, and roads are allowed only if they are compatible with the interpretive goals of a particular area. Other restrictions may be imposed on a case-by-case basis to protect an area's unique values. These could include closures to off-highway (or off-road) vehicle use, and withdrawals from mineral entry. The Mendenhall Glacier, Ward Lake, and Naha Recreation Areas are withdrawn from mineral entry. The need for restrictions for newly designated or expanded areas may be determined during Forest Plan implementation.

Wild and Scenic Rivers

The Wild and Scenic Rivers Act of 1968, as amended, provides a means for recognizing and protecting the "outstandingly remarkable" scenic, recreation, geologic, fish and wildlife, historic, cultural, ecological, and other values of selected rivers. The intent of including a river in the National Wild and Scenic Rivers System is to preserve the free-flowing condition of the river itself, as well as the characteristics of the river's immediate environment for the enjoyment and benefit of present and future generations. The U.S. Congress is responsible for final designation of rivers to be included in the National Wild and Scenic Rivers System.

Rivers are eligible to be considered for inclusion in the National Wild and Scenic River System if they are essentially free-flowing (without major dams, diversions, or channel modifications), and if they possess at least one "outstandingly remarkable" scenic, recreational, geologic, fish and wildlife, historic, cultural, or other similar value. These values should be a unique or exceptional representation for the area studied, and must be related to the river or its immediate environment.

The classification for each eligible stream segment was done according to the criteria in the Wild and Scenic Rivers Act with segments identified as Wild, Scenic, or Recreational Rivers, which are defined as follows:

- Wild River areas are defined as those rivers or sections of rivers that are free of impoundments and generally inaccessible except by trail, with watersheds or shorelines essentially primitive in character and waters unpolluted.
- Scenic River areas are defined as those rivers or sections of rivers that are free of impoundments with shorelines or watersheds still largely primitive and shorelines largely undeveloped, but accessible in places by roads.
- Recreational River areas are defined as those rivers or sections of rivers that are readily accessible by road or railroad, that may have undergone some development along their shorelines, and that may have undergone some impoundment or diversion in the past.

Eligible rivers are further evaluated for "suitability." Generally this analysis considers the appropriateness of Congressional designation as a Wild, Scenic, or Recreational River in light of social and economic values, the resource opportunities enhanced, curtailed, or foregone, and the effect on private lands and other uses of the area. Suitable rivers may be recommended to Congress for designation. If designation occurs, a final boundary is established and a management plan developed.

A total of 26 rivers in central and northern Alaska were designated as components of the National Wild and Scenic Rivers System under ANILCA in 1980, with an additional 12 rivers designated as "study rivers." No rivers in Southeast Alaska or the Tongass National Forest were designated. One of the 12 study rivers is located in Southeast Alaska on the Tongass National Forest. This river, the Situk River, is located near the community of Yakutat.

The Situk River, including the West Fork and Old Situk Creek, was studied in 1983 and was found to possess outstandingly remarkable fish, wildlife, and recreational values of national significance, but was not recommended for designation. The community of Yakutat, the local and regional Native corporations, the Citizens Advisory Council of Federal Areas, the Governor of the State of Alaska, and the Regional Forester on behalf of the Forest Service signed an agreement to recognize each other's responsibility in cooperative management of the Situk River corridor in lieu of designation as a Wild and Scenic River. The Alaska Land Use Council supported development of a management plan for the Situk River, rather than designation as a Wild and

Scenic River (USDA Forest Service 1993) and the Secretary of the Interior formally determined to not recommend designation of the Situk River. The Situk River continues to be managed through a cooperative process.

The National Park Service initiated an evaluation to determine the eligibility of the rivers within the National Parks and Preserves in Alaska. The Alsek River near Yakutat is included in that evaluation. The Tongass National Forest includes the surface and west bank of an 18-mile segment that was found to be eligible and meeting a "Scenic" classification.

The planning process for the 1997 Forest Plan evaluated and identified rivers that could be eligible for inclusion in the National Wild and Scenic Rivers System. There are nearly 900 watersheds on the Tongass National Forest containing some 42,500 miles of perennial stream. As part of this process, all of the rivers and streams on the Forest were examined and evaluated for eligibility for the National Wild and Scenic Rivers System. A total of 300 rivers and streams were initially identified for further study, with 112 of these rivers encompassing a total of 1,394 stream miles subsequently determined to be eligible for consideration as components of the National Wild and Scenic Rivers System. More detail about the process that was used and the individual rivers studied is available in the 1997 Tongass Forest Plan Revision Final Environmental Impact Statement (FEIS) (USDA Forest Service 1997a).

Based on a suitability analysis, the Regional Forester recommended 32 of the 112 eligible rivers for inclusion in the National Wild and Scenic Rivers System as either Wild, Scenic, or Recreational. Appendix E of the 1997 Tongass Land Management Plan Revision Final EIS provides descriptions of each river, and the 1997 ROD contains the rationale for the decision made for each river (USDA Forest Service 1997b, 1997c).

Table 3.21-2
Rivers (Segments) Recommended for Inclusion in National Wild and Scenic River Program in miles

				Outstandingly Remarkable Values						
River Name	**Wild**	**Scenic**	**Rec.**	**Fish**	**Wildlife**	**Recreatio**	**Scenic**	**Hist./Cult**	**Geology**	**Ecology**
Aaron, Oerns, Berg Creeks	-	21	16	X	X	X	X	-	-	-
Anan Creek	17.5	.5	-	X	X	X	-	-	-	-
Blind River	-	-	5	X	X	X	-	-	-	X
Blue River	26	-	-	-	X	-	X	-	X	X
Chickamin River	94	2	-	X	X	X	X	X	X	-
Essowah Lake and Streams	13	-	-	X	X	-	X	-	-	-
Fall Dog Creek (local)	4	-	-	X	X	-	X	X	-	-
Farragut River	29	1	-	X	X	-	X	-	-	-
Gilkey River	9	-	-	-	-	-	X	-	X	-
Glacial River	10	-	-	-	-	-	X	-	X	X
Gokachin-Mirror-Low-Fish Creeks	30	-	-	X	X	X	X	X	-	-
Harding River	-	16	-	X	X	X	-	-	-	-
Hasselborg River and Lakes	24	-	-	X	X	X	-	X	-	-
Kadake Creek	-	-	23	X	X	X	X	X	-	-
Kadashan River	-	8	-	X	X	-	-	-	-	X

Table 3.21-2 (continued)
Rivers (Segments) Recommended for Inclusion in National Wild and Scenic River Program (in miles)

				Outstandingly Remarkable Values						
River Name	**Wild**	**Scenic**	**Rec.**	**Fish**	**Wildlife**	**Recreatio**	**Scenic**	**Hist./Cult**	**Geology**	**Ecology**
Kah Sheets Creek and Lake	5	4	-	X	X	X	-	X	-	-
Katzehin River	10	-	-	X	-	-	X	-	X	-
Kegan Lake and Streams	9	-	-	X	-	X	X	-	-	-
King Salmon River	8	-	-	X	X	-	-	-	-	-
Kutlaku Creek and Lake	2	-	-	X	-	-	-	-	-	-
LeConte Glacier	6	-	-	-	-	-	X	-	X	-
Lisianski River	5	-	-	-	X	-	-	-	-	X
Naha River	17	2	-	X	X	X	-	X	-	-
Niblack Lakes and Streams[1/]	5	-	-	X	-	-	-	-	-	-
Orchard Creek and Lake	10	-	16	X	X	X	X	-	-	X
Petersburg Creek	7	-	-	X	-	X	X	X	-	-
Salmon Bay Lake and Stream	4	2	-	X	X	-	X	-	-	-
Santa Anna Creek - L. Helen	-	4	-	X	-	X	-	-	-	X
Sarkar Lakes	14	3	2	X	X	-	X	X	-	-
Thorne River-Hatchery Creek	-	24	18	X	X	X	X	-	-	-
Virginia Lake and Creek	-	-	9	X	-	X	-	-	-	-
Wolverine Creek-McDonald Lake	6	-	-	X	X	X	-	-	-	-
Total Miles[2]	**359.5**	**87.5**	**89.0**							

Rec. = Recreational river
[1] In November 1998, a non-significant Forest Plan amendment subsequently rescinded the Wild and Scenic River recommendation and associated LUDs for Niblack Lakes and Streams (USDA Forest Service 1999), leaving 31 potential Wild, Scenic, and/or Recreational Rivers
[2] The total miles of recommended Wild River do not include the 5 miles for Niblack Lakes and Streams, which were, as noted above, removed from the recommended list.

Current Situation

Congress has not yet designated any rivers on the Tongass National Forest to be included in the National Wild and Scenic Rivers System. The goal for management of the rivers that were recommended for Wild and Scenic designations is to maintain their outstandingly remarkable values and their free-flowing conditions. The objective is to manage the 31 rivers (or segments), pending designation by Congress as Wild, Scenic, or Recreational Rivers, to maintain the eligibility of the total miles of river for the Wild, Scenic, or Recreational classification.

The 1997 Forest Plan directs that the rivers be managed, within the existing authorities of the Forest Service, to retain their free-flowing character and outstandingly remarkable values. Three LUDs were created for these rivers, one for each classification: Wild River, Scenic River, and Recreational River. The 1997 Forest Plan includes goals, objectives, desired conditions, and specific management prescriptions for each LUD. These are summarized below and described in more detail in the 1997 Forest Plan (USDA Forest Service 1997a).

Wild River LUD. This is the most restrictive of the three LUDs. Scheduled timber harvest and construction of major recreation facilities, roads, and hydroelectric power projects is not allowed. Mining may be allowed or the area may be withdrawn from mineral entry by Congress at the time of designation as a Wild River. Some fish and wildlife habitat enhancements are permitted. This is a Transportation and Utility Systems “Avoidance Area,” but corridors will be

allowed in accordance with ANILCA, Title XI. Twenty-three river segments encompassing a total of 359.5 river miles are currently managed under this LUD (Table 3.21-2).

Scenic River LUD. Hydroelectric power projects are not allowed, but timber harvest is allowed if the adjacent LUD allows timber harvest. Major recreational developments may be compatible with this LUD and minor recreational developments are allowed. The construction of NFS roads is allowed and bridges may occasionally span the river. Mining and some fish and wildlife habitat enhancement are permitted. Like the Wild River LUD, this is a Transportation and Utility Systems "Avoidance Area" but corridors will be allowed in accordance with ANILCA, Title XI. Twelve river segments encompassing a total of 87.5 river miles are currently managed under this LUD (Table 3.21-2).

Recreational River LUD. Although hydroelectric power projects are not allowed, many other management activities are permitted in this LUD. Timber harvest is allowed if the adjacent LUD allows timber harvest. Major and minor recreational developments and NFS roads that make the river easily accessible are allowed. Mining and some fish and wildlife habitat enhancements are permitted. This is a Transportation and Utility Systems "Avoidance Area," but corridors will be allowed in accordance with ANILCA, Title XI. Seven river segments encompassing a total of 89 river miles are currently managed under this LUD (Table 3.21-2).

The LUDs for adjacent land can have significant influence on the management of resources inside Wild, Scenic, or Recreational River LUDs. Many of the corridors designated to the Wild River, Scenic River, or Recreational River LUD are narrow and include the width of the river plus 0.25 mile on each side. The most obvious example of adjacent LUD influence relates to timber, with harvest allowed in Scenic or Recreational River LUDs if it is allowed in the adjacent LUD. A total of 13 miles of recommended river are in this situation. Adjacent LUDs can also more indirectly influence other resources, such as scenery or recreation, particularly in Scenic or Recreational River LUDs. For example, if the surrounding land is designated Remote Recreation where no new roads are allowed, it is less likely that a road will be proposed for a Scenic or Recreational River area. New road construction is not allowed in the Wild River LUD.

Of the 536 miles of recommended Wild, Scenic, or Recreational Rivers, 221 miles of seven rivers (41 percent of the total recommended river miles) are located in Wilderness or National Monument Wilderness. Most of the remaining Wild, Scenic, or Recreational River miles outside of designated wilderness are surrounded by land currently in non-development LUD designations. Although there are differences in specific management prescriptions for each of the LUDs, there are some common directions. In general, non-development LUDs do not permit commercial timber harvest, and new roads are not allowed or are restricted to specific uses. While minor recreational development is consistent with most non-development LUDs, major recreational development is consistent only with Semi-Remote Recreation LUD. Generally, the non-development status and resulting management prescriptions in these adjacent lands tends to reduce the likelihood of development in Scenic or Recreational River LUDs.

Environmental Effects

Direct and Indirect Effects

Timber Harvest

There is no proposed old-growth harvest activity within special LUDs under any alternative. Any effects from old-growth harvest would be indirect effects associated

with changes in areas adjacent to special LUDs. Alternatives 2 and 3 include young-growth harvest activity in a subset of special LUDs, including Special Interest Areas and Recreational and Scenic Rivers. The acreage of land suitable for young-growth timber production would be similar under both alternatives (Table 3.21-3). Alternatives 1, 4, and 5 do not include lands suitable for timber production for young-growth harvest in these areas; timber production would continue to be an allowed activity under the Forest Plan in Special Interest Areas and Recreational/Scenic River LUDs if they are adjacent to a Development LUD.

Table 3.21-3
Estimated Maximum Acres (with Full Plan Implementation) of Young-Growth Timber Harvest in Special LUDs by Alternative[1]

	Maximum 25-Year Harvest (acres)			Maximum 100-year Harvest (acres)		
Alternative	Special Interest Area	Recreational River	Scenic River	Special Interest Area	Recreational River	Scenic River
2	705	329	94	3,705	1,729	493
3	617	229	71	3,596	1,337	416

[1] No harvest is proposed in experimental forests, research natural areas, or LUD II areas.
[2] No harvest is proposed in Special Interest Areas or Recreational River or Scenic River LUD under Alternatives 1, 4, and 5. However, if a Special Interest Area or Recreational/Scenic River LUD is adjacent to a Development LUD, then timber harvest is an allowed activity.

LUD II Areas
There would be no land suitable for timber production for old- or young-growth harvest in LUD II areas under any alternative. Any potential effects of harvest would be indirect effects associated with changes in areas adjacent to LUD II areas. Depending on the location and extent of harvest, there could be edge-related effects, increasing the potential for impacts to portions of LUD II area boundaries. Such impacts could include introduced non-native or invasive plant species, vulnerability to windthrow events, noise from harvest activities, reduced scenic quality, and unauthorized recreation access. The effects of proposed harvest projects on LUD II areas would require assessment under the National Environmental Policy Act (NEPA).

Experimental Forests
There would be no land suitable for timber production for old- or young-growth harvest within experimental forests under any alternative. Any potential effects of harvest for commercial purposes would be indirect effects associated with changes in areas adjacent to the two experimental forests. Limited timber harvest could continue to occur within the experimental forests as part of approved research projects.

Research Natural Areas
There would be no land suitable for timber production for old- or young-growth harvest areas within RNAs under any alternative. Any potential effects of harvest would be indirect effects associated with changes in areas adjacent to RNAs. Indirect effects would be similar to those described above for LUD II areas.

Special Interest Areas
Alternatives 2 and 3 include acres that are suitable for harvest in Special Interest Areas. The 25-year and 100-year maximum young-growth harvest scenarios under Alternative 2 are 705 acres and 3,705 acres; the corresponding numbers for Alternative 3 are 617 and 3,596 acres (Table 3.21-3). These totals represent a small fraction of the total acreage dedicated to Special Interest Areas.

Potential direct effects to individual Special Interest Areas from proposed specific young-growth harvest would be subject to additional analysis under NEPA.

Alternatives 1, 4, and 5 do not include any lands suitable for timber production for young-growth harvest within Special Interest Areas; however, timber production would continue to be an allowed activity if the adjacent LUD is a Development LUD. This would also be the case with Alternatives 2 and 3. Further, limited salvage harvest is allowed in some Special Interest Areas. Any proposed harvest would be subject to additional analysis under NEPA.

The acreage of the Special Interest Areas is sufficient to include and protect the resources of interest for each respective unit. Therefore, none of the alternatives are expected to result in indirect effects associated with harvest activities that might occur adjacent to Special Interest Areas.

Wild and Scenic Rivers

All five alternatives include the Wild, Scenic, and/or Recreational River LUD designation recommendations for the 31 existing river segments designated as potential Wild, Scenic, and/or Recreational Rivers under the 2008 Forest Plan, and at their current respective acreages. These river segments would continue to be managed to protect the outstandingly remarkable values that make them eligible for designation as Wild, Scenic and/or Recreational Rivers by Congress.

Alternatives 1, 4, and 5 do not include any acres of suitable forest land for young-growth harvest within Wild, Scenic, or Recreational River LUDs. No acres of suitable forest land are proposed within Wild River LUDs under any alternative. In Scenic and Recreational River LUDs, timber production would continue to be an allowed activity in areas where the adjacent LUD is a Development LUD. Any proposed harvest would be subject to further analysis under NEPA.

Alternatives 2 and 3 include acres suitable for young-growth harvest within Recreational River and Scenic River LUDs. The 25-year and 100-year maximum young-growth harvest scenarios in Recreational River LUDs under Alternative 2 are 329 acres and 1,729 acres; the corresponding numbers for Alternative 3 are 229 and 1,337 acres (Table 3.21-3). The 25-year and 100-year maximum young-growth harvest scenarios in Scenic River LUDs under Alternative 2 are 94 acres and 493 acres; the corresponding numbers for Alternative 3 are 71 and 416 acres (Table 3.21-3). The presence of suitable acres for young-growth harvest does not guarantee harvest will take place in the future. Actual harvest locations will depend on the specific purpose and need for future harvest, and would be sited to avoid or minimize conflicts with Forest Plan standards and guidelines. Effects from harvest could include reduced scenic quality and recreation access restrictions, particularly during active harvest operations. Site-specific effects to Recreational or Scenic River segments from proposed young-growth harvest would be subject to further analysis under NEPA.

The majority of Wild, Scenic, or Recreational River miles are located in areas surrounded by land in non-development LUDs or designated Wilderness and National Monument Wilderness. Timber harvest is not generally allowed in the non-development LUDs, and new roads are not allowed or are restricted to specific uses. Therefore, none of the alternatives are expected to result in indirect effects associated with harvest activities in most parts of Wild, Scenic, or Recreational River LUDs. For the 13 miles of Scenic or Recreational Rivers adjacent to LUDs where harvest is allowed, indirect effects could occur if the proposed harvest is visible to visitors or otherwise impedes use of the area for its scenic or recreational purpose.

Renewable Energy

Alternative 1 (no action) would continue the current Transportation and Utility System (TUS) LUD system, under which all special LUDs are considered TUS "Avoidance Areas" and where feasible would be avoided through site-specific analysis during project-level planning. Under Alternatives 2 through 5, energy direction in Chapter 5 of the Forest Plan would be applied to the LUDs, similar to how the Forest-wide standards and guidelines in Chapter 4 of the Forest Plan are applied to the LUDs. This is discussed in more detail in the *Renewable Energy* section of this EIS.

The Forest Service has identified 11 proposed renewable energy projects in Southeast Alaska that are active (Table 3.12b-3). None of these projects are located within, or in the vicinity of, any special LUD areas. Should a project be proposed in the future that could affect a special LUD, it would be subject to further analysis under NEPA.

Cumulative Effects

Under all alternatives, there would be no change in the number of units or acres with special LUDs and no direct or indirect effects from proposed renewable energy projects. Under Alternatives 1, 4, and 5, there would be no land suitable for old-growth or young-growth timber production in special LUDs. Timber production would continue to be an allowed use if the adjacent LUD is a Development LUD. As a result, there may be cumulative effects associated with special LUDs under these alternatives if harvest is proposed at a future time. Cumulative effects of any harvest in special LUDs would be further assessed during a project-specific NEPA review process.

The main difference for Alternatives 2 and 3 are the lands suitable for timber production for young-growth harvest in Special Interest Areas and Scenic and Recreational River LUDs discussed above. The presence of land suitable for timber production does not guarantee that harvest will take place. In addition, no other reasonably foreseeable projects in special LUDs are known at this time. Given current management goals and regulatory protections in place for special LUDs, the potential for cumulative effects is considered low.

Appendix C of this FEIS provides a full list of all the projects considered in the cumulative effects analysis.