Snow River Landscape Assessment

Prepared by the
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SNOW RIVER LANDSCAPE ASSESSMENT
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1 Introduction

1.1 Purpose

A Landscape Assessment is a broad level ecosystem analytical tool intended to provide context and information regarding the effects and impacts that management decisions may have on the ecosystem. Its purpose is to guide land management decisions and provide a means of refining the desired conditions of the landscape given the goals and objectives, management prescriptions, and standards and guidelines from the Chugach National Forest Land and Resource Management Plan (USDA Forest Service, Chugach National Forest, 2002a), as well as current policy and other applicable state and federal regulations. A Landscape Assessment is an intermediate step between the Forest Plan and project planning, and serves as a basis for developing project-specific recommendations and determining restoration and monitoring needs within the analysis area.

The structure of this landscape assessment is based on “Ecosystem Analysis at the Watershed Scale: A Federal Guide for Watershed Analysis,” a publication produced by a variety of agencies, governments, and organizations (Regional Interagency Executive Committee, 1995). The analysis is driven by a set of issues and key questions for a specific watershed. This type of analysis is not a decision-making process, but uses existing data and information to establish the context for project-specific decisions.

This document is divided into the following eight sections, which parallel the suggested structure in the federal guide for watershed analysis (Regional Interagency Executive Committee, 1995):

- 1.0 Introduction
- 2.0 Watershed Characterization
- 3.0 Key Issues and Questions
- 4.0 Current Conditions
- 5.0 Reference Conditions
- 6.0 Synthesis and Interpretation
- 7.0 Desired Condition, Opportunities, Management Strategies, Data Gaps, Monitoring and Research Needs
- 8.0 Recommendations

The following topics are discussed within each of these sections:

- Lands
- Geology, Minerals, and Soils
- Hydrology
- Vegetation and Ecology
- Fire
- Aquatic Species and Habitats
- Terrestrial Species and Habitats
- Human Uses: Past and Present

1.2 The Analysis Area

The Snow River Watershed lies on the eastern Kenai Peninsula, about 60 miles southeast of Anchorage, Alaska, and just northeast of Seward, AK (Figure 1.1). With a drainage area of approximately 104,564 acres (163 square miles), the watershed lies within the Kenai Mountains and comprises the headwaters of the Kenai River. The watershed is characterized by a glacially sculpted valley flowing southwest, then north into Kenai Lake and the Kenai River.

The Snow River Watershed lies on the Seward Ranger District of the Chugach National Forest. Nearly the entire watershed is undeveloped backcountry, and activities within the watershed are limited by difficult access and a limited number of maintained trails. The Seward Highway and the Alaska Railroad cross the lower portion of the watershed, providing recreational access to the western portion of the watershed. The upper portion of the watershed is accessible by floatplane to Paradise Lakes. Skiing, hiking, hunting, fishing, and snowmachining are some of the activities that take place in the watershed, and two well-used Forest Service public-use cabins are located at Paradise Lakes.

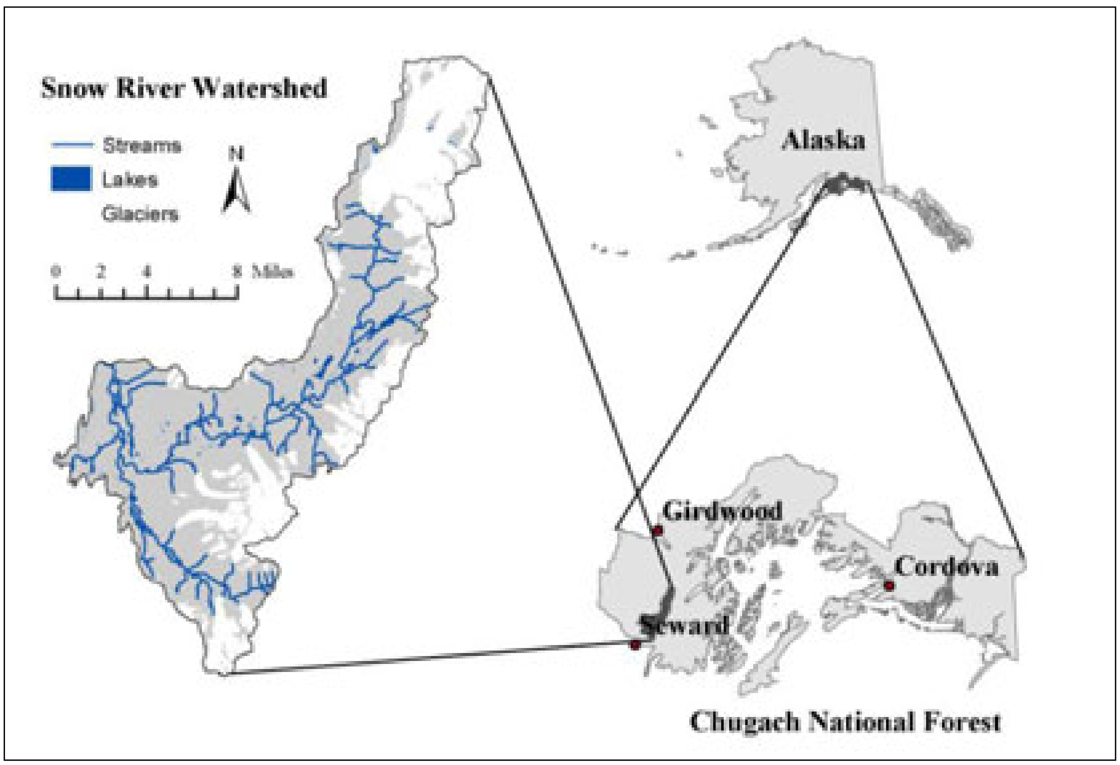

Figure 1.1. Location of the Snow River Watershed.

2 Watershed Characterization

2.1 Lands

The Snow River Watershed covers approximately 104,564 acres of highly scenic, mountainous topography. Glaciers cover the northern and eastern portions of the watershed. The Snow River flows to the southwest through a steep-walled valley for about 16.5 miles from Paradise Lakes at 1400 feet in elevation to Kenai Lake at 436 feet in elevation. Peaks and ridges along the valley rise to over 4500 feet.

The majority of the land ownership in the Snow River Watershed is held by the Forest Service (102,004 acres). A variety of land ownerships exist along the Seward Highway corridor in the western portion of the watershed (Figure 2.1).

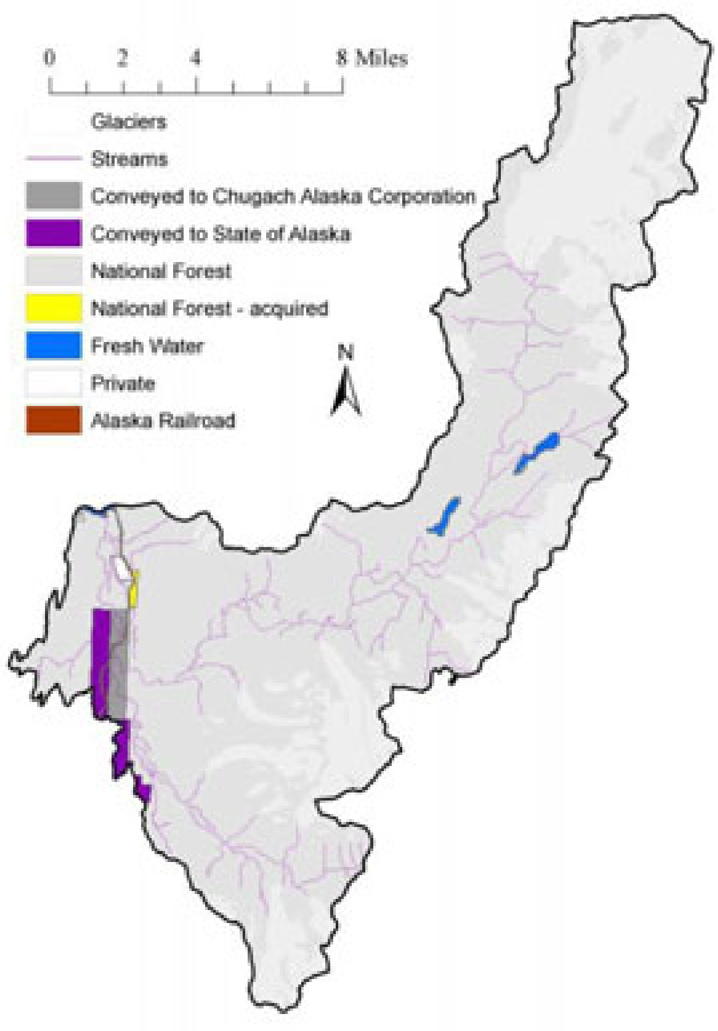

Figure 2.1. Land ownership in the Snow River Watershed

The Alaska Railroad Corporation (ARRC) owns 156 acres along the railroad corridor, the State of Alaska owns 1334 acres along the lower Snow River, Chugach Alaska Corporation (CAC) owns 892 acres along the lower Snow River, and a 179-acre private parcel exists near the mouth of the Snow River.

2.2 Geology, Minerals, and Soils

2.2.1 Geology

Regional Geology

The assessment area lies within the Upper Cretaceous Valdez Group metamorphic sequence of rocks (Tysdal and Case, 1979) (Figure 2.2). This group crops out in the western and northern portions of the Chugach National Forest as an arcuate-shaped band of rocks consisting primarily of a slightly metamorphosed, steeply dipping, marine clastic (flysch) sequence. These rocks formed from sediments deposited by turbidity currents in a marine environment. Later they were swept into a subduction trench and metamorphosed. Winkler et al. (1984) reported that the deformation and metamorphism of the Valdez Group occurred between 65 and 50 million years ago. These rocks are speculated to have accreted to the southern Alaska mainland during late Cretaceous and early Tertiary time (Hoekzema, 1986). The thickness of the Valdez Group is unknown, but is believed to be at least several miles thick.

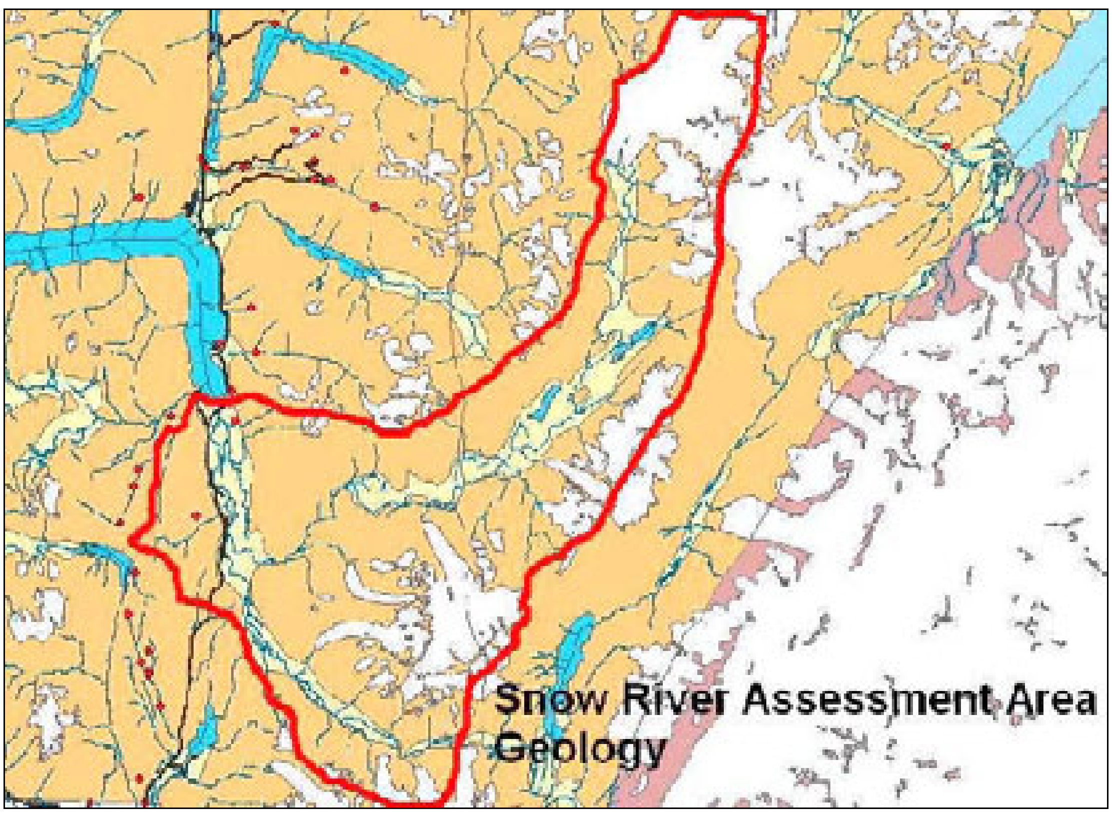

Figure 2.2. Geology Map of the Snow River Assessment area, showing mineral prospects and occurrences (red dots 1 (S-219) and 2 (S-210)).

Two prominent sets of faults occur in Valdez Group rock. Regionally, the most apparent occur as relatively widely spaced (several miles) north-northeast striking steeply west-dipping, longitudinal faults. These faults are diagonal-slip faults. The other prominent set of faults is the smaller, closely spaced (hundreds of feet) parallel faults (shear zones) that are recognized throughout the area. Locally, older faults occur as relatively closely spaced (50 to 500 feet) west- to northwest-striking, steeply dipping transverse faults.

2.2.2 Minerals

Mineral occurrences in the Snow River watershed are located in the western portion south of Kenai Lake. The Devils Club Ledge contains quartz and arsenopyrite. The Lakeside prospect contains quartz, arsenopyrite and pyrite (figure 2.2).

2.2.3 Soils

Geologic and Geographic Setting
The bedrock geology of the study area is dominated by undifferentiated sedimentary rocks consisting primarily of graywacke, sandstones, siltstones, and slate (Figure 2.2). They are part of the Valdez Group, which together with the McHugh Complex make up the Chugach Terrane. The terrane is part of an assemblage of arcing terranes that were driven onto the North American Continent late in the Cretaceous Period resulting in uplifting and consequently the formation of the Chugach-Kenai Mountains (Kelly, 1985).

The majority of the soils in the study area are forming on surficial deposits of colluvium, alluvium, till and glacial outwash. The Snow River and the South Fork Snow River run through glacially carved valleys which are underlain by compact glacial till, particularly the mountain sideslopes. In some areas, landslides and avalanches deposit colluvial material on footslopes, and the valley bottoms are overlain with stream and glacial deposits. These materials will strongly influence the type of soils that develop on them which will aid in providing a general overview of the soils distributed throughout the study area. On-site soil investigations have been limited to areas within two miles of either side of the Seward Highway. Consequently, soils information for areas farther upstream and upslope into the alpine region are limited to generalizations associated with landtype position.

Landtype Association and Soils
The Landtype Association (LTA) is part of the National Hierarchal Framework that is used to delineate landscapes on the Chugach National Forest. Ecological units at this level are defined by the “geomorphic process and how it affects the topography, surficial geology, local climate, soils, and potential natural plants community patterns” (Davidson, 1997). Soils in the study area can be described in terms of where they lie on the landscape. This is because the geomorphic processes that formed the different landtypes are intricately related to the pedogenic processes that formed the soil on those sites (Soil Survey Division Staff, 1993). Soil mapping units and their descriptions will be provided if they have been developed for particular landtypes in the study area. The mapping units represent the major types of soils typically found on those sites based on survey work done throughout the Chugach National Forest by Davidson (1989) and Davis et al. (1980).

Erosion Processes

Erosion processes can be evaluated in terms of landslides, surface erosion, and streambank erosion. Landslides are not common in the study area, but there are critical slope stability factors that have to be evaluated when management activity is considered. Sites are evaluated based on their slope, topographic position, and any subsurface restrictions. These criteria are individually rated, and the total score for a particular site can be used as an indication of its stability. Surface erosion is normally not a problem in areas as well vegetated as the study area with the exception of recently exposed surfaces. Recently exposed areas can be found where there is continual frost shattering and sloughing off material at the higher elevations. Avalanches can also remove the protective cover that vegetation provides and contribute to surface erosion. The dominant erosion processes are those related to natural stream migration, flooding and avalanches. Disturbance from human activity is limited to areas near the Seward Highway, railroad tracks, and powerline maintenance roads. Particularly susceptible are the wetlands since these landscape features are usually associated with the low-lying transportation corridors (Figure 2.3).

2.3 Hydrology

2.3.1 Climate

The climate of the Snow River Watershed is cool and moist. The average daily temperature at the mouth of the watershed is approximately 36 degrees F, decreasing dramatically with elevation. The average maximum July temperature at Moose Pass reaches about 67 degrees F, and the average minimum January temperature is about 6 degrees F (Table 2.1) (Western Regional Climate Center, 2005).

Table 2.1. Climate statistics for weather stations near the Snow River Watershed.

		Moose Pass 3 NW	Seward
Location	Elevation (ft)	480	40
	Latitude	60º30'	60º07'
	Longitude	149º26'	149º27'
	# of years of data	47	54
Temp	Average Daily Temp (F)	35.6	39.9
	Average Max July Temp (F)	66.6	62.3
	Average Min Jan Temp (F)	6.2	20.4
Precip	Average Annual Precip (in)	28.2	68.2
	Average Annual Snowfall (in)	82.1	83.2
	Average Jan snowpack depth (in)	13	6
	Average March snowpack depth (in)	15	7
Weather Station data from Western Regional Climate Center (2005)			

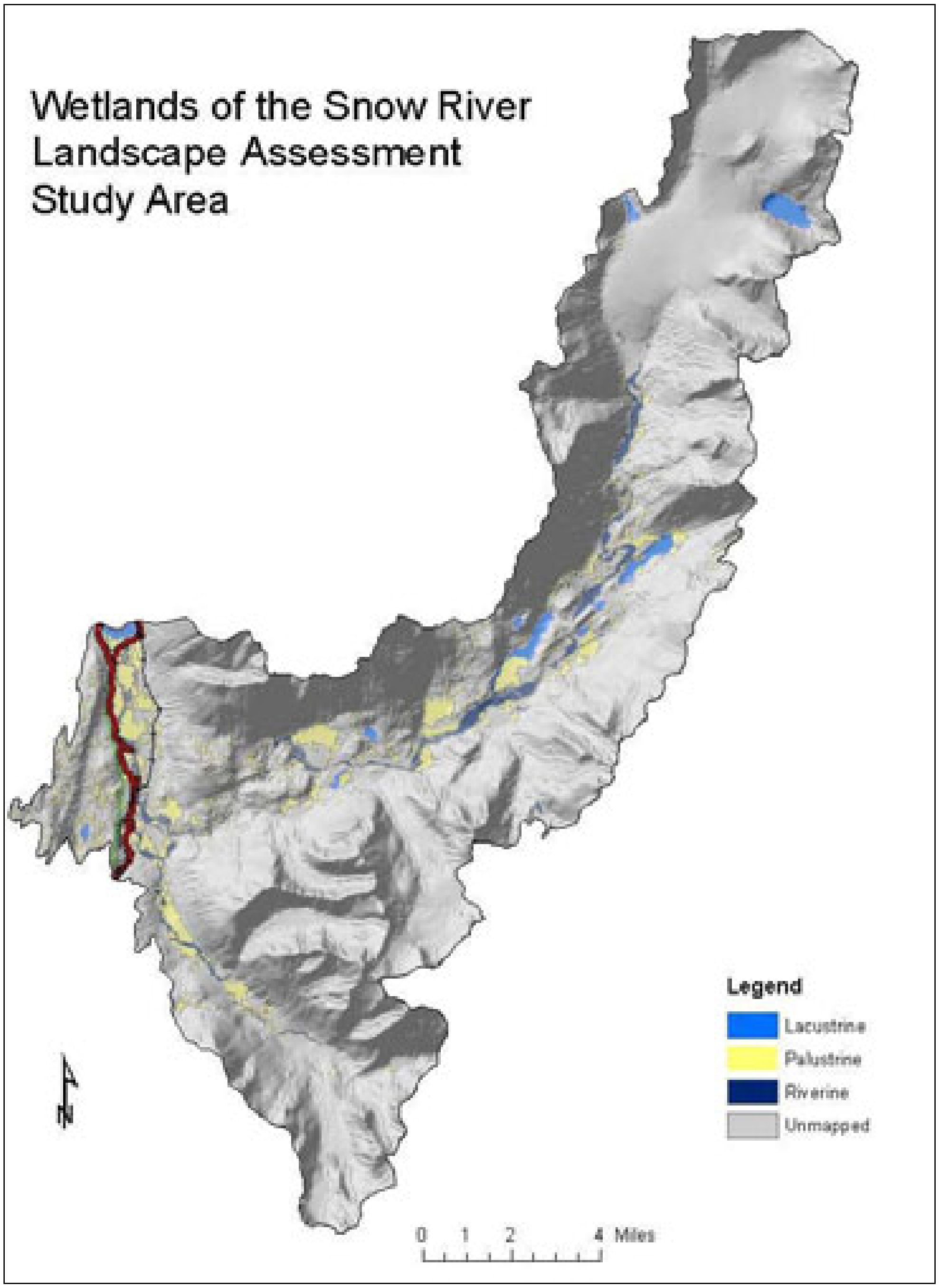

Figure 2.3. Wetland type and distribution in the Snow River Watershed.

Precipitation increases dramatically in the watershed with elevation. Because storms typically circulate in a counterclockwise direction in the Gulf of Alaska, storms generally approach from the east. The high elevation portions of the watershed to the east receive abundant precipitation, whereas the lower elevation areas to the west are in the rain shadow of the Kenai Mountains. Average annual precipitation ranges from less than 40 inches at the mouth of the watershed to over 160 inches in the high elevations, where glaciers are abundant (Figure 2.4). Rainfall is the heaviest in the fall months, and winter months receive more precipitation than summer months.

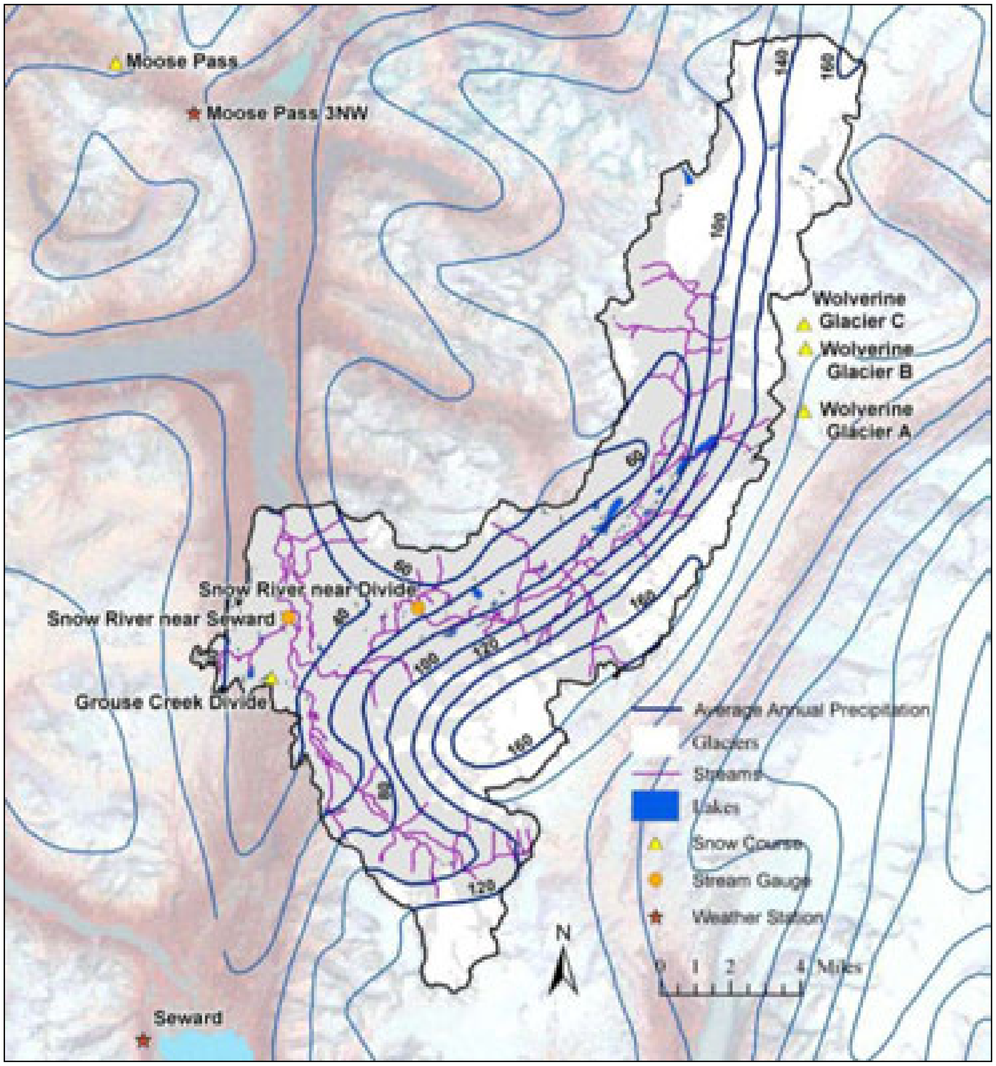

Figure 2.4. Average annual precipitation for the Snow River Watershed.

Snowpack and snowfall in the Snow River Watershed increase dramatically with elevation and to the east. Average February 1 snowpack depths range from 38 inches at Grouse Creek Divide in the lower watershed to as much as 200 inches at high elevations on Wolverine Glacier, just east of the watershed (Table 2.2). Snowfall at the mouth of the watershed accounts for about 30% of the total annual precipitation. The head of the watershed receives very heavy snowfall, contributing to numerous glaciers and accounting for over 60% of the total annual precipitation.

Table 2.2. Snow data for the Snow River Watershed.

		Grouse Creek Divide	Moose Pass	Wolverine Glacier A	Wolverine Glacier B	Wolverine Glacier C
Location	Elevation (ft)	700	700	1950	3610	4430
	Latitude	60º16'	60º31'	60º23'	60º25'	60º25'
	Longitude	149º21'	149º30'	148º55'	148º55'	148º55'
	# of years of data	21	33	21*	19*	20*
Precip	Average Feb 1 Snow Depth (in)	38	18	100	146	199
	Ave. Feb 1 Snow Water Equivalent (in)	12.4	4.4	46.3	63.5	85.6
	Average April 1 Snow Depth (in)	61	21	93	169	230
	Ave. April 1 Snow Water Equivalent (in)	19.7	6.5	37.3	67.5	98.4
	Maximum snowpack of record (in)	85	45	193	275	472
	Max. Snow Water Equiv. of record (in)	36	16.8	104.3	126.8	212.6
	Average annual precipitation (in)	60	-	-	-	-

*Snow data from USDA Natural Resources Conservation Service (2005). * Limited data available each year.*

2.3.2 Watershed Morphometry

The Snow River Watershed Association is about 30 miles long and drains an area of 104,564 acres (163 square miles). The watershed association lies within the Snow River 5th-level watershed, and the Upper Kenai Peninsula 4th- level watershed. The valley of the northern (main) fork of Snow River flows southeast and ultimately empties into a broader valley, where the South Fork Snow River joins it from the south. The South Fork Snow River drains a smaller, 10-mile long subwatershed. The lower Snow River then flows north into Kenai Lake. Elevations range from 436 feet at Kenai Lake to about 5500 feet in the northern headwaters of the watershed, and 6000 feet at Paradise Peak in the southern portion of the watershed.

Lakes cover 993 acres, or 0.9% of the watershed. The most prominent lakes are Upper and Lower Paradise Lakes, covering 215 and 163 acres, respectively. These lakes occupy bedrock basins scoured out by past glacial activity. Numerous other small lakes exist throughout the valley floor, and several small lakes also exist in the western end of the watershed. A 2-mile long by 0.5-mile wide basin on the eastern side of Snow River Glacier creates a glacially dammed lake that fills and releases as a glacial outburst flood every 2 to 4 years.

Winter avalanches commonly occur on the steep sideslopes of the valley and in the headwaters of the Snow River. A large avalanche and mudslide at Mile-18 at the head of Kenai Lake impacted the Seward Highway and Alaska Railroad in 1977 resulting in reconstruction of the highway further from the sideslope (March and Robertson, 1982). Numerous alluvial fans exist along tributary streams at the bases of the steep valley sides. The Alaska Railroad crosses a substantial fan along the lower Snow River Valley.

2.3.3 Glaciers

The Snow River Valley was sculpted by several major glacial episodes in the Pleistocene. At this time, glaciers filled the entire valley. As a result of the extensive past glaciations, the valley has a relatively flat bottom and the valley sides are oversteepened. The main Snow River Valley is a hanging valley, dropping steeply at its terminus before its confluence with the South Fork Snow River. As a result of post-glacial fluvial erosion following glacial recession, the Snow River has incised into a steep, 4-mile long, narrow gorge as it descends from the hanging valley.

Currently, about 31,600 acres, or 30% of the Snow River Watershed is covered by glaciers. The most prominent glacier is the 13,700-acre Snow River Glacier, filling the northern headwaters of the watershed and creating the source of the Snow River. Numerous other glaciers occupy the eastern side of the watershed but do not reach the valley bottom. Several glaciers also exist in the South Fork Snow River subwatershed. Glacial outburst floods, also known as jökulhlaups, originate from a glacially dammed lake adjacent to the Snow River Glacier and have occurred regularly on the Snow River over the past century. These events occur every 2 to 4 years, generally in the late fall or early winter. The origin of the floods is a 2-mile long, 0.5-mile wide and 450-foot deep lake basin on the east side of the Snow River Glacier (Figure 2.5). This basin is in an unglaciated side-valley that collects rain and snowmelt runoff. When the level of the lake reaches about 90% of the height of the ice dam, the ice dam begins to float, allowing water from the lake to work its way into the glacier and create a sub-glacial conduit that connects with a main channel beneath the glacier. As the lake drains, the tunnel enlarges and the discharge increases. After the lake drains, the tunnel collapses on itself, and the process begins again. The lake always drains subglacially well before it would begin to drain out the other side of the side valley.

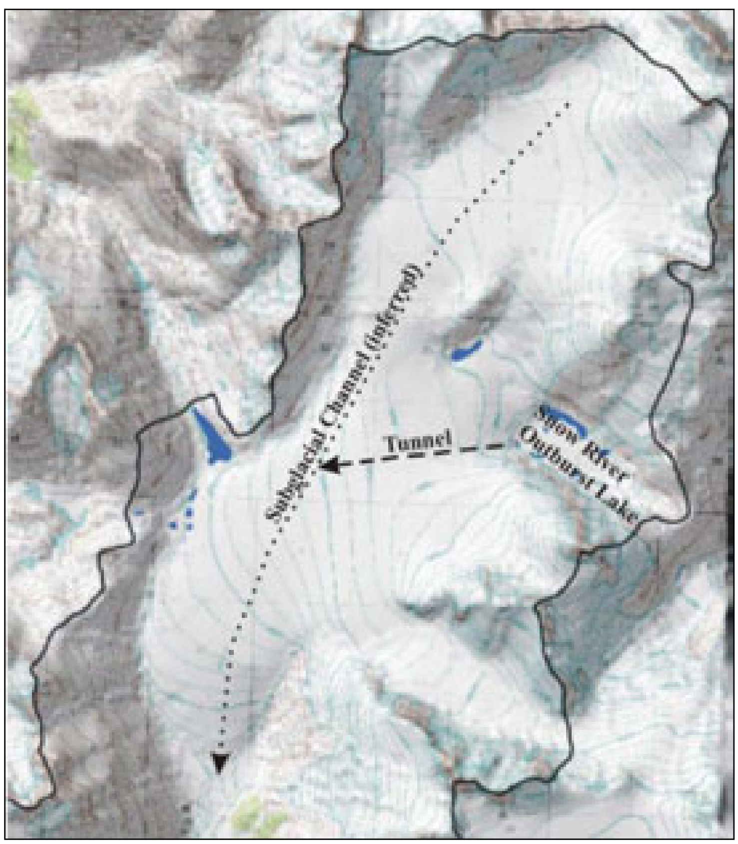

Figure 2.5. Dynamics of the Snow River glacial outburst system.

2.3.4 Streams

A total of about 130 miles of mapped streams lie in the Snow River Watershed (Figure 2.6). Channel types were assigned based on the Tongass National Forest Channel Type User Guide (USDA Forest Service, Alaska Region, 1992).

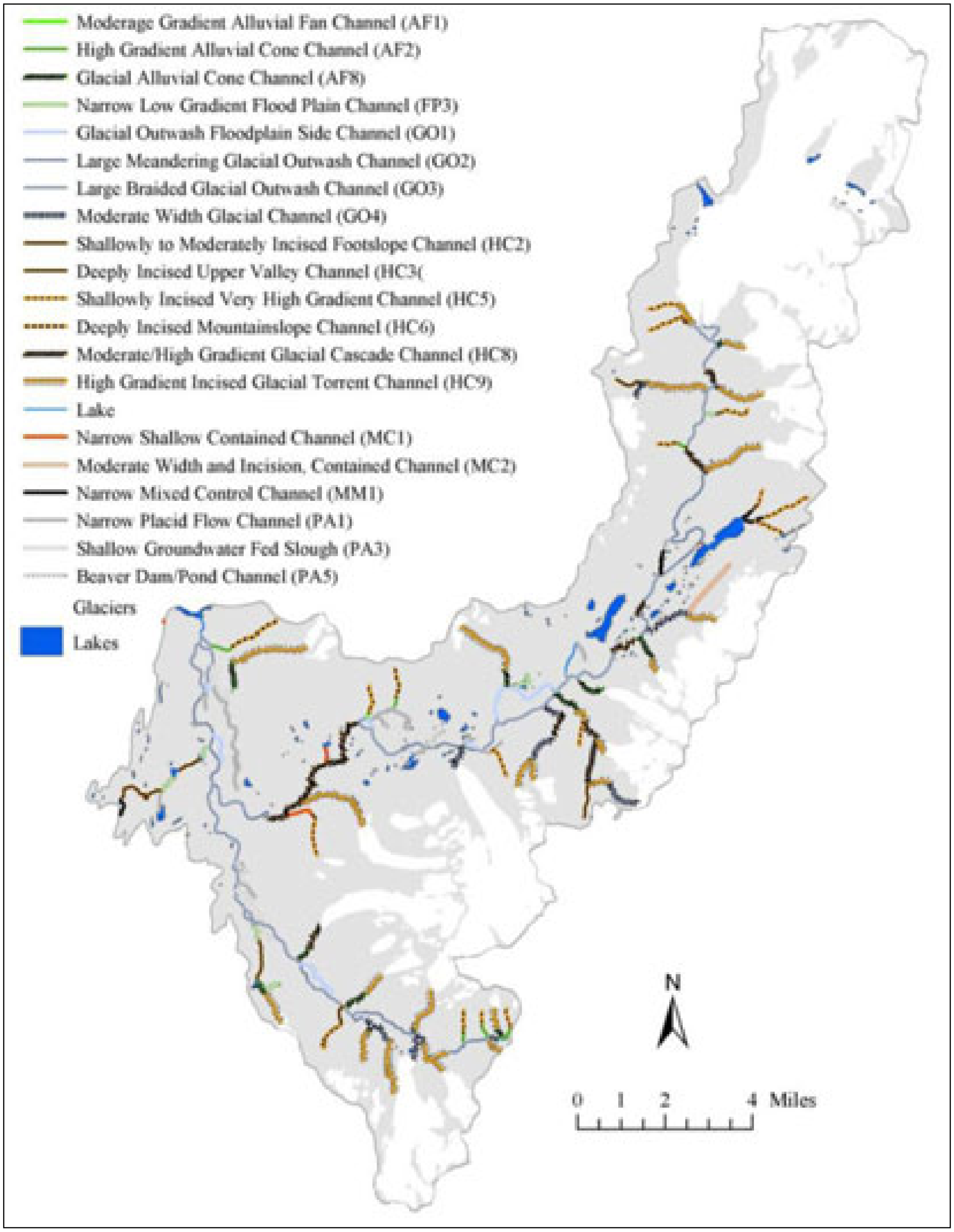

Figure 2.6. Stream channel types in the Snow River Watershed. Data from USDA Forest Service.

About 38% of the streams are Glacial Outwash (GO) channels, draining the numerous glaciers in the watershed. Most of the length of the Snow River is a Glacial Outwash channel. Another 38% of the streams in the watershed are High Gradient Contained (HC) channels, draining the steep valley sides throughout the watershed. The gorge of the Snow River at the end of the hanging valley is also a High Gradient Contained channel. Palustrine (PA) channels comprise 10% of the streams, in the flat valley floors. Alluvial Fan (AF), Floodplain (FP), Moderate Gradient Contained (MC), and Moderate Gradient Mixed Control (MM) channels also exist within the watershed. A subglacial channel is assumed to exist beneath the Snow River Glacier. Flood flows from the Snow River Glacier outburst floods follow this channel.

The lower Snow River is a wide, braided channel with a wide floodplain and numerous clear-water sloughs and tributaries. Beaver dams are common in this area. High flows from Snow River outburst floods can cause considerable channel erosion and migration on the low gradient portions of the Snow River, and particularly on the lower Snow River upstream of Kenai Lake. Dynamic shifting meanders and braided channels are common where the valley morphology allows for channel migration. Bank erosion in these areas can occur rapidly, and debris washed down into the lower Snow River includes large sediment, trees, river ice, and glacial ice. Sediment deposition and debris jams can contribute to increased dynamic changes in channel morphology.

2.3.5 Wetlands

Wetlands cover 7710 acres, or 7.4 % of the Snow River Watershed (Figure 2.3). More than half of these wetlands are palustrine wetlands, or areas associated with swamps, bogs, ponds, beaver ponds, and floodplains. Palustrine wetlands are particularly prominent along the middle portion of the Snow River Valley and in the floodplain at the mouth of the lower Snow River at Kenai Lake. Numerous scattered palustrine wetlands lie in the lower watershed west of the Snow River. Lacustrine wetlands, or wetlands associated with lakes, cover 1084 acres and include Upper and Lower Paradise Lakes, as well as other small lakes. About 2376 acres of riverine wetlands exist along much of the length of the Snow River. Wetlands are absent in the uplands of the watershed, where steep slopes, glaciers and alpine areas are predominant.

2.3.6 Streamflows

Continuous daily streamflow data since 1997 are available for the lower Snow River, discontinuous data are available for 1970 through 1977, and 5 years of streamflow data exist for the northern fork of the Snow River from 1960 to 1965 (US Geological Survey, 2005). Additionally, Snow River outburst flood magnitudes have been monitored since 1949 (National Weather Service, Alaska-Pacific River Forecast Center, 2005). Streamflows are controlled primarily by glacial melt, although snowmelt, rainfall, and glacial outburst flood events also have considerable impacts on the hydrograph.

Spring snowmelt runoff generally begins in early May, and flows gradually rise during the summer (Figure 2.7). Summer peak flows as a result of glacial melting generally occur in August, with typical flows of about 3000 to 4000 cfs, during the peak of glacial melting. Extreme flood events occur in September, October, and November, as a result of fall rainstorms and glacial outburst flood events. These peak flows greatly exceed the summer peak flows during glacial melting, with rainfall peaks exceeding 10,000 cfs and glacial outburst floods ranging from 7,000 to 30,000 cfs. Rainfall peaks generally last 2 to 4 days, whereas glacial outburst events last up to 2 weeks. Rainfall and glacial outburst flood events can be greatly amplified if they occur together, or during periods of high flows from glacial melting. Winter flows during January, February, March, and April remain very low, less than 500 cfs, as a result of freezing in the glacier.

Outburst flood events from the Snow River Glacier have occurred every 2 to 4 years since 1949. Outburst floods likely occurred prior to 1949 from a different location on the glacier. Estimated flows have been recorded for each of these events, ranging from 7,300 to 29,600 cfs, and averaging about 16,600 cfs (National Weather Service, Alaska-Pacific River Forecast Center, 2005) (Figure 2.8).

These events generally occur in September, October, or November, although some events have occurred as early as July or as late as December. The floods generally last about 10 to 14 days, with the discharge gradually increasing during the course of the flood to a peak discharge near the end of the event.

Figure 2.7. Average daily streamflows for the Snow River, USGS Station 15243900. Period of record 4/1/97 to 9/30/03 (US Geological Survey, 2005).

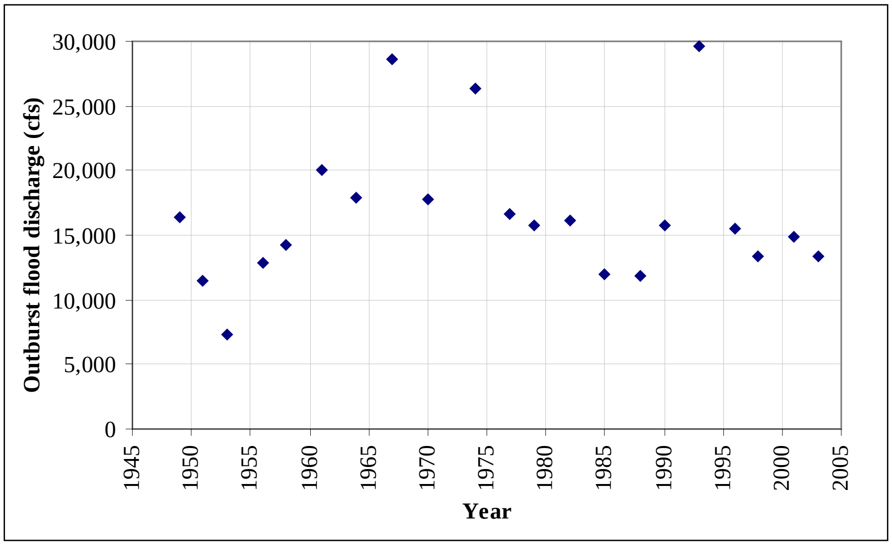

Figure 2.8. Snow River outburst flood estimates between 1949 and 2003. Data from National Weather Service, Alaska-Pacific River Forecast Center (2005).

2.3.7 Water Quality

With the scarcity of development and human activities in the analysis area, water quality is generally not affected by human activities. Because of the large percentage of the watershed that is glaciated, sediment loads and turbidity are high in the Snow River during the summer and fall. Outburst events are capable of eroding banks, moving large quantities of debris and sediment, and carrying large pieces of ice from the glacier. Existing water quality data for the Snow River from 1951 to 1970 meet Alaska State standards (Alaska Department of Environmental Conservation, 2003).

2.4 Vegetation and Ecology

A variety of plant community types occur throughout the Snow River assessment area, influenced mainly by natural disturbances, but also affected by some human use. Plant communities encompass a wide range of habitats, including coniferous forest, deciduous forest, mixed conifer/deciduous forest, forest edges, tall shrublands, low shrublands, seeps and wet areas, riparian areas, streambanks, waterfalls, lake margins, ponds, sphagnum bogs, subalpine meadows, alpine tundra areas, and grasslands. Coniferous forested habitats are generally Lutz spruce (*Picea* x *lutzii*, a varied hybrid between Sitka spruce [*P. sitchensis*] and white spruce [*P. glauca*]), mountain hemlock (*Tsuga mertensiana*), or mixed spruce-hemlock stands. Hardwood forests include stands of cottonwood, also known as balsam poplar (*Populus balsamifera*), and birch (*Betula papyrifera*). Nonforested communities include grasslands (including *Calamagrostis canadensis* monocultures, sedge meadows [*Carex* spp.] and other mixed graminoid patches), alder (*Alnus* spp., but mainly *Alnus crispa*, the Sitka alder), other brush, including willow (*Salix* spp.), other low shrubs, and alpine tundra (including a variety of low forbs, lichens, and subshrubs). Rock and some permanent snow fields in the highest elevation are also present across the landscape.

2.5 Fire

The upper portion of the Snow River Watershed is fairly isolated with occasional summer use by airplanes and a limited amount of hikers due to a lack of established trails. The lower portion of the watershed has the highest concentrations of users due to the proximity of the Seward Highway, railroad, Primrose Campground, trailheads and lakes.

The Kenai Peninsula is a transitional zone between boreal forests merging with the coastal rain forest. Sitka spruce thrives in the near coastal zone where climatic conditions limit the frequency and intensity of naturally occurring fires. Mountain hemlock is considered to occur as a subalpine forest, which usually burns infrequently; however, fire is the primary large-scale disturbance agent in these forests (Agee, 1989). White spruce is adapted to a wide range of ecosystems and climatic conditions and has a transcontinental range across Alaska where it overlaps with Sitka spruce near sea level (Burns and Honkala, 1990). Fire has played an integral role in the evolution and maintenance of the flora and fauna of northern circumpolar forest habitats. Throughout the range of white spruce, fire has been an important, sometimes dominant factor in forest dynamics. White spruce is probably more susceptible to destruction by fire than any other tree in Alaska (Lutz, 1956).

Fire has historically been present in this century in the Kenai Mountains but whether fire is the important disturbance process creating structural and landscape diversity within this ecosystem is unknown. There are three distinct areas of fire frequency: prehistoric (pre-1740), settlement (1741- 1913) and post-settlement (1914 to present). Forests on the peninsula had not sustained timber harvest prior to 1740. Uncut forests provide a rare opportunity to discern the natural dynamics of vegetation in an expanding landscape becoming dominated by both human and insect disturbances.

There are limitations with the accuracy of forest history reconstructions due to lack of living trees having survived recent spruce bark beetle infestations. Isolated areas remain throughout the forest where the stand ages still span the time of fire history.

Prehistoric

The evidence for prehistoric fire events on the forest from radiocarbon dates on soil charcoal range from 4500 years before present (ybp) to 570 ybp (Reiger, 1995). Historical evidence supporting a climax forest is cited by the following authors. Langille (1904) and Holbrook (1924). Both concluded from evidence indicated by old logs and decayed stumps of large size, that a prehistoric forest of greater proportions once existed, probably destroyed by fire before the Russian occupancy of the region. Although large historic fires were recorded on the Forest during the settlement period, we do not know how this compares with the number and size of fires during prehistoric fire history.

Settlement

Beginning in the late 19^{th} century and continuing through the early 20^{th} century, this period shows high fire frequencies on the Kenai Peninsula. Perhaps the earliest written occurrence of Russian occupancy on the Forest was in late 1793 (Pierce, 1983). Russian shipbuilders prospected in the Kenai Peninsula mountains for iron ore. The iron ore was transported down along Resurrection to the bay.

The coming of the American gold seekers saw the first use of the forests, exploiting the forests to obtain lumber for sluice boxes (Langille, 1904). Many of the gold seekers were careless with fire, with the result that they burned not only a large part of the timber but their cabins and outfits as well (Holbrook, 1924).

There were extensive fires on the Forest between 1913 - 1915. The basic cause for these fires was attributed to railroad activity igniting the vegetation. The drought conditions following the 1912 Katmai Volcano eruption also contributed to the fire behavior creating favorable weather for burning. Holbrook (1924) also reports “the region has been visited by numerous fires and most of the better grade of timber has been burned”. He mapped approximately 30,000 acres of burned area on the forest. These large disastrous fires included the Resurrection Creek watershed covering 10,000 acres including the Hope fires; namely Cripple Creek, Bear Creek and Sunrise fires (1904-1930) burning a total of at least 6,000 acres.

Post-settlement

Human impact on the forest has varied and early impacts have been masked by those which came later. Four large fires in the 1950s totaling 751 acres were reported within the Snow River Watershed area; all human caused. Fire occurrence data from 1933 to 2000 (67 years) shows a total of 41 fires recorded, totaling 761 acres burned within the watershed with an average of 11.35 acres burned per year. The majority of fire starts are small fires under 0.1 acre in size along the railroad and highway.

Current Fire Regime

Fire regimes are characterized by frequency, intensity, severity, forest types, and spacing of fire across landscapes patterns over time (Agee, 1994). Fire regimes help describe the role natural fire plays in the ecosystem. Fire is infrequent and severe within the watershed. The time between fires is 200 years or more. Examples of vegetation in this type of fire regime (Fire regime V) are Pacific silver fir, western hemlock, mountain hemlock, subalpine and alpine plant communities. About 73.59 percent (65,999 acres) of the watershed is Regime V. This does not include non forested areas of rock and ice.

Condition Class

At present, condition class mapping of the watershed within a given condition class is unavailable. Mid scale condition class mapping for Southwest Alaska could be completed by early June of 2007. Efforts at the forest level are proceeding and project level condition classes could be validated on a project by project basis.

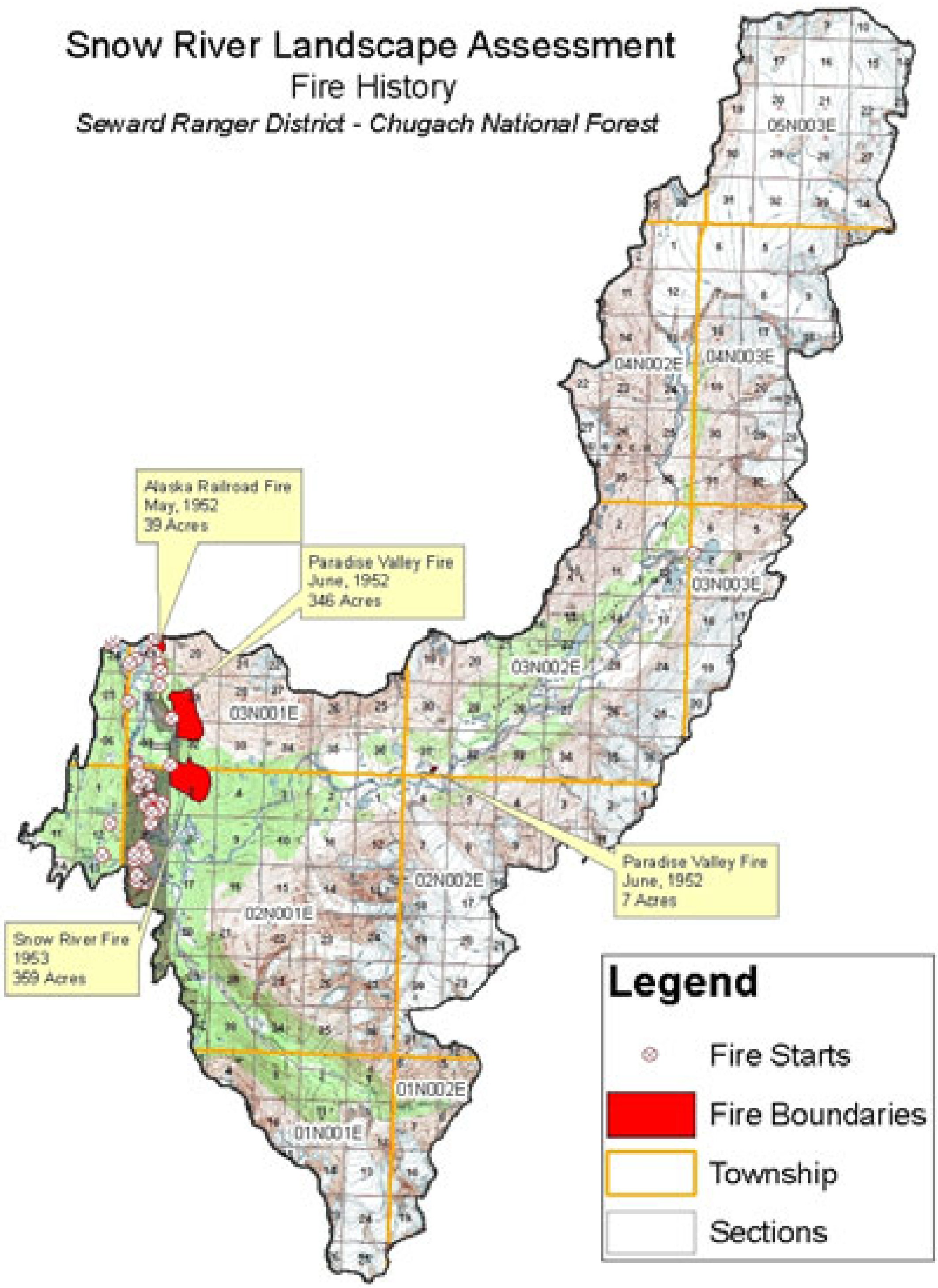

Figure 2.9. Fire History for the Snow River Landscape Assessment Planning Area

Fire Behavior
Under normal weather conditions (Low) fire will pose little threat outside the Wildland Urban Interface (WUI), but under extreme weather conditions and low relative humidities (90th weather percentile i.e. High) fire behavior in the beetle killed spruce stands (Fire behavior fuel model (FM) 10) , grasses (FM 1,3) change and pose the greatest risk (See Table 2.4 below). Fire behavior fuel models of 10, 8, 6, 3 and 1 were used to depict the landscape assessment area for generic outputs. Some base input assumptions were made to run the Behave Model they are as follows;

Table 2.3. Weather and Fuel Moistures

	1 Hour (0 to 1/4 inch) Fuel Moisture	10 Hour (1/4 to 1 inch) Fuel Moisture	100 Hour (1 to 3 inch) Fuel Moisture	Live Fuel Moisture	Wind Speed	%Slope
Low	12	14	16	120	5	50
High	6	8	10	120	10	50

Below are the fire behavior predictions by fuel type and weather conditions.

Table 2.4. Fire Behavior Outputs by Fuel Model

	Low	Low	Low	High	High	High
Fire Behavior Fuel Model	Flame Length in Feet	Rate of Spread by Chain per Hour	Spotting Distance by Mile	Flame Length in Feet	Rate of Spread by Chain per Hour	Spotting Distance by Mile
10	4.9	9.0	.2	7.9	22	.5
8	1.0	2.0	.1	1.6	5	.2
6	5.7	34	.2	9.8	95	.6
3	12.4	114	.4	21.4	326	1.0
1	0	0	0	7.5	270	.5

2.6 Aquatic Species and Habitats

The Snow River and South Fork Snow River drain headwater glaciers as well as non-glacial sources such as Paradise Lakes. The Snow River and many of its tributaries occupy channels dominated by glacial processes, with banks made of bedrock, large boulders, and cobbles.

The Snow River is a very productive anadromous stream. However, the majority of the watershed is backcountry, and not much of the area outside of the highway corridor has been surveyed. The South Fork Snow River has coho and sockeye salmon as well as Dolly Varden char as far as 5.3 miles upstream of the confluence with the North Fork. The North Fork Snow River has sockeye spawning as far as 2 miles upstream from the confluence with the South Fork, where a series of large waterfalls prohibit the upstream migration of sockeye and coho salmon.

Surveys in 1994 showed juvenile coho salmon in a side channel off the main stem of the South Fork Snow River approximately 5 miles above the confluence with the main North Fork Snow River. Adult sockeye salmon were also noted in the area. The Alaska

Department of Fish and Game (ADF&G) anadromous catalog (ADF&G, 1992) may not fully represent the distribution of salmonids within the Snow River system. The South Fork Snow River has a spawning population of Dolly Varden that utilizes Boulder Creek mainly in October. The US Fish & Wildlife Service has been conducting radio telemetry studies since 1998 on Dolly Varden of the Kenai Peninsula.

Paradise Lakes have arctic grayling and some rainbow trout. Upper Paradise Lake was stocked with 242 grayling in 1962, and the mortality rate was listed as 27%. The lake was stocked with 165 grayling in 1963. The stocking was successful, and the resulting progeny from the original plant left the lake via the Snow River and made its way into the water of Lower Paradise Lake. Lower Paradise Lake was stocked with 4,800 rainbow trout in 1968. Grayling in both lakes average 10 to 12 inches in length (ADF&G, 1995). These lakes are not on a trail system but are accessible by float plane, or less commonly on foot, with considerable bushwhacking. The lakes sit in an isolated valley with spectacular views of some glaciers. In the past 5 years, Upper Paradise Lake had 470 visitors and Lower Paradise Lake had 413 visitors.

Also included within the watershed are Long, Meridian, Grayling, and Leech Lakes, as well as other small unnamed lakes. Long and Meridian Lakes are on a 5-year stocking plan. Rainbow trout are stocked in odd years. A trickle dam was installed in 1985 at Leech Lake prior to stocking with rainbow trout. Leech Lake has not provided successful over-winter habitat for rainbow trout. Grayling Lake has a grayling population. The other small lakes in the area are landlocked and may have stocking potential, but further analysis would be required.

2.7 Terrestrial Species and Habitats

Terrestrial habitats include an almost pristine mosaic of wetland and upland habitats, which provide a diverse array of high quality habitat. Nearly 200 species of wildlife are commonly found on the Kenai Peninsula.

Habitats range from barren snow and ice, steep rocky slopes, and alpine tundra and meadow that provide summer range for mountain goat, Dall sheep and other species, to a variety of forested upland habitats and wetlands on the side slopes and alluvial valley bottoms. These habitats support the diverse array of animal populations of large and small mammals, migratory and resident birds, small mammals, and other species.

Forested areas are generally below 1500 feet, and are primarily mountain hemlock-Lutz spruce/rusty menziesia plant community types, often with devil's club present.

Early seral or stand initiation type habitats (Oliver, 1996) provide feeding habitat for moose, wolves, snowshoe hare, and lynx, and nesting habitat for neotropical migrants such as sparrows and warblers. Flooding, avalanche, wildfire, spruce bark beetle, and succession promote early seral habitat.

Old growth forest habitats provide potential nesting habitat for goshawks and marbled murrelets, neotropical migrants and raptors. These habitats also provide thermal cover, hiding cover, and denning areas for large mammals, travel corridors for moose, bear, wolverine, and wolves, and winter foraging areas for mountain goats. There are some larger diameter old growth mountain hemlock and Lutz spruce, mostly on bench areas, lower slopes, and just below low ridges. Lutz spruce/devil's club is a minor type of the forested areas. The largest trees are found in this type.

Mountain hemlock dominates stands that occur on ridges and convex slopes, providing potential nesting habitat for goshawks, winter foraging habitat for mountain goats, and bedding areas for bear and moose. Canopy gaps with devil's club and steep slope areas with mountain hemlock/blueberry provide good berry foraging areas for bears.

Broadleaf forest types, such as mature birch in the stem exclusion phase, support populations of other species of migratory songbirds which include several species of thrushes and warblers. Succession leaves paper birch snags present, providing good habitat for cavity nesting birds.

Salmon runs in the Snow River and associated lakes and tributaries are an important seasonal source of food and support populations of many terrestrial species of wildlife, including brown and black bear, bald eagles, wolves, and a host of others. Wetlands provide important nesting and foraging habitat for sensitive species such as trumpeter swans, as well as other waterfowl.

Wildfire, spruce bark beetle (*Dendrocthonus rufipennis*) infestations, other natural processes such as avalanches, flooding, and jökulhlaups and human activities affect wildlife habitat. Wildfires and spruce bark beetle infestations appear to have been limited throughout the watershed. The Snow River jökulhlaup is a major event that occurs every 2 to 4 years, causing major disturbance in the valley bottom, affecting vegetation and sometimes destroying salmon spawning areas. At the same time, this natural disturbance provides new seral vegetation that can be eaten by moose and creates new oxbow lakes, ponds, or side channels that are great for fish rearing and waterfowl nesting.

Beaver activity has caused flooding in places, creating wetland, sedge meadow, and willow dominated vegetation types. Some of these areas provide potential swan nesting habitat.

Human activities and development, particularly recreation, may also affect wildlife habitat. Float plane activity, use of cabins at Upper and Lower Paradise Lakes, occasional use by hikers, snowmachiners, hunters, and flight see-ers may affect wildlife. Habitat alterations caused by human activities are relatively minor, and these are primarily limited to areas in and around the recreation cabins at Upper and Lower Paradise Lakes.

2.7.1 Sensitive Species, Management Indicator Species and Species of Special Interest

There are no federally-listed threatened or endangered species that occur in the Snow River Watershed, as all listed species within the Chugach National Forest boundary are associated with marine environments. One sensitive species, the trumpeter swan, was found to be breeding in the watershed in 2004. Within the Snow River Watershed, there are three management indicator species (brown bear, moose and mountain goat) and eight species of special interest (gray wolf, wolverine, lynx, river otter, bald eagle, northern goshawk, marbled murrelet and Townsend's warbler). There are few available data for management indicator and other species of concern in the watershed. The Alaska Department of Fish and Game conducts annual fall counts for moose and periodic surveys for mountain goats and caribou. Seward Ranger District biologists conduct annual surveys of northern goshawk, bald eagle, owl and neotropical migratory birds. Habitat models have been developed to characterize brown bear, moose, mountain goat and Dall sheep habitat.

2.8 Human Uses

2.8.1 Human Uses: Past

The heritage resources of the Snow River Watershed include both prehistoric and historic remains, including properties that are eligible for inclusion in the National Register of Historic Places. Of the 104,564 acres in the watershed, only 3415 acres have been surveyed for cultural materials.

Formal reports have been generated for archeological surveys in the analysis area, but information on many surveys in the past 30 years has not been formally documented and is available from field notes only. Additionally, most identified cultural resources have not received formal evaluations for the National Register of Historic Places (NRHP).

Although the Snow River region has many historic properties, there is evidence of prehistoric use as well. Human occupation of the Snow River Watershed began thousands of years ago and continues to this day. Currently, there are 34 archeological sites within the watershed, with an additional 11 sites located directly on or just outside of the watershed boundary. Nearly all of these sites are from the historic period, and are located in the western region of the project area along the highway and rail line, where the majority of the archeological surveys have occurred.

The cultural resources of this region mostly date to the early 1900s, but historic documentation of the area extends back through the 1800s (Barry, 1997). The Snow River Watershed was primarily used as a transportation route for Native Alaskans and early explorers. Since that time this area has seen traffic from the Alaska Railroad, miners, tourists and others.

Cultural resource sites and features are susceptible to many altering elements, which may adversely affect their integrity. As recreational use increases, it becomes increasingly important to ensure that cultural materials are protected from vandalism and looting. Significant cultural resources exist that need documentation and protection. In addition, the probability of discovering additional historic properties is high within the assessment area. It is important to preserve what we can of our heritage, and to do this we must consider the effects that human use, as well as the environment, may have on these resources.

2.8.2 Human Uses: Present

The amount of recreation use in the Snow River Watershed is low relative to other areas on the Seward Ranger District. The majority of the recreation use in the Snow River Watershed occurs during the summer months (June-August) and coincides with the arrival of seasonal summer tourists; however, snowmachine use and cross country skiing also occur along the Snow River corridor and trails. Snowmachine use is the predominant winter recreation activity occurring in the Snow River corridor.

The recreation activities taking place in the Snow River Watershed include hiking, fishing, hunting, trapping, cross-country skiing, biking, and snowmachining. The predominant recreation activities are hiking, fishing, skiing, and snowmachining. The majority of the Forest Service trails in the watershed are located west of the Seward Highway.

Moose Pass (pop. 134) is the nearest community, located approximately 10 miles north of the mouth of the Snow River. Seward (pop. 3,040) is located approximately 16 miles south of the mouth of the Snow River. Anchorage, the largest city in Alaska (pop. 258,782) is located approximately 60 air miles (100 miles by road) north of the Snow River Watershed.

3 Key Issues and Questions

The following issues and key questions are important for management of the Snow River Watershed and provide a framework for the landscape assessment. Some of these questions address natural processes that provide a basis for evaluating other issues, whereas others are important management considerations and should be evaluated by a variety of resource specialists.

3.1 Lands

Issue: Development and uses outside of National Forest system (NFS) lands (Chugach Alaska Corporation (CAC), state, private, and railroad) have potential impacts to Forest Service lands (i.e. Easements or staging areas).

Issue: Development within NFS lands (electronic sites, campground or trail construction or reconstruction, and recreation facility development) has potential impacts to Forest Service lands.

3.2 Geology, Minerals and Soils

3.2.1 Geology and Minerals

Question*: What is the current level of mining activity in the Snow River Watershed? Are there active mining claims within the watershed?*

Question: *What is the potential for mineral development in the Snow River Watershed? Is there a demand for sand and gravel from National Forest lands?*

3.2.2 Soils

Issue: Increased human uses in the Snow River Watershed will have a negative effect on soil erosion rates, particularly along streambanks, wetlands, and alpine environments. Current levels of erosion seem to be occurring at a natural rate since access to most of the study area is limited. These areas are especially sensitive because micro-climate and soil conditions necessitate a longer recovery time for damaged vegetation.

Question: *Will an increase in user access have a detrimental effect on soil erosion processes occurring throughout the study area?*

3.3 Hydrology

Issue: The Snow River jökulhlaup is a major natural disturbance in the Snow River Watershed. These glacial outburst floods impact most resources and uses in the watershed.

Question: *How do glacial outburst floods on the Snow River impact recreational uses, structures, property, roads, and railroads in the Snow River Watershed, as well as downstream residents along Kenai Lake and the Kenai River?*

Question: *How will glacial recession in the Snow River Watershed affect the Snow River glacial outburst flood system?*

Question: *What effects may channel migration and bank erosion along the Snow River have on property, structures, roads, and railroads in the lower Snow River Watershed?*

Issue: Human uses in the Snow River Watershed may have impacts on hydrological processes.

Question: *What are the potential water quality effects of motorized uses in the Snow River Watershed? These uses include the Seward Highway, the Alaska Railroad, snowmachines along the South Fork Snow River, and floatplanes at the Paradise Lakes.*

Question: *How is the Alaska Railroad affected by the alluvial fan at Mile-16.6?*

Issue: Avalanches commonly occur in the Snow River Watershed as a result of the steep valley sides, high relief, and abundant snowfall.

Question: *What avalanche hazards exist in the Snow River Watershed?*

3.4 Vegetation and Ecology

Question: *What are the major vegetation successional processes at work on the landscape?*

Question: *Will current and predicted recreational use flows increase the population and spread of non-native species?*

Question: *How will the current use and predicted recreational use affect sensitive plant populations?*

Question: *How has the spruce bark beetle infestation affected the plant community composition, structure, and function, and how will it continue to affect the landscape over time?*

Question: *What is the amount and distribution of stand structure types as they relate to wildlife habitat and landscape level plant community function?*

3.5 Fire

Issue: Spruce bark beetle infestation in the watershed may result in an increased risk of natural or human-caused wildfire, with associated degradation of air quality.

Question**:** *Will increased recreation use bring the likelihood of more human caused fires?*

Question: *Will the spruce bark beetle outbreak in the area, along with increased recreation use, increase the threat of wildfire impacting the campground and homes in the Primrose area due to unwanted ignitions?*

3.6 Aquatic Species and Habitats

Question: *Are angler needs being met at the Paradise Lakes, Meridian Lake, and Long Lake?*

Question: *What is the condition of the grayling population in Grayling Lake?*

Question: *Are any of the small lakes northwest of Grayling Lake suitable for stocking?*

Question: *What is the present and future availability of hatchery-raised fish for stocking from the Alaska Department of Fish and Game?*

Question: *What improvements can be made in the watershed for spawning and/or rearing habitat for coho and sockeye salmon?*

Question: *What is the potential for stocking rainbow trout in Lower Paradise Lake?*

Issue: Anecdotal evidence of spawning and rearing coho and sockeye salmon in the Snow River drainage exists, yet very little scientific data are available on which to base management practices.

3.7 Terrestrial Species and Habitats

Issue: Trumpeter swans are a sensitive species, previously unknown to breed on the Seward Ranger District, although they are known to stage in this area during spring and fall. Four swans were documented during the breeding season west of Lower Paradise Lake. On the Kenai National Wildlife Refuge, float planes have been documented to disturb nesting birds. Float planes use lakes in the watershed to practice “touch and go” landings and to access cabins on Upper and Lower Paradise Lakes. Float planes have the potential to disturb breeding swans.

Question: *How many trumpeter swans breed in the watershed? Where do they nest? Are they being impacted by float planes or other recreational activities?*

Question: *How many brown bears inhabit the watershed? How are hiking, fishing, flight seeing, and other recreation activities affecting brown bears, and how are these potential effects impacting the population over time? Have there been documented bear/human encounters near recreation sites, and if so, are the trends increasing?*

Question: *What is the distribution and abundance of threatened, endangered, or sensitive wildlife species, management indicator species, and species of special interest?*

Question: *What are the current habitat conditions (existing and potential habitat), and trends for these species? What is the distribution and abundance of key habitat components such as old growth, thermal and hiding cover, snags, downed logs, and travel corridors?*

Question: *What was the likely historical (pre-European settlement) relative abundance and distribution of these species?*

Question: *How has the spruce bark beetle infestation affected the watershed and the abundance and distribution of these species? Does the proposed hazardous fuels treatment in the Primrose area (1300 acres) cover the area impacted by the bark beetle, and are there additional areas that could potentially be treated?*

Question: *What important wildlife travel corridors exist in the Snow River Watershed?*

Question: *How are recreation activities affecting these species? What are the expected recreation trends in the watershed? How would heli-skiing affect wildlife in the watershed? How does snowmachine activity affect wildlife travel corridors?*

3.8 Human Uses

3.8.1 Human Uses: Past

Issue: Information regarding cultural resources within the Snow River Watershed is limited. Of the 104,564 acres in the watershed, only 3415 acres have been surveyed for cultural materials. The first step in preserving and understanding the heritage of this area is locating and documenting significant archeological sites and features.

Question: *What heritage resources are present in the watershed that have yet to be documented? Where are they located?*

Question: *How does historic use of the area compare with current uses, and what are future trends for use and development? What patterns are visible in the archeological record? Are people still trapping, hunting and mining in the same areas?*

Issue: Natural erosion processes are an ever present challenge in the preservation of archeological sites. The destruction of sites located in areas that endure changing water levels, from outburst flooding as well as other seasonal trends, has certainly already occurred. The loss of information can be minimized by recording as much information as possible before additional effects occur.

Question: *Are all the heritage resources that may be destroyed or damaged in the near future by natural processes documented adequately and protected if possible?*

Issue: Archeological sites are of interest to many people. Unfortunately, often individuals may unintentionally damage the integrity of a site without even realizing that they are doing so, or that it is illegal. Whether it is deliberate looting or innocent curiosity, it can result in the loss of valuable cultural information. With the presence of recreation in the area comes the responsibility to protect the heritage resources and to educate the public.

Question: *What effect does modern recreation have on archeological sites? What are the direct and indirect damages, both currently and in the future? What educational opportunities exist?*

Question: *How have past management efforts affected heritage resources?*

3.8.2 Human Uses: Present

Question: *What is the current level of recreation use occurring in the Snow River Watershed?*

Issue: The public, particularly nearby residents, oppose recreation facility development in the Snow River Watershed, and this attitude may influence recreation management in the area.

Question: *Is the existing recreation development sufficient to meet the recreation demand of the public for the Snow River Watershed?*

Question: *Is future recreation development in the Snow River Watershed desired by the public?*

Issue: In general, increases of participation in recreation activities may lead to increased user conflicts.

Question: *Will further recreation development along the Snow River corridor increase user conflicts between hikers, bikers, and other visitors?*

Question: *In general, should there be an increase in commercially guided opportunities in the Snow River Watershed?*

Question: *Should the Forest Service conduct a formal Recreation Management Plan for the Snow River Watershed?*

Issue: Recreation development (trails, cabins, etc.) may adversely impact other forest resources, such as vegetation, soils, streams, and wildlife.

4 Current Conditions

This portion of the landscape assessment discusses the current range, distribution, and condition of resources within the Snow River Watershed and provides a summary of all information relevant to the issues and key questions that is known about the watershed.

4.1 Lands

The Forest Service is the predominant landowner in the Snow River Watershed. The other land owners include Chugach Alaska Corporation (CAC) (891 Acres), the State of Alaska (1,334 acres), private landowners (179 acres), and the Alaska Railroad (156 acres).

The majority of the land within the watershed is managed under a Backcountry Prescription (91,869 acres) (USDA Forest Service, Chugach National Forest, 2002a). The management intent of these areas is to emphasize a variety of recreational opportunities for backcountry activities in natural appearing landscapes. Other management area designations in the watershed include Wild River (6321 acres); Scenic River (1489 acres); Fish, Wildlife and Recreation (1384 acres); and Transportation Corridor (150 acres).

Land use permits in the watershed include the following: (1) City of Seward powerline; (2) driveway access from Primrose Road to private property; (3) Alaska Railroad Mile-16 water diversion; and (4) communication sites on Wolcott (Sheep) Mountain.

At this time, developed lands consist of the following: (1) two Forest Service cabins at Upper and Lower Paradise Lakes; (2) a developed campground at Primrose Creek; (3) developed trailhead or trails at Grayling Lake Trails, Primrose, and Iditarod National Historic Trail (INHT); (4) Alaska Railroad; (5) the Wolcott Mountain electronic sites, (6) ski trail system near Golden Fin Lake; (7) gravel extraction site on CAC land at Mile-14; and (6) the Seward Highway.

The only planned development at this time consists of further construction of the INHT and reconstruction of the Seward Highway from Mile-18 to Mile-25. A Forest Service special use applicant has proposed constructing a driveway to the private parcel of land located on the west side of the Snow River Watershed on the east side of the Lower Snow River. Future development of this parcel (160 acres) is likely.

There are no known or planned new developments on the State or CAC lands. Additional sand and gravel extraction at the existing mineral site on CAC land is possible. In addition, routine maintenance occurs on the power line right-of-way, the Seward Highway, Primrose Road, and the Alaska Railroad.

There are no additional lands selected for conveyance to the State of Alaska or any Native Corporation pursuant to ANILCA or ANCSA within the Snow River Watershed that have not been perfected.

4.2 Geology, Minerals and Soils

4.2.1 Geology and Minerals

There are three basic systems under which the disposal of federal minerals located on National Forest System lands are managed: the U.S. mining laws (1872 Mining Law as amended), mineral leasing laws, and mineral sale laws. The minerals falling within these systems are known as locatable, leasable, and salable minerals respectively.

All public domain lands are open to mineral entry unless specifically closed. If the lands are open to mineral entry under the 1872 Mining Law, mining claims can be located and the mineral resources can be developed. Bona fide mineral development cannot be prohibited when lands are open to mineral entry. Additionally, statutes provide for a mining claimant's rights to reasonable access for the purposes of prospecting, locating mining claims, and developing the mineral resource. Such access and development must be in accordance with the rules and regulations of the Forest Service. However, the rules and regulations may not be applied so as to prevent lawful mineral activities or cause undue hardship on bona fide prospectors and miners (USDA Forest Service, Alaska Region, 2003).

Local Geology

Bedrock (*Kv*) consists mostly of interbedded slate and metagreywacke belonging to the Late Cretaceous Valdez Group. Fossil evidence has established a Maestrichtian age (Jones and Clark, 1973) for deposition of the sediments by turbidity currents in a trench-fill environment (Budnik, 1974).

Thick deposits of unconsolidated Quaternary (*Qu*) sediments occupy much of the Snow River basin, Paradise Valley, and the South Fork Snow River Valley. These well-washed and well-sorted gravels (mineral materials) along the Seward Highway are suitable and have been utilized for highway reconstruction and other local construction purposes.

The Placer River fault, a major thrust fault, trends north/south through the analysis area, about six or seven miles east of the Seward Highway. It disappears under the gravels in Paradise Valley, and south of Snow River it is intermittently exposed. It disappears under the South Fork Snow River, reappears again to the south, and finally disappears into Day Harbor. A two-mile wide zone of high-grade metamorphic rock occurs on the west side of the fault. The bedrock in this zone is schistose interbedded siltstone and metagraywacke. The siltstone is a shiny steel-gray and the graywacke is a dark gray. Since most of the known gold deposits of the Valdez Group rocks occur in the medium grade metamorphic rock, this could explain the general lack of mineral occurrences.

Another major thrust fault trends northeast/southwest, east of and generally parallel to the Nellie Juan River. It forms the contact zone that separates the Valdez Group unit of rocks from the younger Orca Group. This fault is roughly parallel to but outside of the assessment area.

Locatables

Locatable minerals are those mineral occurrences upon which mining claims can be located (mineral entry) under the General Mining law of 1872, as amended. In general, the locatable minerals are those that are mined and processed for the recovery of metals. They also may include certain nonmetallic minerals and uncommon varieties of mineral materials, such as valuable and distinctive deposits of limestone or silica. However, “uncommon varieties” are not known to occur within the subject area.

Small, sometimes high-grade, lode gold (Chugach-gold) deposits that occur as epigenetic hydrothermal veins formed along well defined fractures in the Valdez Group, and placers derived from the erosion of these veins are by far the most common types of mineral deposits in the surrounding area. Samples collected by the U.S. Bureau of mines below the bedrock canyon above Paradise Lake showed some anomalous gold values (Hoekzema and Fechner, 1984). However, Snow River has no history of producing placer gold.

There are currently no placer claims, and only two lode claims (filed by the same claimant) within the assessment boundary. The lode claims are located just south of Kenai Lake and slightly west of Seward Highway, and no production has been recorded from these claims (Figure 4.1).

Mineral Occurrences
Devils Club Ledge (Figure 2.2, red dot labeled “1”) prospect is located 270 foot above Kenai Lake, between Mile-17 and 18 of the Alaska Railroad. The Lakeside prospect is nearby. Workings consist of several open cuts and stripping. The mineralization consists of two quartz veins hosted by slate bedrock. The first vein is 15 inches wide, nearly vertical, and strikes N80W. It has been traced for 75 feet. The second vein parallels the first and has a width of 4 to 8 inches. The Lakeside deposit (Figure 2.2, red dot labeled “2”) consists of a 4 to 10-inch wide vein that strikes north and dips 50 degrees east. Both the Devils Club Ledge and the Lakeside veins contain arsenopyrite. Pyrite occurs in the Lakeside vein.

The Hale, Peel and Lyngholm occurrence is reported to be in the vicinity of Meridian Lake, but a more precise location is not known. A mining claim was located on the property in 1915 and relocated in 1976. There are no reported workings, and no additional information is available concerning the character of the occurrence.

Snow River has no history of producing placer gold. However, samples collected by the U.S. Bureau of Mines below the bedrock canyon above Paradise Lake showed some anomalous gold values (Hoekzema and Fechner, 1984).

Metallic Minerals
A mineral potential report (Nelson and Miller, 2000) was prepared by the U.S. Geological Survey to provide minerals information to the Chugach National Forest (CNF) for preparation of the Chugach National Forest Land and Resource Management Plan (USDA Forest Service, Chugach National Forest, 2002a). The report focused strictly on locatable mineral resources, and not on leasable resources such as coal, oil, or gas.

For the purpose of assessing the mineral potential, the CNF was divided into mineral resource areas (tracts) that contain both identified and undiscovered mineral resources. These tracts were drawn on the basis of one or more of the following criteria:
(1) geochemical anomalies, (2) favorable geologic units, (3) presence of mines, prospects or mineral occurrences, and (4) geophysical anomalies. Bliss (1989) used six mineral deposit models to describe the types of deposits known from the CNF. Of these deposit types, only four are sufficiently known and defined in the CNF to be suitable for

consideration in outlining and ranking of mineral resource tracts. These deposit types include the following: (1) Cyprus-type massive sulfide, (2) Chugach-type low-sulfide gold-quartz veins, (3) placer gold, and (4) polymetallic vein.

Within the mineral potential map provided by Nelson and Miller (2000) (Figure 4.1), the following units are within the Snow River assessment area:

- Red area - (Kenai Lake tract), identified resources - most favorable.
- Orange area – (Kenai Lake tract) identified resources - moderately favorable.
- White area – Not an identified tract - low potential.
- Yellow area – (Blackstone Glacier tract) undiscovered resources - highly favorable.

The Snow River watershed contains two of these tracts identified as highly favorable, the Kenai Lake tract (red and orange) and the Blackstone Glacier tract (yellow). The Kenai Lake tract is defined by the presence of identified resources of gold from both placer and Chugach-gold deposits. Five areas within this tract are considered highly favorable for mineral development and production; the remainder of the tract is considered moderately favorable for mineral development and production. A highly favorable area (in red) overlaps the assessment area along a small portion of the west boundary. The moderately favorable area (in orange) covers approximately 22% of the assessment area and includes one mineral occurrence and one mineral prospect (Figure 2.3, white stars). The central section of the assessment area, comprising approximately 50%, is shown in white. This area is considered to have low potential for mineral resources. The Blackstone Glacier tract, shown in yellow, overlies the north end of the assessment area and comprises approximately 28% of it. The bulk of this tract is considered highly favorable for containing undiscovered resources of gold from placer and Chugach-gold deposits based on the presence of favorable host rocks and supportive geochemical data (Nelson et al., 1984). There are no known mineral occurrences where this tract overlaps the assessment area.

Although mineral prospects are located in the assessment area, there is no record of any historic placer or lode gold production and there is no current interest in exploring for minerals in this area.

Leasable Minerals
The bedrock in the assessment area is the Valdez Group, which is considered to have no known potential for oil and gas, coal or other leasable deposits.

Mineral Materials
Stream gravels (Quaternary deposits) occurring along the lower reaches of the Snow River have a high potential for mineral development. Since the 1970s, the Forest Service has issued permits for sand and gravel along the Snow River between Mile-14 and Mile-18 of the Seward Highway. Some of this area was later conveyed to native ownership, and they sold sand and gravel, mostly for highway reconstruction purposes. There is a long history of sand and gravel production from the Snow River alluvial gravels along the highway route.

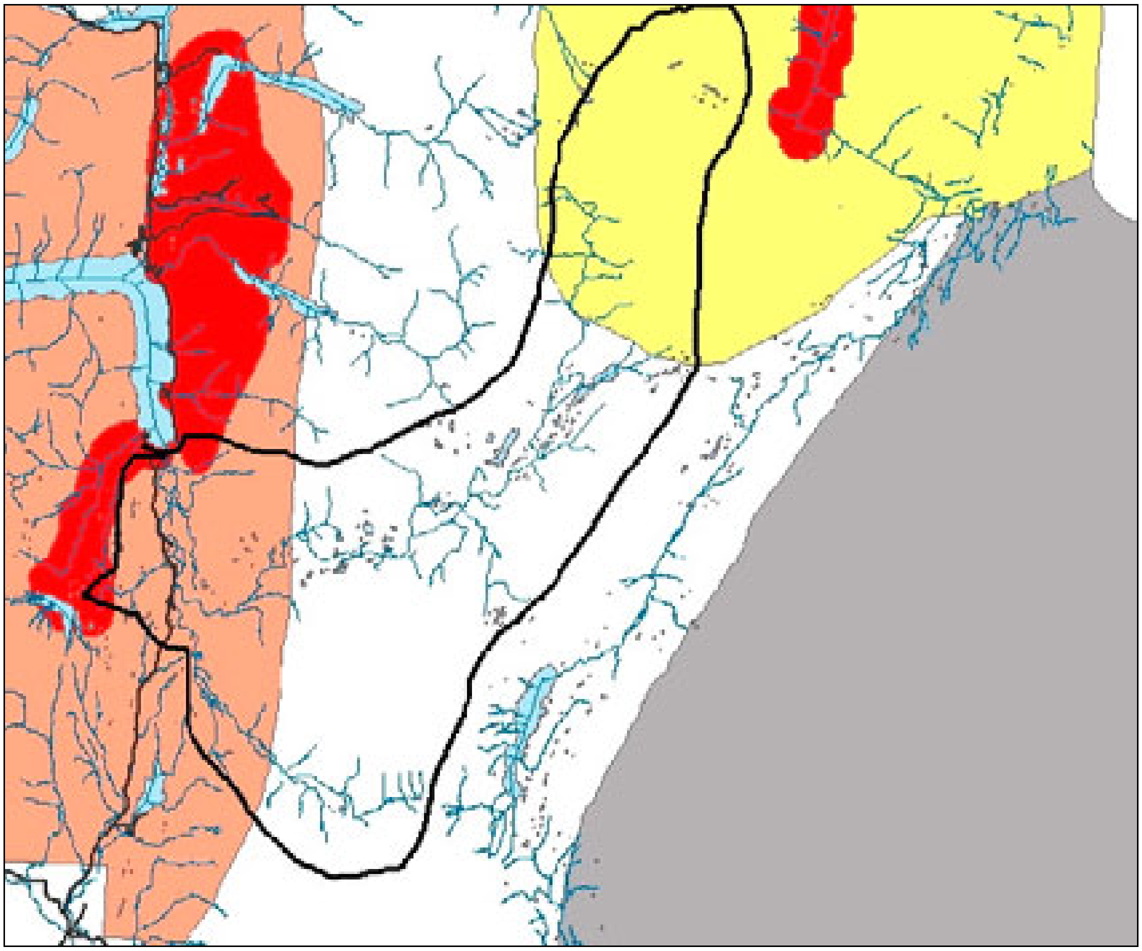

Figure 4.1. Mineral Potential Map (Nelson and Miller, 2000).

In 2003, the State of Alaska, Department of Transportation, applied for a permit to conduct exploration along the Snow River between Mile-18 and Mile-25. They proposed digging test pits with a spacing of 300 to 500 ft, using a backhoe with a 1-yard bucket. The gravels would be subject to tests to confirm the quality of the material. They are attempting to identify large reserves of suitable mineral materials for future highway projects.

Extensive alluvial sand and gravel deposits located in Paradise Valley and the upper reaches of Snow River are unlikely to be developed due to lack of road access. Sand and gravel deposits adjacent to the railroad corridor could be developed utilizing the railroad for transportation.

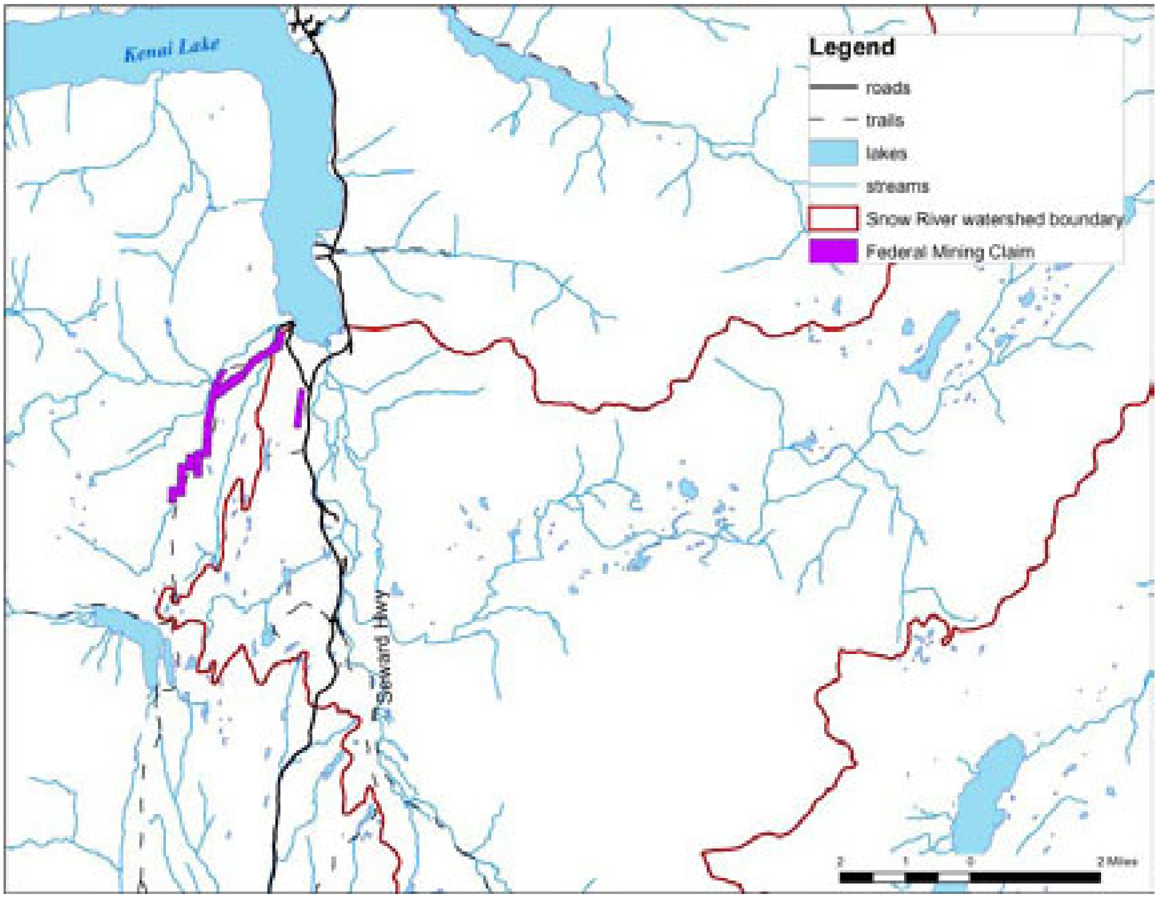

Figure 4.2. Mining claims (in purple) near Kenai Lake.

Abandoned Mine Hazards

The Chugach National Forest has had an abandoned mine program since at least 1990 when the Forest Geologist and the Bureau of Mines began to inventory hazards together. This was accomplished by researching known mine/prospect sites (489 sites Forest-wide) and visiting the sites most likely to represent a hazard to the public, Forest Service employees, and the environment. No known abandoned mines or mine hazards have been identified in the assessment area.

4.2.2 Soils

The most comprehensive soils information available for the study area is from the Kenai Road Corridor Soil Survey (Davidson, 1989) (Figure 4.3). This publication contains detailed information on each soil map unit, including management considerations for roads, trails, campgrounds and associated interpretations and limitations. The soil mapping was initially based on details observable from aerial photographs such as geomorphic landforms and changes in vegetative cover and slope. Further work was done on the ground to fine tune map lines and describe the soil components and associated soil properties. The soil characteristics found in the study area are highly dependent on the colluvial, alluvial and glacial deposits on which they were formed. The following is a brief description of each soil map unit mapped along the road corridor in the study area.

<u>100 Soil Map Unit Series</u>: These soils consist mainly of Typic Haplocryods, which are medium-textured soils greater than 40 inches deep. They tend to be well drained and moderately permeable. They are typically found on mountain sideslopes and footslopes over glacial till. The unit also has a shallow depth class that is less than 20 inches deep and is mapped near bedrock outcrops.

<u>200 Soil Map Unit Series</u>: These soils consist mainly of Typic Dystrocryepts, which are medium-textured soils greater than 20 inches deep. These soils tend to be well drained with moderately rapid to rapid permeability. They are less developed than the 100 series and are mapped on alluvial terraces, glacial till-covered sideslopes, and avalanche chutes.

<u>300 Soil Map Unit Series</u>: These soils consist mainly of Typic Cryaquents and Typic Cryorthents, which are coarse- to medium-textured soils greater than 40 inches in depth. They are the least developed of the soil series mapped in the area. The Typic Cryaquents are associated with wetlands. They are somewhat poorly drained soils with moderate permeability. They are mapped on lower terraces, floodplains and valley bottoms. The Typic Cryorthents are somewhat excessively drained soils with rapid permeability. These soils are mapped on stream terraces and tend not to be as wet as the Cryaquents.

<u>400 Soil Map Unit Series</u>: These soils consist of organic soils which are typically associated with wetlands. They are deep, very poorly drained soils mapped on terrace depressions and along valley bottoms lined with glacial till or lacustrine silt. The 402 unit covers the mud flats and is mapped on the southern end of Kenai Lake.

Landtype Associations

The Landtype Association (LTA) is the highest level of landscape mapping which includes representative soil descriptions, landtypes, and vegetation components. These units are typically described in one or two locations, and the representative data is extrapolated to the remaining polygons of the same map unit. Inferences can be made about soil composition based on previous soil mapping done throughout the Kenai Peninsula (Davis, et al., 1980) that was eventually integrated with the Landtype Association mapping units (Figure 4.4, Table 4.1). The following is a brief description of each Landtype Association unit mapped in the study area.

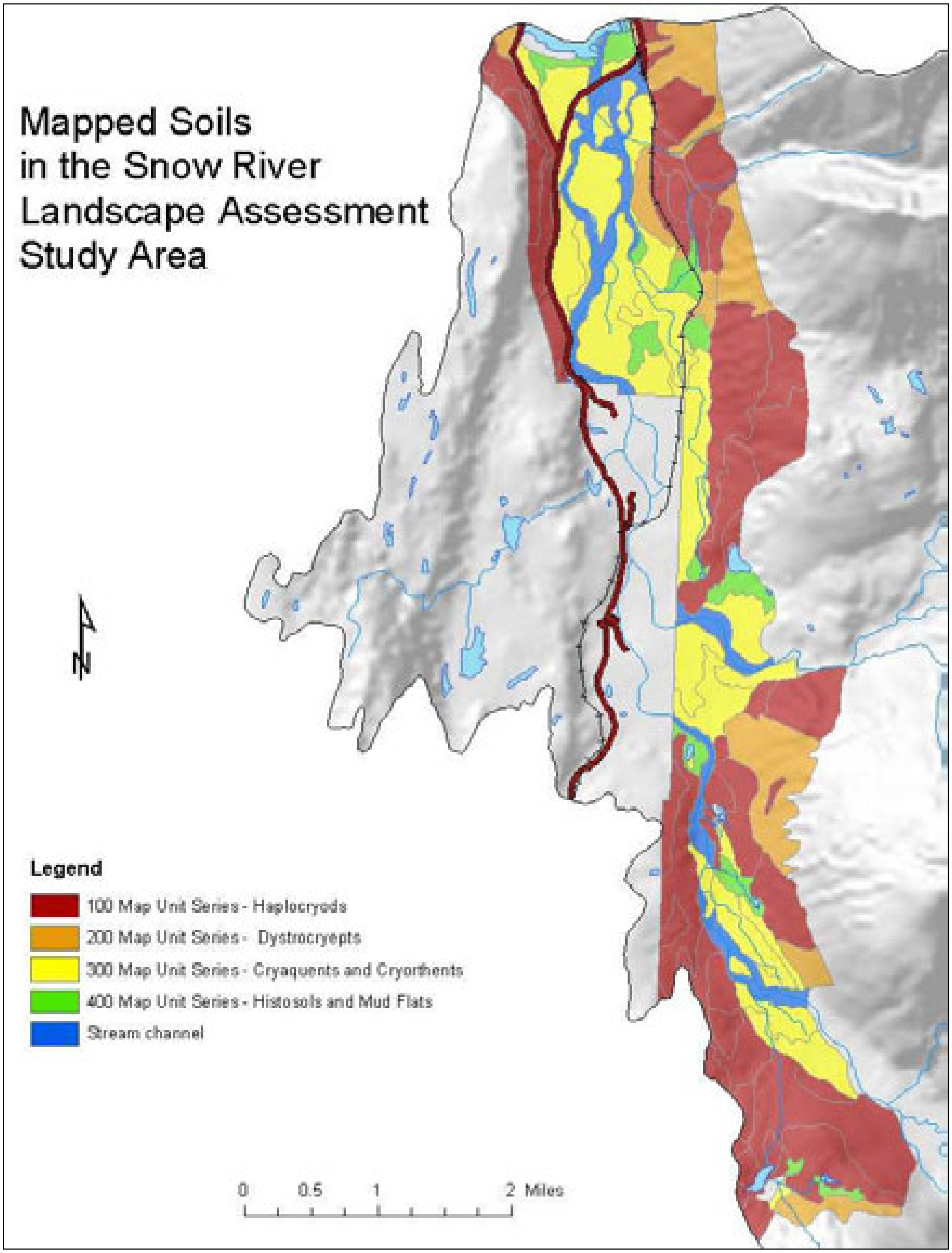

Figure 4.3. Mapped soils in the Snow River Watershed.

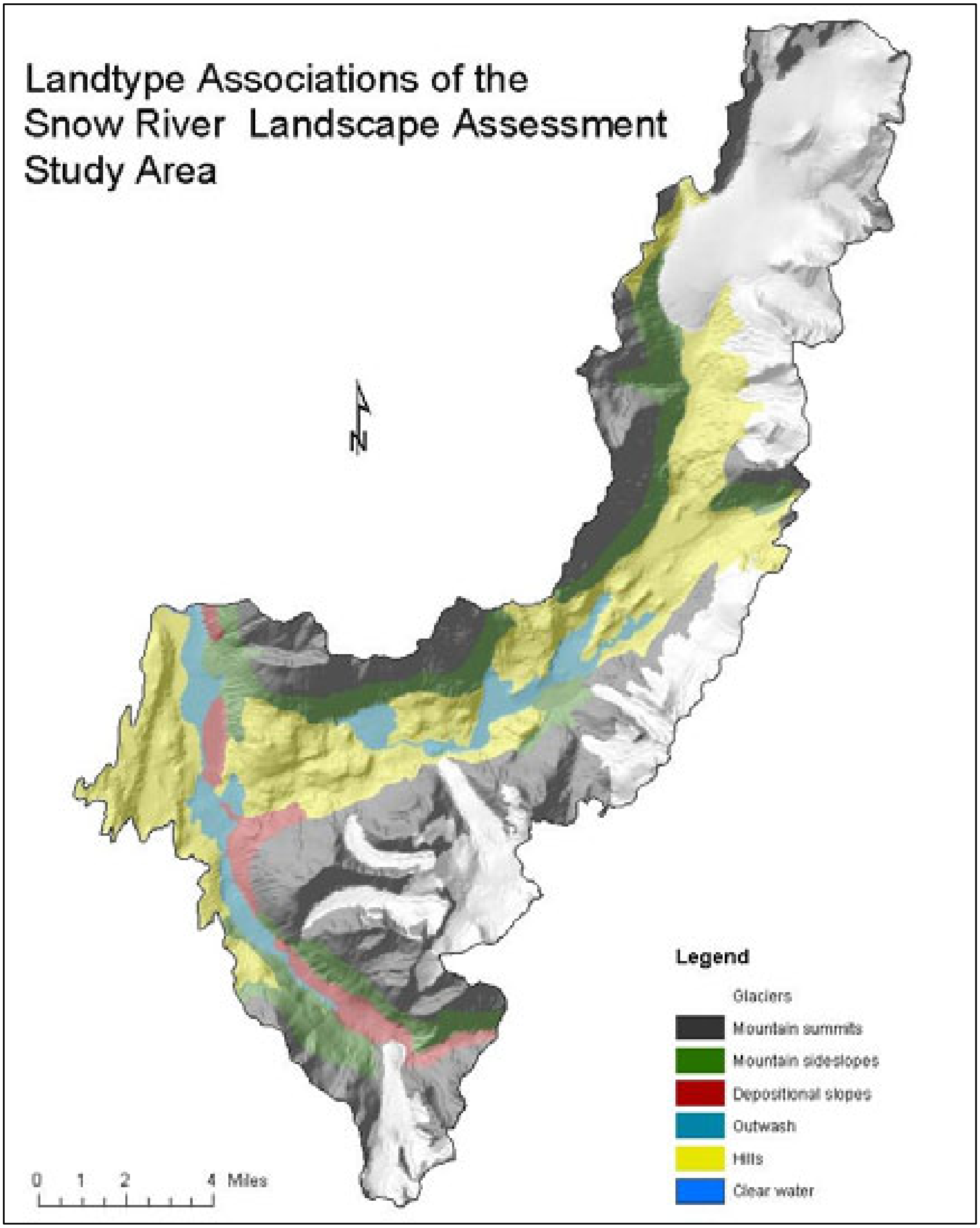

Figure 4.4. Landtype Associations of the Snow River Watershed.

Table 4.1. Landtype Associations of the Snow River Watershed.

Landtype Association	Acres	Percent
Glaciers	32,290	31
Mountain Summits	27,160	26
Hills	24,590	24
Mountain Sideslopes	11,960	11
Outwash	5,190	5
Depositional Sideslopes	3,320	3
Clear Water	50	<1
Total	**104,560**	**100**

Glaciers LTA: The Glacier LTA covers 31% of the study area. The unit consists primarily of active glaciers, ice fields and rock inclusions. Soil development is minimal because of the lack of exposed mineral substrate. This LTA is found throughout the northern and eastern extent of the study area.

Mountain Summits LTA: The Mountain Summits LTA is mapped on 26% of the study area. These units are characterized by rocky terrain with intermittent ice and snow. The soil that does occur tends to be stony, weakly developed and shallow. Subtle changes in the soil profile and depth occur between concave to convex positions on the landscape. The management limitations are typically due to high elevations, steep slopes, shallow soils, and the occurrence of avalanches and rockfall.

Hills LTA: The Hills LTA is mapped on 24% of the study area. Soils are formed from glacial till or ice-scoured bedrock knobs. Soil type is highly dependent on landscape position. Soils on knobs and shoulder slopes will be shallower and less developed than those on sideslopes. Those in toe slope positions and basins that receive and pond water will tend to develop organic soils and may support wetland vegetation. This LTA is mapped throughout the study area but is particularly common in the North Fork Snow River valley.

Mountain Sideslopes LTA: The Mountain Sideslopes LTA is mapped on 11% of the study area. These areas are characterized by disturbance in the form of mass wasting and slope erosion. The soils in these units may be forming on top of compact glacial till which can act as a water restricting layer and can increase the likelihood of failure on steeper slopes (Swanston, 1997). A land stability analysis (Appendix A) should be performed before ground disturbance to evaluate the risks. The extent of soil development is typically determined by its position along the sidelsope. The soils get deeper and more developed as one moves from the higher, steeper, convex positions to the lower, gentler, concave positions down slope. Soils are typically medium-textured and well drained. Areas that are not subject to continual erosion or deposition from material above will usually exhibit greater soil development and will support mature conifer forests. The management limitations are generally related to soil erosion, which can be accelerated by ground-disturbing activities.

Outwash LTA: The Outwash LTA is mapped on 5% of the study area. These soils are forming on active floodplains and on glacial outwash sediments that were laid down under high water energy. This association is scattered throughout the valley bottoms in the study area. Soils forming on alluvium tend to be stratified with different layers of sediments. Layer composition will differ in the amount of fine sediments and rock size depending on the energy of the streamflows under which they were deposited. Limitations for these soils are usually due to drainage or permeability problems associated with one or more restrictive layers in the soil profile or a high water table. Wetlands and hydric soils are common on these units.

Depositional LTA: The Depositional LTA is mapped on 3% of the study area. These soils are forming at the base of long sideslopes where sediments from higher slopes are accumulating and also include stream terraces that are no longer affected by floods or streambank erosion. The soils in this unit are usually deep, coarse textured, and well drained, except in areas where subsurface runoff accumulates. Limitations are usually associated with drainage problems and avalanches.

Erosion Processes

Erosion can occur in the form of landslides, surface erosion, and streambank erosion. Landslides on forested land are dependent on several factors. Swanston (1997) developed a rating system for slope stability on the Tongass National Forest, which factored in topographic attributes, soil properties, geology, and hydrologic conditions. This system was later modified for use on the Chugach NF by Dean Davidson (Appendix A). Of these factors, slope gradient is the most critical. Landslides most frequently occur on slopes greater than 72%. Between 72% and 56%, stability depends on other factors such as topographic position and restrictive layers. Slopes less than 56% are less likely to fail unless there are other critical limitations (Swanston, 1997). The Mountain Sideslopes unit is particularly susceptible to landslides based on these criteria. Many of the soils in these units are underlain by compact glacial till that can serve as a slippery surface if groundwater is restricted and starts to flow just above it.

Figure 4.5 overlays the Mountain Sideslopes LTA with two critical slope categories, the 56 to 72% slope class and the greater than 72% slope class. This provides a general overview of potential problem sites when taking into consideration two of the most significant land stability criteria. In the North Fork Snow River valley, the west and south-facing slopes of Sheep Mountain have a number of areas where these two factors overlap. Aerial photographs reveal a history of landslides and avalanches just above the railroad tracks in the immediate area. Similar patterns can be seen throughout the study area on predominantly south-facing slopes.

Surface erosion is minimal in the study area because of the heavy vegetative cover found throughout the watershed. Areas that have been recently deglaciated or areas that are high in the Mountain Summits LTA and are covered with frost-churned rocks are exceptions. These areas may not have developed enough of a soil stratum to support vegetation and keep sediments intact and protected from wind and water. Also, areas that have recently been disturbed due to mass wasting, avalanches, or stream dynamics will be more susceptible to surface erosion for the same reasons.

The streambank erosion that occurs in the study area is natural and typically caused by stream migration but can be accelerated by glacial outburst floods. These floods originate in the northern end of the watershed and have occurred every two to four years since the 1950s (Post and Mayo, 1971). The sudden increase in flows in the Snow River can cause channel changes, floods, and increased lake levels in Kenai Lake.

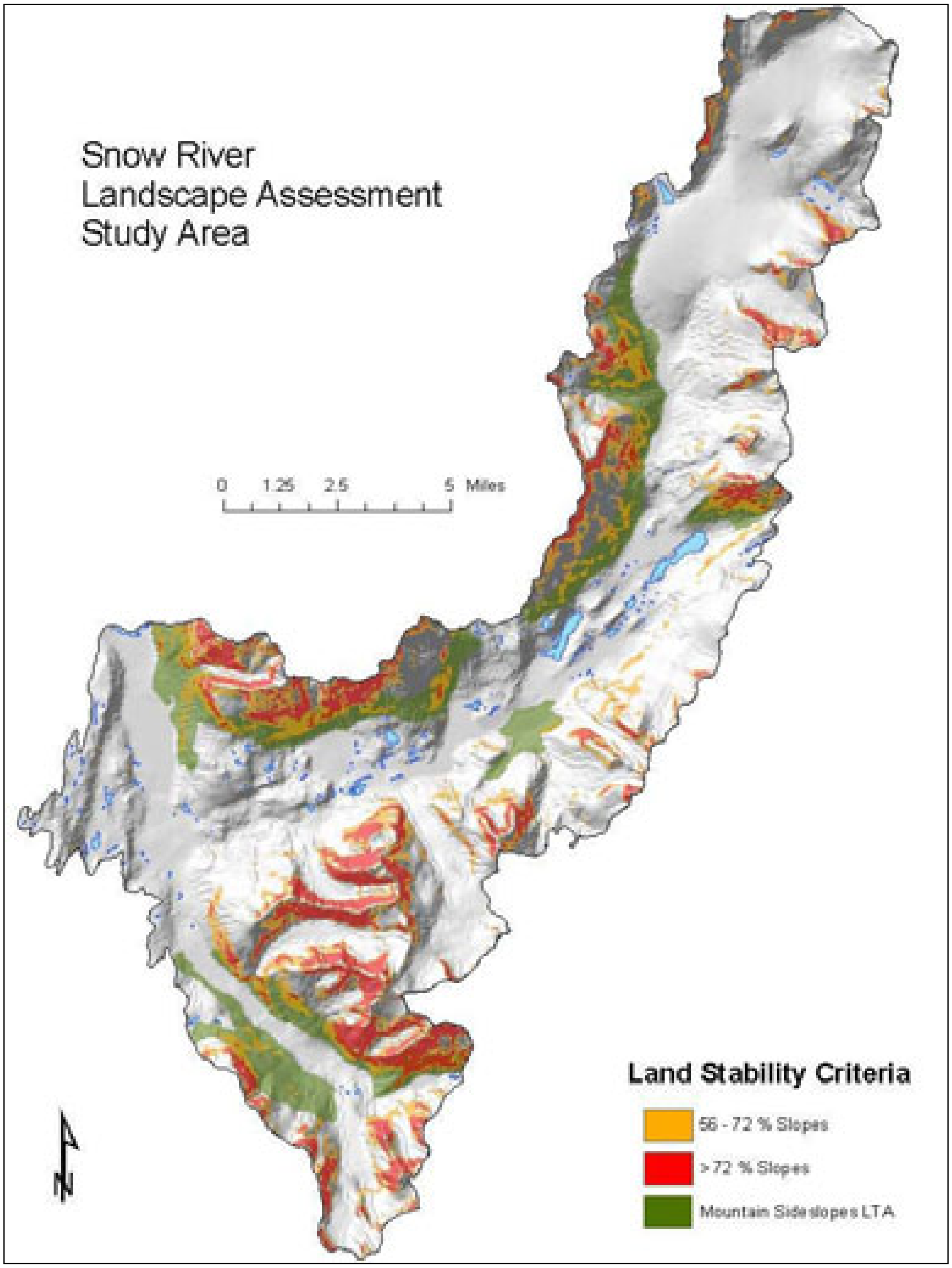

Figure 4.5. Map of the Snow River Watershed illustrating possible areas of concern based on selected land stability criteria.

4.3 Hydrology

4.3.1 Climate

The climate throughout Alaska has gradually become warmer over the past century. Weather data suggest that the average annual temperature has increased by about 2 degrees F over the last 50 years in Seward and Moose Pass (Western Regional Climate Center, 2005) (Figure 4.6). Winter temperatures have increased at a faster rate than summer temperatures. Kenai Lake generally freezes during the winter, but warm winter temperatures allowed the lake to remain unfrozen during the winters of 2001-2002 and 2002-2003. The recession of glaciers throughout Alaska has been a direct result of this changing climate. The influence of the warming climate on hydrologic processes is further discussed in the following sections.

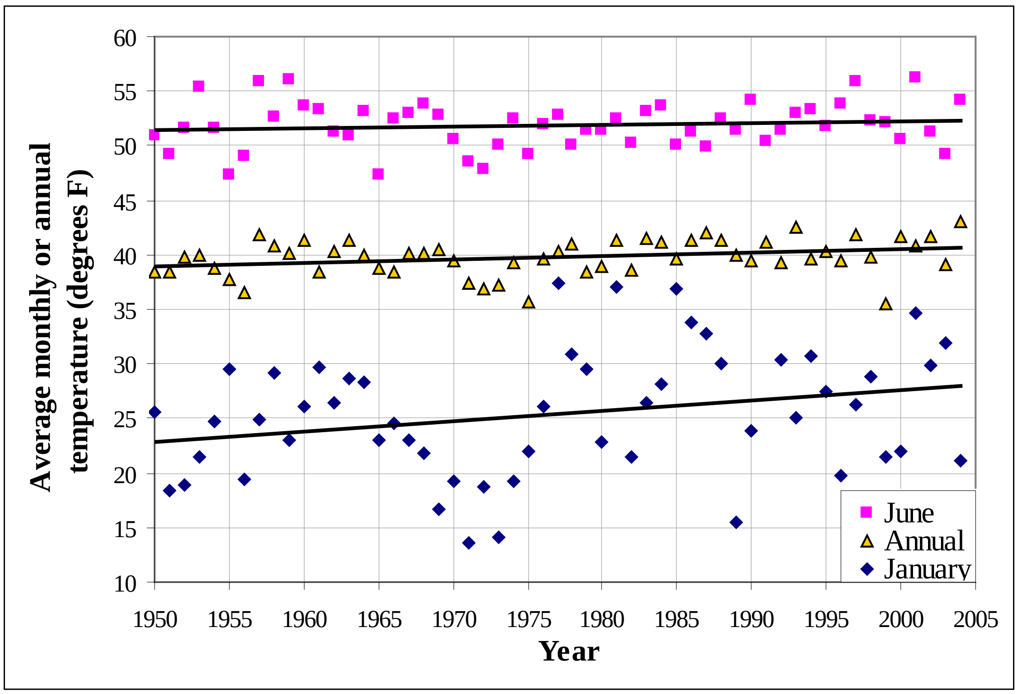

Figure 4.6. Average monthly and annual temperatures, 1950-2004 for Seward, AK (Station #508371-2). Data from Western Regional Climate Center (2005).

4.3.2 Glaciers

The Snow River Glacier has been receding during the last century. Since 1950, the glacier has steadily receded about 1300 feet, or on average about 25 feet per year (Figure 4.7). The glacier has also thinned considerably, likely by as much as hundreds of feet in the lower portion of the glacier. A trim line can be seen along the margin of the lower glacier, where the deglaciated sideslopes remain unvegetated. The other smaller glaciers in the watershed are experiencing similar glacial recession and thinning.

As a result of glacial recession and thinning, the magnitude and number of glacial outburst systems on the Snow River Glacier has changed. The first recorded glacial outburst event on the Snow River occurred in December 1911. Between 1911 and 1949, small outburst floods occurred generally in November, December, or January (Post and Mayo, 1971), and the origin of these floods may have been different from that of the outburst system that currently operates. By 1949, the glacial outburst lake basin was of sufficient size to release large outburst floods. Outburst floods since 1949 have been larger in size and generally occur in September, October, or November. Just south of Moose Creek, another small basin was glacially dammed by the Snow River Glacier. By some time in the 1980s or 1990s, glacial thinning caused this small lake to no longer fill behind the glacier, but drain along the margin of the glacier.

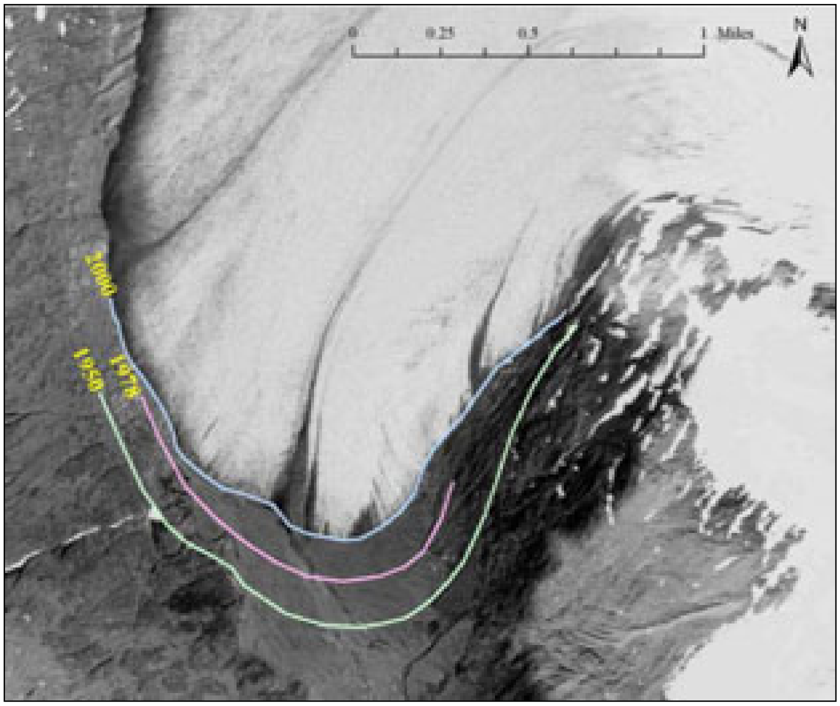

Figure 4.7. Recession of the Snow River Glacier, 1950 to 2000.

The Snow River outburst floods are decreasing in size and are likely to become smaller in the future. As the glacier continues to thin, the height of the glacial dam decreases, the level of the lake decreases, and the volume of the flood flow decreases. At some point in time the outburst floods are likely to no longer occur, when glacial recession and thinning allow the basin to drain along the side of the glacier. This is not likely to happen in the near future, but it is also possible that a different glacial outburst system could develop.

4.3.3 Streamflows

Streamflows on the Snow River are highly dynamic as a result of the jökulhlaup from the Snow River Glacier. These floods can cause the water level of Kenai Lake to rise relatively quickly. However, because of the size and depth of the lake, Kenai Lake attenuates these floods. It takes about a day for the flood peak to travel down the 22-mile length of the lake. By the time it reaches Cooper Landing and the Kenai River, the flood peak is more spread out and about half the size of the original flood (Figure 4.8).

Most of the flood impacts to humans occur on property around Kenai Lake, as development is minimal in the Snow River Watershed itself. During outburst flood events, the road to Primrose Campground is generally closed as a result of flooding, and houses in the area experience flooding. The outburst flood in 1974, with a flow of over 25,000 cfs, occurred during a time of heavy September rainfall, resulting in heavy flooding across Kenai Lake, including Cooper Landing. The flood peaks generally dissipate even further by the time they reach Skilak Lake, where the effects are low to moderate. A rarer case of flooding occurred immediately after the March 1964 earthquake, when numerous underwater landslides in Kenai Lake caused wave run-up onto the land in numerous locations, including the Primrose area. These waves carried large chunks of ice from the frozen lake and caused damage to property along the lake (McCulloch, 1966).

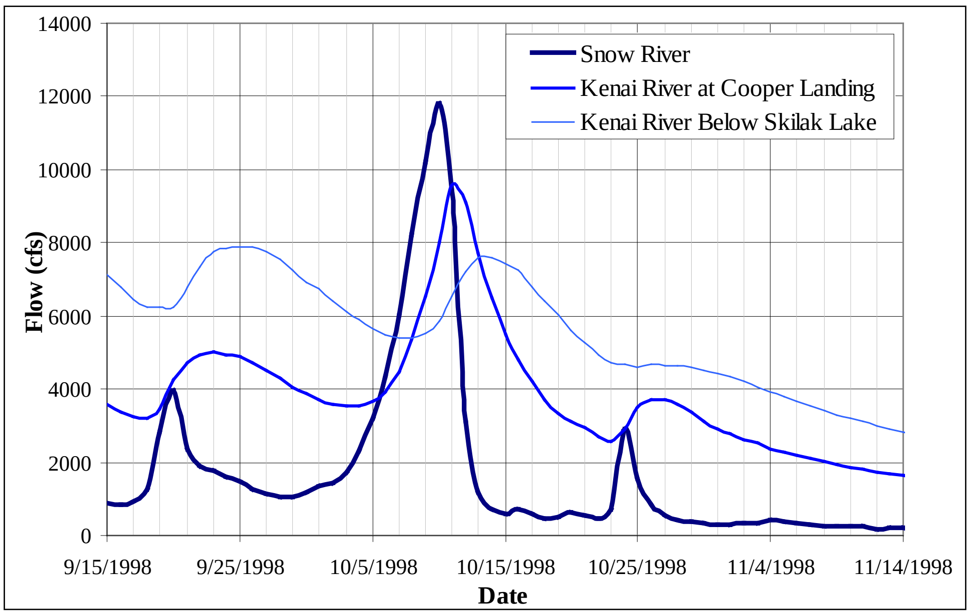

Figure 4.8. Flood attenuation of the 1998 Snow River Glacier outburst flood.

Snow River outburst floods generally carry numerous logs and abundant debris from bank erosion associated with the floods. This debris enters Kenai Lake and slowly makes its way across the lake. Debris that enters the Kenai River can create log jams and other navigational hazards for the numerous boaters that use the Kenai River. Ice is also transported down the Snow River during these floods. This includes large chunks of ice from the glacier, and outburst floods that occur during the winter can break up and transport sheets of river ice downstream. The potential for ice to break up and cause ice jams exists downstream on the Kenai River.

Early glacial outburst floods, between 1911 and 1949, were generally smaller than the natural peak flows from glacial melt, snowmelt, or rainfall. Outburst floods since 1949 have been considerably larger than the natural peak flows (Post and Mayo, 1971). Flood magnitudes from the Snow River outburst floods have shown a slightly decreasing trend since about 1960 (Figure 2.8). The outburst flood magnitudes and volumes are likely to continue to decrease as glacial thinning continues. As the glacial dam decreases in height, the volume of the glacial lake prior to an outburst event also decreases.

4.3.4 Stream Channel

Flood flows from the Snow River outburst floods can cause considerable bank erosion, channel scour, and sediment deposition, resulting in dynamic changes in the Snow River. These effects occur primarily on the Glacial Outwash channels of the Snow River (GO2 and GO3 channels), where the channel is not confined by bedrock (Figure 2.6).

The lower Snow River upstream of Kenai Lake is wide and braided, with a broad, vegetated floodplain. These channels are dynamic, and channel migration is common. Over the last 40 years, the lower Snow River has become more sinuous, and channels have become more well-defined. This may be a result of lower sediment loads during normal flows, associated with recession of the glaciers.

However, outburst floods continue to be a large source of sediment to the lower Snow River. Over the last 40 years, the outlet of the Snow River into Kenai Lake has shifted to the east, and in the process has built a considerable delta into Kenai Lake (Figure 4.9). This delta has expanded approximately 2000 feet into Kenai Lake in the past 40 years. A portion of the Seward Highway now lies on these deltaic deposits after a portion of it was reconstructed in the 1970s. Sediment from these large floods is also deposited on the floodplain of the lower Snow River, resulting in continued building of the land surface.

The Snow River channel is adjacent to the Seward Highway in two locations. Just downstream of the confluence with the South Fork Snow River and upstream of the railroad bridge, a meander bend of the Snow River has migrated toward the road and railroad (Figure 4.9). These structures have basically stopped the migration of the meander bend, but the river is threatening the stability of the road and railroad. The highway is on a high embankment above the river. In another location about 1.5 miles downstream, another meander bend in the channel is adjacent to the highway. The location of the river here has not changed drastically in the past 40 years. The road is constructed on the edge of the valley sideslope, where bedrock provides some structural support to the road as well as the river bank. However, portions of the bank are eroding, threatening the stability of the road. The railroad, on the east side of the valley, is not currently threatened by channels of the Snow River except at the railroad bridge.

4.3.5 Alluvial Fans

A 2-square mile drainage basin on the east side of the lower Snow River Valley creates an alluvial fan at its base. The Alaska Railroad crosses this fan at Mile-16.6 (Figure 4.9). Because this small watershed is steep and partially glaciated, sediment production is high. The fan continues to aggrade, causing problems where the railroad bridge crosses the alluvial fan channel. Approximately every two years, Alaska Railroad personnel channelize the stream upstream of the railroad, but sediment continues to be deposited, reducing the freeboard of the bridge. Current solutions include additional excavation and diking to further channelize the stream and move excess gravel out of the way. Commercial mining of the excess gravel has also been discussed, but no plans for this currently exist. At some point, the channel will migrate to another portion of the fan, as it has many times during the life of the fan.

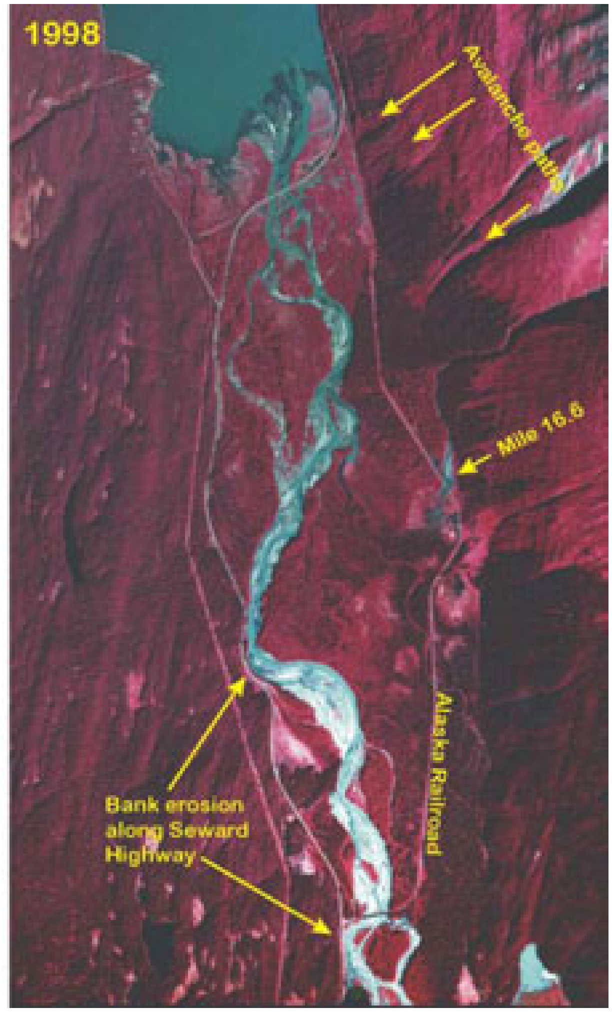

Figure 4.9. The lower Snow River in 1961 and 1998.

4.3.6 Avalanches

Avalanches are widespread throughout the watershed. Avalanche paths at Mile-18, Mile-18.2, and Mile-18.5 of the Seward Highway have the greatest effects on human uses (Figure 4.9). An avalanche and mudslide occurred at the Mile-18 site in May 1977 (March and Robertson, 1982). This avalanche path has a vertical drop of 3800 feet, and this event caused considerable damage to the Seward Highway. The highway was subsequently re-built to avoid this avalanche path. Numerous other avalanche paths are located throughout the watershed, but do not affect structures, roads, or railroads. Winter backcountry users are at risk when traveling near the steep valley side slopes. Many of these avalanches can run a short distance out onto the flat valley plain.

4.3.7 Water Quality

Most of the effects on water quality in the Snow River Watershed are from natural sources. High sediment loads are common as a result of the high proportion of the watershed that is glaciated. Outburst flood events from the Snow River Glacier cause considerable increases in sediment loads, which in turn affect the water quality of Kenai Lake. Most of this sediment settles in Kenai Lake before entering the Kenai River.

Human-caused threats to water quality in the Snow River, Kenai Lake, and the Kenai River include the potential for oil or gasoline spills from the Seward Highway or Alaska Railroad into the Snow River. Such an event could affect fish not only in the Snow River, but in the entire Kenai River watershed. Additional water quality concerns exist from motorized uses within the Snow River watershed. With the numerous “touch-and-go” landings on Paradise Lakes during the summer, the potential exists for spilled oil and gasoline to accumulate to levels that could be harmful to fish in the lakes. No water quality data have been collected for these lakes. Snowmachine use in the South Fork Snow River Valley also has the potential to cause oil and gasoline pollution in the rivers, streams, ponds, and wetlands. As much as a third of the fuel mixture used in standard two-cycle snowmachine engines is emitted out the exhaust pipe unburned (US Environmental Protection Agency, 2002). These unburned hydrocarbons accumulate in the snowpack over the winter and are released when the snow melts. No water quality data for hydrocarbons exist in the Snow River Watershed.

4.4 Vegetation and Ecology

The assessment area includes several consolidated cover types as defined in the Chugach National Forest GIS database (2004). The cover type layer in the GIS database was derived from a more detailed Timber Type layer, and several cover types reflect consolidations of these types according to the Chugach National Forest Resource Information Management Data Dictionary (USDA Forest Service, 2004). White spruce and Sitka spruce were combined to form the hemlock-spruce type, although in this landscape there is no Sitka spruce. Mixed hardwood-softwood type includes aspen-white spruce, birch-white spruce, cottonwood-Sitka spruce, cottonwood-white spruce, cottonwood-birch-white spruce, aspen-hemlock, birch-Sitka spruce, and birch-hemlock. Cottonwood-balsam poplar (which are taxonomically similar) was combined with cottonwood-birch to form cottonwood, aspen-birch and aspen were called aspen, and natural grass and alpine high meadow were combined to form grass and alpine. The original Timber Type layer was derived from aerial photo interpretation in the late 1960s and early 1970s. Additions and changes have been made to this layer as changes are noted on the ground, but the cover types listed polygon by polygon do not necessarily have complete accuracy.

Cover type information is summarized in Table 4.2. The cover types, from the Chugach National Forest GIS Database (2004) Cover Type layer include 7880 acres in alder, 9 acres in aspen, 41 acres in birch, 23 acres in black spruce, 2108 acres in cottonwood, 4838 acres in hemlock, 11,151 acres in hemlock-spruce, 15,165 acres in grass and alpine, 397 acres in mixed hardwood-softwood, 748 acres in muskeg meadow, 4755 acres of other brush, 1364 acres of other nonforested, 1828 acres of Sitka spruce, 28,405 acres of snow and ice, 2387 acres of water, 20,177 acres of rock, 3159 acres of white spruce, and 130 acres of no data. This information should be interpreted with some caution as these data are from the late 1960s and early 1970s, and many vegetation types have shifted or changed. However, of all the landscape areas across the Chugach National Forest, this landscape has been subjected to the least spruce bark beetle damage of those areas previously analyzed on the Kenai Peninsula, and this

GIS data may be more representative of current conditions than in other landscape areas.

Table 4.2. Cover type acreage and percent, from the Chugach National Forest Data Dictionary (2004).

Forested Cover	Acres	Percent
hemlock	4,838	4.63
hemlock-spruce	11,151	10.66
Sitka spruce	1,828	1.75
white spruce	3,159	3.02
black spruce	23	0.02
mixed hardwood-softwood	397	0.38
cottonwood	2,108	2.02
birch	41	0.04
aspen	9	0.01
Total	**23,554**	**22.53**

Nonforested Cover	Acres	Percent
alder	7,880	7.54
muskeg meadow	748	0.72
grass and alpine	15,165	14.50
other brush	4,755	4.55
other nonforested	1,364	1.30
rock	20,177	19.30
water	2,387	2.28
snow and ice	28,405	27.17
Total	**73,789**	**77.35**

No Data	Acres	Percent
no data	130	0.12
Total	**130**	**0.12**

Grand Total	**104,564**	**100**

When considering the landscape as a whole, broad categories of cover type can be important in gaining a clear picture of forested cover as compared to nonforested cover. Much of this landscape falls into a nonforested vegetation category, including grasslands, alpine meadows, and shrub or brushlands. Table 4.2 shows that close to 74 percent of this landscape area is nonforested. Much of the acreage is in rock or snow and ice (nearly 30 percent) as this landscape contains many steep side slopes angling down to the broad river valley, and many upper valleys.

Figure 4.10. View of icefields in upper part of watershed, with alder and forbs in foreground.

This assessment shows the common effect in this part of Alaska of elevational gradients on the distribution and type of vegetation. Vegetation above 1500 feet elevation is generally shrub and alder-dominated communities, including areas of dwarf birch, salmonberry, willow, various ericaceous shrubs and heath, mountain-ash, and others. Forested areas are generally confined to below 1500 feet. Within the forested types, the system of streams that flow into Snow River, and in turn, into Kenai Lake, create a number of unique riparian vegetation types including some nonforested vegetative types at lower elevations (Viereck et al., 1992).

Forested types comprise the remaining 26 percent of the assessment area, and no data exist for only 130 acres of the area. The dominant vegetation in most of the forested areas include mountain hemlock-Lutz spruce/rusty menziesia plant community types, often with devil's club present, or mountain hemlock-Lutz spruce/devil's club types (DeVelice et al., 1999). The GIS data does not differentiate between Lutz and white spruce, so white spruce in this area can be considered Lutz spruce. Lutz spruce/devil's club is a minor type of the forested areas. The largest trees are found in the Lutz spruce/devil's club plant communities. Lutz spruce dominates stands occurring on concave slopes, draws, and slopes with devil's club (indicating water moving near the surface. Mountain hemlock dominates stands that occur on ridges and convex slopes. Some mountain hemlock-rusty menziesia types are found on ridges. Canopy gaps from areas of blow down feature abundant rusty menziesia, devil's clubs, or Sitka alder with mountain hemlock and rusty menziesia regeneration present. Steep slope areas also have mountain hemlock/blueberry types with abundant rusty menziesia.

Figure 4.11. Typical lower elevation spruce-shrubby types with alpine areas in background.

There are some larger diameter old growth mountain hemlock and Sitka spruce in places. Productive areas are evident by large-sized stands within the assessment area, mostly on bench areas, lower slopes, and just below low ridges. Productive spruce areas have had few management activities in the past. Water courses and ephemeral streams are common in many lower slope areas. Lower slope areas feature some Sitka or Lutz spruce/Sitka alder types, commonly associated with horsetails (*Equisetum arvense*). Cliff and rock-bound areas are common on the upper slopes. Draws are dominated by Sitka alder, devil's club, and sometimes willows (*Salix* spp.) in the lower third. Rock outcrops are common along the ridges and along the river valley. More pure Sitka-like spruce are found in the lowest river drainages and the southern-most edge of the assessment area.

Forested understory is often dominated by wood fern (*Dryopteris dilatata*) in some places, moss (many spp.) in others, and oak fern (*Gymnocarpium dryopteris*) in others. Seral stages show many paper birch snags present. Undisturbed avalanche areas appear to regenerate with birch in some areas.

Horsetails and Sitka alder are common along the riparian areas and the frequent meanders of the Snow River. Plant community types in these areas include open scattered spruce with balsam poplar (*Populus balsamifera*), or cottonwood in the GIS data, Lutz spruce/Sitka alder, Lutz spruce/common horsetail, and Lutz spruce/oak fern. Bark beetle activity is not evident in these areas. Some flat areas adjacent to the river banks are dominated by a mix of willow species. Wet *Sphagnum* spp. moss areas are common in places in the lower valleys. Lower areas, particularly near the river or its tributaries, are subject to flooding and scouring by ice in the winter and spring. Early successional vegetation including grasses (dominated by *Calamagrostis canadensis*), sedges (*Carex* spp.) and mixed shrubs are present. Alluvial disturbance is obvious in places.

4.4.1 Natural Disturbance

Most canopy gaps have good Lutz spruce regeneration. Much of the assessment area appears to be susceptible to windthrow, so management activities should take this into account when planning thinning regimes.

There are avalanche-prone sideslopes covered with Sitka alder in the slide paths. Below the avalanche slopes are evidence of power blasts in snapped off trees and high volumes of downed woody material.

Beaver activity has caused flooding in places, creating wetland and sedge meadow and willow-dominated vegetation types. Dead spruce trees are often still standing in beaver activity areas. These and other wetland areas would be sensitive to any kind of development activity, including recreational development of trails or timber stand management activities.

Jökulhlaups, or glacial outburst floods created by an ice dam on the Snow River Glacier, occur every two to four years, releasing a sudden surge of flood water down the Snow River when the dam breaks. This event contributes to the scoured appearance of the immediate river banks and the lack of mature tree communities in areas affected by this flooding.

4.4.2 Human Disturbance

Areas of tie-hacking are present along the lower reaches of the Snow River. The Seward Highway runs along a small portion of the Snow River, and there is a bridge over its outlet at Kenai Lake. There are two USFS cabins constructed at Upper and Lower Paradise Lakes, but there are no established or maintained trails to either of these cabins. Very little management work has been done in this area due to the difficulties in accessing much of this landscape, the steep slopes, and limited productive forest.

Areas of this landscape are used recreationally by off-road vehicles. Access is frequently through the Alaska Railroad bridges, although access is technically not permitted. The Alaska Railroad parallels the highway for several miles, then drops down to the Kenai Lake shore. Damage to the gravel areas favored by ATV users is evident through tire and scour marks. ATV damage often occurs in pale poppy (a sensitive plant) habitat.

The landscape is used recreationally in the winter by snowmachiners and cross country skiers. Access is limited by technical skills in both of these sports. The effects of these activities on vegetation is minimal during the winter months.

4.4.3 Sensitive Plants

Kenai Lake stream inlets comprised of gravel substrate, including the inlet for the Snow River, provide habitat for the pale poppy, although the only documented populations near the assessment area are located at the mouth of Victor Creek.

Habitat for other sensitive plants listed on the Regional Forester's Sensitive Plant Species List (USDA 2002c) include alpine areas, upper riparian zones, *Sphagnum* bogs, steep cliff faces, and freshwater pools. There are likely populations of undiscovered sensitive plants from the Regional Forester's List. There are also likely a number of rare species, as ranked by the Alaska Natural Heritage Program (Lipkin and Murray, 1997).

4.4.4 Invasive and Non-Native Species

Invasive species, a subset of non-native species that are characterized by rapid spread and takeover of native habitats, are limited in this landscape because of the relatively few trails and roads. Some invasive species are found along the railroad and the highway, and the few short trails that lead into the landscape area, including white sweet clover (*Melilotus alba*) and butter-n-eggs or toadflax (*Linaria vulgaris*).

Non-native species are found along the highway and railroad, in the gravel areas below the railroad bridges, in the roadside pullouts, at trailheads, along trails, and especially around the two Forest Service public-use cabin sites. These species include pineapple weed (*Matricaria discoidea*), common dandelion (*Taraxacum officinale* ssp. *officinale*), white cover (*Trifolium pratense*) and common chickweed (*Stellaria media*).

Increases in recreational use, addition of trails, huts, campgrounds, or other development would lead to an increase in both non-native species and invasive species in this landscape. This effect should be minimized or avoided in Alaska, which is still relatively free of the invasive problems found in other parts of the western United States (Boughten and Shephard, 2002).

4.4.5 Spruce Bark Beetle Effects

Spruce bark beetle damage is limited in this assessment area. There are some dead spruce scattered near the highway, but most spruce appears healthy. Stand exam data from this area in 1996 indicates that only 6 percent of the spruce had suffered mortality at that time. More current data is not available, but a visual examination of recent aerial photos, viewsheds from the highway and overflights reveal that mortality is still limited. Further spruce bark beetle activity or mortality is not anticipated in this assessment area.

4.5 Fire

Air Quality

Alaska periodically experiences air pollution from natural events including forest fires; volcanic eruptions and high wind glacial dust storms. The municipalities of Anchorage, Fairbanks and Juneau have experienced degraded air quality due to automobile exhaust and wood burning for home heating. Overall, Alaska residents enjoy a high degree of air quality.

Smoke, particularly from wildfires, has the potential to affect both local and regional air quality. Depending on its concentration, smoke from wildland fires can impact highway and aircraft safety, and affect visitor enjoyment. Fine particulate matter found in smoke can directly reduce local visibility and cause respiratory distress and disease in some individuals (NWCG 2001)

Fuel consumption and emissions are dependent on variables for ignition including fuel moisture, relative humidity, temperature, topography and wind speed. Predicted emissions from wildfire in the assessment area could be estimated using emission factors from First Order Fire Effects Model (FOFEM) during a given event.

Non-Attainment Areas near the Snow River Watershed
Ambient air quality standards (AAQS) are defined as maximum concentrations of pollutants present in the air at levels considered safe to public health and welfare. For each standard an adequate margin of safety is provided to protect sensitive members of the population, such as young children, the elderly and people suffering from illnesses. The National AAQS (NAAQS) were first established by the Clean Air Amendments of 1970. The municipality of Anchorage is a non-attainment area for particulate matter of 10 microns (EPA 2004).

Foreseeable Impacts
Temporary and short-term visibility impacts can be expected in the immediate area during actual wildfire and would be affected by wind speed and direction. Drainage inversions will affect nighttime dispersal of smoke, with possible smoke effects 5 to 10 miles down canyon. Smoke from burning forest fuels can impact human health, particularly for the ground crews at the site.

Residents near the actual burn area may receive some respiratory discomfort; however, it is expected that most impacts will be in the form of nuisance smoke and/or smell. Smoke from the wildfire and the associated emissions would reside in the local airsheds a relatively short time depending on the weather and duration of fire. During the evening hours during a wildfire, some smoke would be expected to settle into the lower draws and drainages toward Anchorage, Cooper Landing, Seward, Moose Pass and the Sterling Highway. Some signing may be needed along roads to warn the public of smoky conditions. Smoke trapped in low-lying areas would be expected to dissipate when the nighttime inversion lifted.

4.6 Aquatic Species and Habitats

The Snow River area is not known to be a high-use angler area. There are four stocked lakes in the Snow River Watershed. Meridian and Long Lakes are on a five-year stocking plan, receiving up to 1500 fry during stocking years (ADF&G, 2005a). Lower and Upper Paradise Lakes have not been stocked since the sixties, and both seem to be maintaining fish populations. Although Lower Paradise Lake was never stocked with arctic grayling, it has a very stable population that apparently migrated into the lake from Upper Paradise Lake during a flood event. Rainbow trout are present in Lower Paradise Lake, but are not abundant according to angler accounts from cabin log books. Dolly Varden char are using the South Fork Snow River for spawning (Palmer, 2005). The South Fork Snow River is open to fishing from June 11 through September 14, and November 1 through May 1 (ADF&G, 2005b). According to the Alaska Department of Fish and Game Anadromous Catalog (ADF&G, 1992), the distribution of coho and sockeye salmon on the South Fork Snow River extends approximately 5.34 miles upstream from the confluence with the North Fork.

4.7 Terrestrial Species and Habitats

The diverse mosaic of habitat types within the Snow River Watershed supports populations of an array of large game and other nongame animals. Management has focused on management indicator species and species of concern to characterize existing conditions. In addition, while no threatened or endangered species, or potential habitat for these species exist in the watershed, trumpeter swans, a sensitive species, have been documented in the watershed during surveys in 2004. Several other sensitive species have existing or potential habitat in the watershed (Table 4.3).

Table 4.3. Threatened and Endangered Species (TES), Management Indicator Species (MIS), and Species of Special Interest (SSI) habitat of the Snow River Watershed.

SPECIES	MIS	TES	SSI	EXISTING HABITAT?	POTENTIAL HABITAT?
Humpback Whale		X		No	No
Steller's Eider (Threatened)		X		No	No
Montague Island Tundra Vole (Sensitive)		X		No	No
Osprey (Sensitive)		X		No	Yes
Peale's Peregrine Falcon (Sensitive)		X		No	No
Steller Sea Lion (Endangered)		X		No	No
Dusky Canada Goose (Sensitive)	X	X		No	No
Kittlitz Murrelet (Candidate)		X		No	No
Trumpeter Swan (Sensitive)		X		Yes	Yes
Brown Bear	X			Yes	Yes
Black Oystercatcher	X			No	No
Moose	X			Yes	Yes
Mountain Goat	X			Yes	Yes
Gray Wolf			X	Yes	Yes
Lynx			X	Yes	Yes
Marbled Murrelet			X	Unknown	Unlikely
Montague Island Hoary Marmot			X	No	No
River Otter			X	Unknown	Yes
Sitka Black-Tailed Deer			X	Unknown	Yes
Townsend's Warbler			X	Unknown	Yes
Wolverine			X	Yes	Yes
Bald Eagle			X	Yes	Yes
Northern Goshawk			X	Unknown	Yes

4.7.1 Sensitive Species

Trumpeter Swans

Potential habitat for trumpeter swans was mapped using available GIS data (Figure 4.12). Specific habitat characteristics were selected that represented the type of habitat where swans have been found in areas such as the Cordova Ranger District and the Kenai National Wildlife Refuge (KNWR). These criteria included all low-energy, wetland streams identified as Narrow Placid Flow (PA1) channels (USDA Forest Service, Alaska Region, 1992), and smaller lakes and ponds less than 260 acres in size. The Snow River Watershed contains 13.5 miles of PA1 channel type streams and 932 acres of smaller lakes and ponds (Figure 4.11). There appears to be high quality habitat in the Snow River valley upstream of the canyon. All potential habitat was surveyed in 2004 in the spring and fall to determine occupancy and reproduction.

Trumpeter swans were observed in the watershed during the breeding season during surveys conducted in 2004 and 2005 (Figure 4.12).

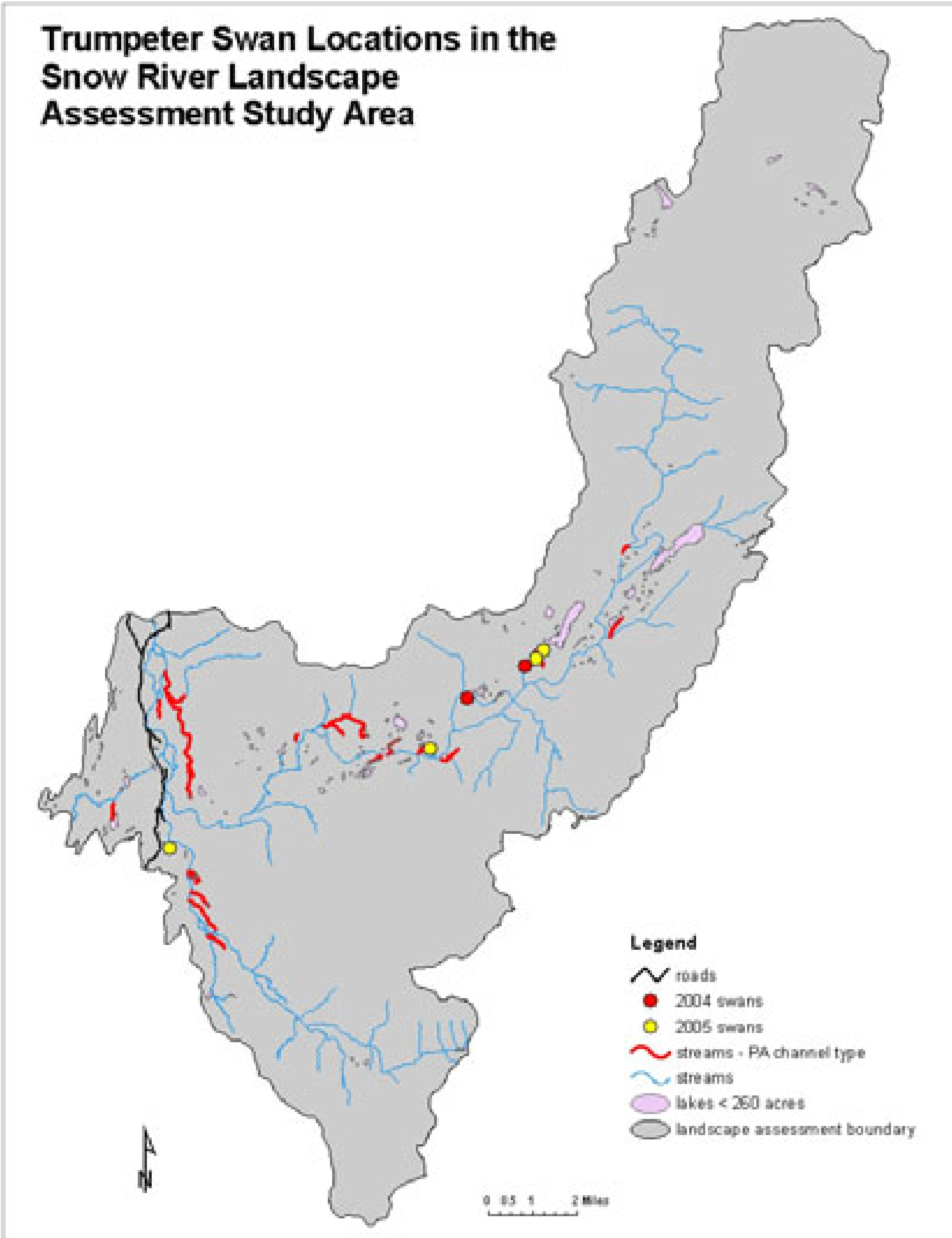

Figure 4.12. Trumpeter Swan Locations in the Snow River Watershed.

A flock of four swans was seen during the spring survey on May 28, 2004, and a single swan was seen during the fall survey on August 4, 2004. During the 2005 spring survey, one pair and a single swan were seen in the North Fork Snow River, and a single swan was seen in the South Fork Snow River near Mile-12 of the Seward Highway. Later in the season, a pair was seen in the vicinity frequently. No nests or cygnets were observed during surveys, so it is unknown whether the swans were using the Snow River area for breeding.

Osprey

The osprey (*Pandion haliaeetus*) is a Region 10 sensitive species. It is considered uncommon to rare throughout Alaska (Palmer, 1988). The osprey is widely distributed across much of Alaska south of the Brooks Range, but localized in the vicinity of lakes, large rivers, and coastal bays (Gabrielson and Lincoln, 1995). Osprey nests are generally located in the hemlock/spruce forest type and are usually near lakes, streams, beaver ponds, coastal beaches or large estuaries. They nest near water, atop trees, posts, rock pinnacles, or even the ground. Interaction and competition with the abundant bald eagle population may be a limiting factor (USDA Forest Service, Chugach National Forest, 2002b).

Osprey are not known to use the Snow River Watershed, but potential nesting and foraging habitat do occur in the watershed. Osprey may travel through the area during spring and fall migrations, but they are not considered to be winter residents.

4.7.2 Management Indicator Species

Moose

Moose are primarily associated with early to mid-succession habitat and riparian areas (USDA Forest Service, Chugach National Forest, 2002b) and are dependent on early seral vegetation types including young hardwoods (willow, birch, aspen and to a smaller extent, cottonwoods). The availability of winter range is considered to be the major limiting factor for moose population size. On the Kenai Peninsula, other limiting factors include predation, hunting, and mortality from vehicular collisions (Lottsfeldt-Frost, 2000). Renecker and Schwartz (1998) found that the distance between feeding and hiding/thermal cover also can be a limiting factor, especially in areas of large-scale disturbance.

Chugach National Forest GIS data indicate that high value moose habitat covers just less than 35,000 acres within the watershed. The largest amount of high quality moose habitat is found in riparian areas along the river valley, however high quality habitat is distributed throughout the watershed on all but the highest elevations.

Current cover-type mapping in the GIS database must be updated to more accurately reflect the existing distribution of hardwood habitat types used and favored by moose. Existing GIS vegetation-type mapping does not accurately identify early seral vegetation. For example, birch stands mapped in the seedling/sapling size class are typically 80 years old and no longer provide forage. An updated analysis of existing habitat composition, including age and size classes, is needed to estimate the acreage and quality of moose habitat and to identify the location and extent of potential habitat enhancement opportunities (e.g., prescribed burning or silvicultural treatments). The Alaska Department of Fish and Game considers the overall habitat on the Seward

Ranger District to be of low quality and capable of supporting only 2 to 5 moose per square mile.

The spruce bark beetle has not had a significant impact on the watershed. The only areas which have been impacted are on the west side of the watershed in areas adjacent to the highway. In more heavily infested areas, such as near the Primrose Road and Campground, dead or dying spruce forest types are likely to be replaced by early seral phase vegetation communities favorable to moose.

Mountain Goat

Mountain goats use cliffs, alpine, sub-alpine and old-growth habitats and are generally found near steep cliffs with slopes greater than 50 degrees. In Southcentral Alaska, winter habitat may be a limiting factor for mountain goat populations. They are also sensitive to low-level aircraft flights over summer alpine kidding habitats and wintering areas (USDA Forest Service, Chugach National Forest, 2002b).

Based on Chugach National Forest GIS data, mountain goat winter range primarily occurs on south-facing alpine slopes on approximately 4142 acres within the watershed. Mountain goats are known to occur on Sheep Mountain and on Paradise Peak (Shuster, 2005). Goats have also been seen during aerial surveys for trumpeter swans in August on the slopes at the top of the Snow River drainage flanking the Snow River Glacier.

Brown Bear

Brown bears have large home range requirements and are generally intolerant of human activities and development. Suring et al. (1998) estimated the Kenai Peninsula population at 280 bears, or about 12 bears per 386 square miles. On the Kenai Peninsula, the primary limiting factor is spring and summer feeding habitat. Spring and summer habitat includes south-facing hillsides and avalanche chutes, big game winter ranges, and salmon streams that provide the high quality foods that bears need to develop fat reserves before denning and to replenish fat stores depleted after denning. Carrion, berries, and fish sources in the watershed provide a diversity of food sources for bears.

Chugach National Forest GIS data indicate that the watershed contains 2,801 acres of low value brown bear habitat, 62,005 acres of moderate value habitat and 675 acres of high value habitat. Of the high value habitat, 148 acres occur along the South Fork Snow River, 92 acres occur along the mainstem of the Snow River downstream of the confluence of the South Fork, and 436 acres occur in the upper Snow River valley above the confluence of the South Fork.

Roads and trails, other existing development, and increasing levels of recreational activities in the watershed may reduce the quality of available habitat and increase the number of negative bear-human encounters. On the Kenai Peninsula, habitat modification and human activities have resulted in an increase in the number of brown bears killed in defense of life or property (DLP) (Suring and Del Frate, 2002). During the summer, bears concentrate along low-elevation valley bottoms and coastal salmon streams in areas that are heavily used by humans. Several encounters have occurred at salmon streams resulting in injury to humans and injury or death to brown bears.

4.7.3 Species of Special Interest

Bald Eagle

Bald eagles in Southcentral Alaska generally nest in old cottonwood trees near water and use the same nest each year (Daum, 1994). The proximity of large nest trees to food sources is the primary limiting factor for the bald eagle population. Eighty-two percent of all bald eagle nests on the Seward Ranger District are in mature cottonwood trees with an average diameter of 31 inches and within one-quarter mile of an anadromous fish-bearing stream.

There are four documented bald eagle nests in the watershed, two on the mainstem of Snow River near the inlet of Kenai Lake near the highway, one on the South Fork Snow River approximately 1.5 miles upstream of the confluence, and one on the North Fork Snow River downstream of Lower Paradise Lake (Figure 4.13). Information on historic populations of bald eagles is not available. Habitat impacts, if they exist in the watershed, are likely related to natural disturbances such as flooding and human disturbance from recreation and aircraft.

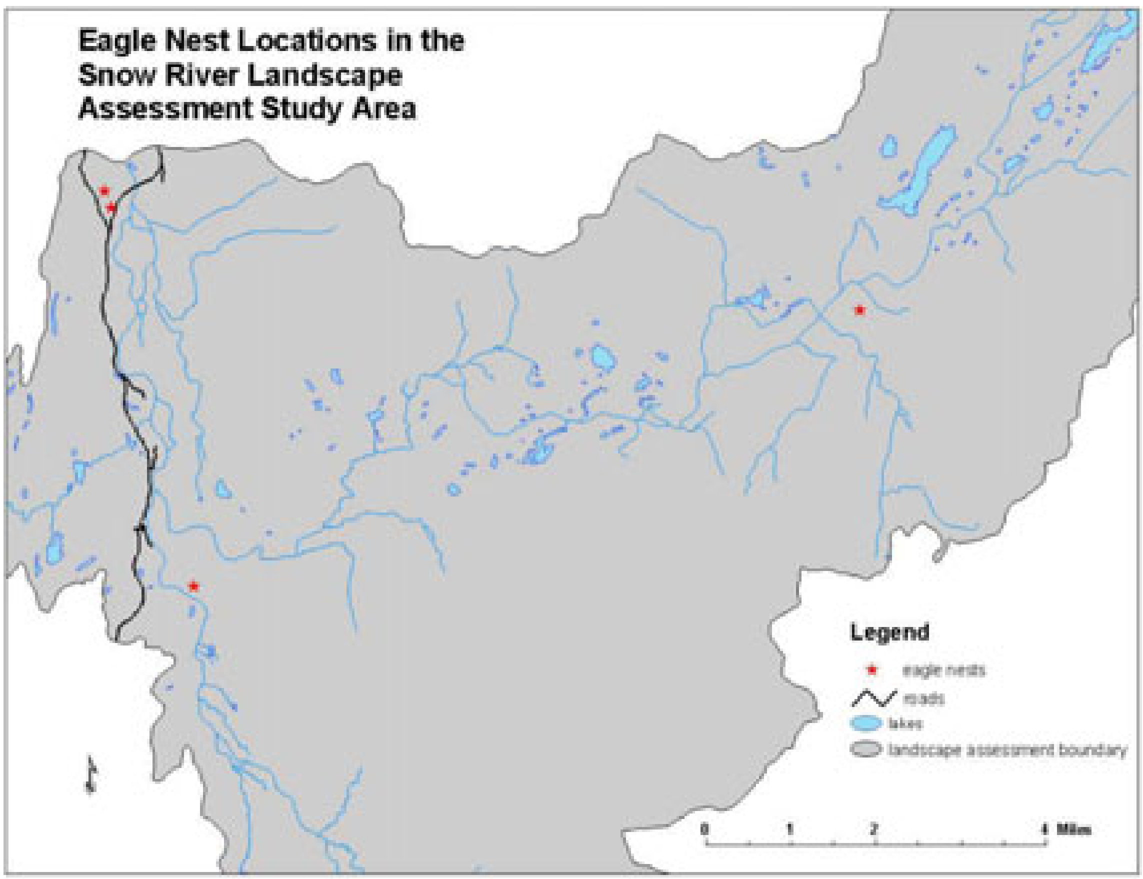

Figure 4.13. Bald Eagle Nests in the Snow River Watershed.

Wolverine

The wolverine is a scavenger and opportunistic forager with a low biotic potential and large home range requirement. Similar to the brown bear, it is sensitive to human activities and development. Recreational uses and hunting may be population-limiting factors.

Little is known about wolverine populations and their use of the watershed. Four sets of wolverine tracks were seen during aerial surveys in the upper Snow River Valley in 1992 (Golden et al., 1993). A wolverine was observed by USFS biologists in June 1996 in the western part of the watershed, east of the Snow River and the railroad (Shuster, 2005). Wolverines travel over a wide range of habitats in search of food such as big game carrion (moose and goats) that occur within the watershed.

Northern Goshawk

The northern goshawk is an uncommon forest raptor that feeds on small and medium sized mammals and birds (Iverson et al., 1996). They are year-round residents of the Chugach National Forest (USDA Forest Service, 1984). The amount and juxtaposition of feeding and nesting habitat appears to limit population viability in Southeast Alaska (Iverson et al., 1996). The nesting-breeding season is from March to July. The majority of goshawk nests on the Seward Ranger District are in old growth hemlock-spruce stands characterized by a closed canopy, large average diameter, gap regeneration, and an open understory (SRD goshawk nest files).

There are three known northern goshawk nests located within the Snow River watershed, and additional potential habitat exists in older hemlock and hemlock-spruce forests within the watershed (Figure 4.14). The area on the west side of the highway between Primrose Campground and Ski Lake was surveyed in 1996 (Foster Wheeler Environmental Corporation, Inc 1996). The Meridian nest was discovered, and an additional unoccupied nest was found approximately ½ mile west of the junction of the Primrose spur and the Seward Highway. In 2004, two additional nests were discovered in the Primrose area and in the Snow River area near Mile-12 of the Seward Highway. Both of these nests were active and produced young. No surveys have been conducted to determine if goshawks are present and breeding in the remainder of the potential habitat areas of the watershed.

The majority of old growth hemlock and spruce stands in the watershed are in the southwest portion of the watershed along the highway and the river. There are also some stands of old growth in the Snow River valley around the Paradise Lakes area. Although these stands are not as extensive based on GIS data, they may provide nesting or foraging habitat. Based on the antiquity of the GIS data, there are potentially additional areas mapped as mature spruce and hemlock forest that may be approaching, or currently exist as old growth within the study area which may provide additional habitat for goshawks.

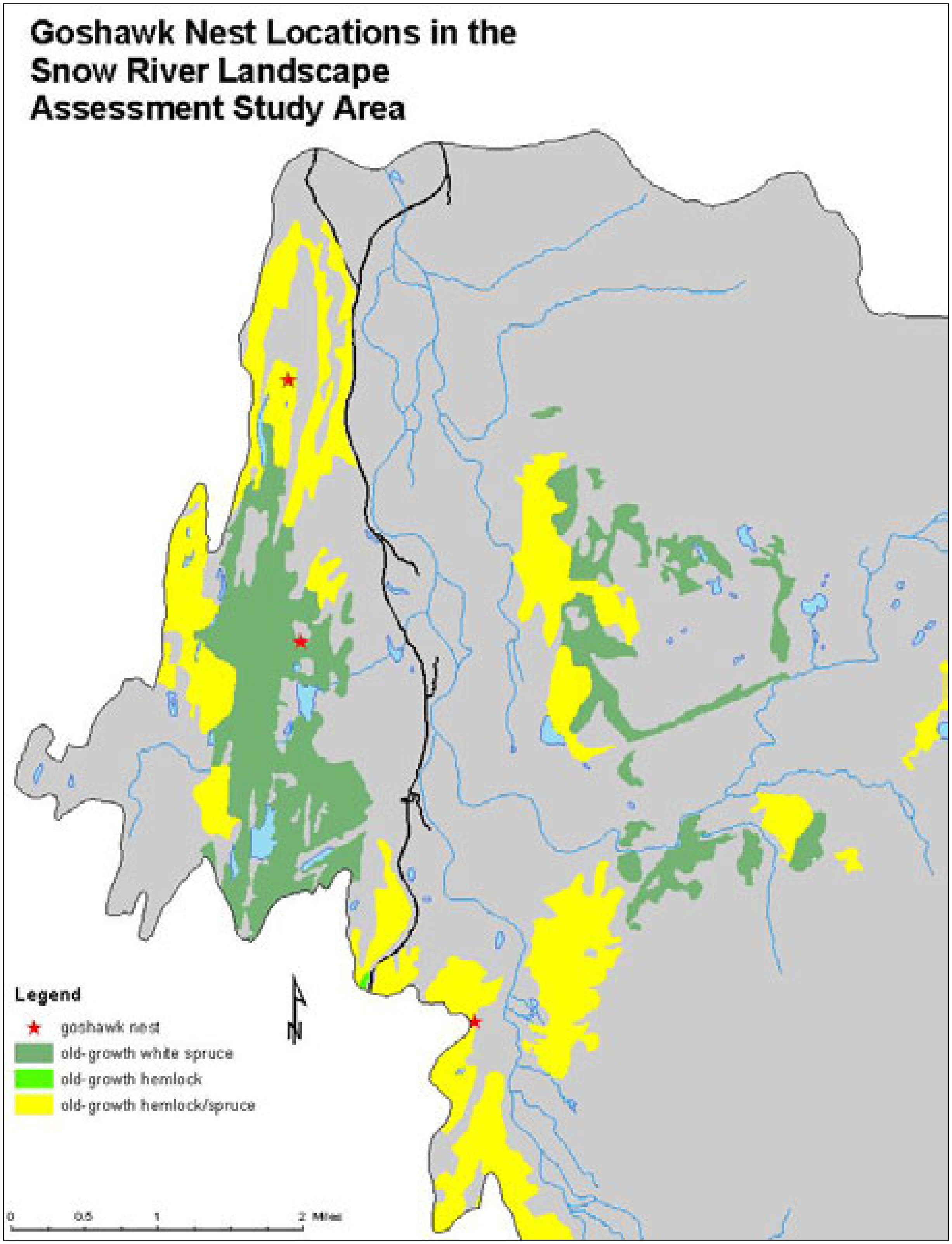

Figure 4.14. Northern Goshawk nests and potential habitat in the Snow River Watershed.

River Otter

River otters are associated with coastal and fresh water environments and the immediately adjacent (within 100 to 500 feet) upland habitats (Toweill and Tabor, 1982; USDA Forest Service, Chugach National Forest, 2002b). Beach characteristics affect the availability of food and cover, and adjacent upland vegetation also provides cover (USDA Forest Service, Chugach National Forest, 2002b). Otters travel several miles overland between bodies of water and develop well-defined trails that are used year after year (USDA Forest Service, Chugach National Forest, 2002b). River otters breed in late winter or early spring. Young are born from November to May with a peak in March and April (Toweill and Tabor, 1982). The family unit usually travels over an area of only a few square miles (USDA Forest Service, Chugach National Forest, 2002b). Data on river otter populations in the Snow River watershed are lacking. Habitat for river otter is likely along the South Fork and mainstem Snow River and some of its tributaries.

Lynx

Lynx use a variety of habitats, including spruce and hardwood forests, in early successional communities. They require a mosaic of conditions, including early successional forests for hunting and mature forests for denning (Koehler and Brittell, 1990). Lynx habitat in Alaska occurs where fires or other factors create and maintain a mixture of vegetation types with an abundance of early successional growth (Berrie, 1973; Berrie et al., 1994). In Alaska, lynx tend to use elevations ranging from 1000 to 3500 feet and seldom use unforested alpine slopes (Berrie, 1973). Mating occurs in March and early April, and kittens are born 63 days later under a natural shelter such as a wind-fallen spruce or rock ledge (Berrie et al., 1994). The production and survival of lynx kittens is influenced dramatically by cyclic changes in snowshoe hare and other small mammal populations (Poole, 1994). The populations of lynx on the Chugach National Forest are thought to be stable and within the range of historic viability (USDA Forest Service, Chugach National Forest, 2002b). Lynx probably occur throughout forested sections of the Snow River Watershed, but no data are available.

Marbled Murrelet

Marbled murrelets are medium sized seabirds that inhabit near-shore coastal waters, inland freshwater lakes, and nest in inland areas of old-growth conifer forest or on the ground (Carter and Sealy, 1986; Marshall, 1988). Except for the fall period when they are molting, flightless, and stay on the ocean, murrelets are known to fly to tree stands.

Marbled murrelet surveys were conducted in 1991, 1994, 1996 and 2003 in the southwest portion of the watershed. Specific areas where surveys have been conducted include Ski Lake, Meridian, Grayling, Leech and Long Lakes, Primrose Road and Campground and the Snow River valley along the railroad corridor adjacent to the Snow River (SRD district wildlife files). Murrelets were detected in all of these areas. Due to the number of sightings and the type of behavior exhibited, it is likely that there may be nest areas in the area around Meridian and Grayling Lakes. The Snow River valley area had the lowest number of detections. There has been speculation that due to the high number of detections and nesting behavior exhibited in the Victor Creek area, murrelets could be utilizing the Snow River as a flyway at a higher elevation than the survey points, which are all located around 450 feet in elevation. Mature hemlock and spruce hemlock forests in this watershed may provide suitable nesting habitat.

Townsend's Warbler

Townsend's warblers are found throughout forested locations in the Snow River Watershed. They are associated with older, mature spruce and hemlock forests and are not found as often in young coniferous or hardwood forests.

The Seward Ranger District has two point count routes that fall within the watershed. Surveys on these routes have been conducted since 2002. Both routes traverse a variety of habitats, but include sections of mature and old growth spruce and hemlock forests. Townsend's warblers have been identified on both survey routes in all years. Results from surveys taken at these and other locations on the District indicate that Townsend's warblers are found in higher numbers in older spruce and hemlock forests, and that they have declined in numbers between 1994 and 2000 (Prosser, 2002).

No GIS data exist on the Chugach National Forest for Townsend's warbler habitat, but it can be assumed that it occurs throughout forested sections of this watershed, most abundantly in hemlock and spruce-hemlock forests.

Gray Wolf

Wolves are habitat generalists. During winter, wolves are found at lower elevations in forested or woodland areas (Stephenson, 1994). Wolves are highly social animals and usually live in packs that include parents and pups of the year. Pack size usually ranges from 2 to 12 animals. In Alaska the territory of a pack often includes from 300 to 1,000 square miles of habitat, with the average being about 600 square miles (Stephenson, 1994). Wolves normally breed in February and March, and pups are born in May or early June (Stephenson, 1994). There are approximately 10 to 11 packs on the Seward Ranger District. Personnel conducting field work in the Snow River area have documented wolf tracks in the gravel bars along the river and heard wolves howl at night (SRD wildlife files).

4.8 Human Uses

4.8.1 Human Uses: Past

Knowledge of the current range, distribution and condition of cultural resources depends on the research of historic records, reports, archives and field investigations. The information available for the known cultural resources comes primarily from research and field investigations conducted by the Chugach National Forest Heritage Department and private sector archeological contracts for various Chugach National Forest projects.

The known sites around the Snow River Watershed are almost entirely from the historic period and are concentrated around the current Seward Highway and Alaska Railroad corridor where the majority of the archeological surveys have occurred. This prehistoric travel corridor corresponds to the primary route of the Iditarod National Historic Trail (INHT). There are also many historic connecting trails to the INHT, which reflect the long history of human occupation in this region. Of the 44 historic archeological sites, ten are sites of historic residences and homesteads, three are roadhouses, twelve sites are affiliated with mining in the area, eight sites are associated with the railroad, and five are historic trails and roads (Table 4.4, Figure 4.15).

Table 4.4. Archeological sites in the Snow River Landscape Assessment Area.

AHRS #	FS#	Other #	Site Name	Period	Type
SEW-00020*	29		Divide (Summit R.R. Station)	Historic: 1904	Transportation: Railroad
SEW-00029	167		Alaska Railroad (ARR)	Historic: 1904-	Transportation: Railroad
SEW-00115*	41		Tunnel O	Historic: 1917-	Transportation: Railroad
SEW-00116 (NLUR #6,7)	30		Primrose (Lake Kenai)	Historic: 1917-1920s	Transportation: Railroad
SEW-00117*	31		Lakeview (Kenai R.R. Station)	Historic: 1904-1940s	Transportation: Railroad
SEW-00142* (S – 213)	42		Primrose Mine	Historic: 1910s-1930s	Mining
SEW-00148	49		Iditarod Trail	Historic: 1890s-1920s	Transportation: Trail
SEW-00163*; NLUR 12,13,14	32		Victor Creek Prospect	Historic: 1930s	Mining
SEW-00250	492		Minnie Andacher Homestead	Historic: 1930s	Residence/Homestead
SEW-00598*			Cabin and Log Garage	Historic: 1920s	Residence/Homestead
SEW-00599			Ayh Hostel, Garage, And Tourist Cabin	Historic: 1950s	Residence/Homestead
SEW-00600*			Manson-Ostburg Garage	Historic: 1951	Transportation: Road
SEW-00602*			Knopik Cabin And Garage	Historic: 1930s	Residence/Homestead
SEW-00759	625		Upper Paradise Lake Artifact	Prehistoric	Prehistoric Native
SEW-00840*			Victor Creek Camp	Historic	Mining
SEW-00841 (S – 219)			Devil's Club Ledge Adit	Historic: ~1900	Mining
SEW-01028 (NLUR #18)	677		Tie Hacker's Camp On Meridian Lake	Historic: 1916-1923	Transportation: Railroad
SEW-01053*			Primrose Trail	Historic: 1800s-today	Transportation: Trail
SEW-01061	678		Meridian Lake Trespass Cabin	Historic	Residence/Homestead
SEW-01065*	42		Primrose Mine Pit	Historic: Early 1900s	Mining
SEW-01138			Hubbard Mine	Historic: 1912	Mining
SEW-01172			CCC Trail Section	Historic: 1930s-1940s	Transportation: Trail

SEW-01173*			Railroad Tie Hackers Skid Road	Historic: 1905-1910	Transportation: Trail
SEW-01174			Trestle	Historic	Transportation: Trail
SEW-01175			Cabin Remains	Historic	Residence/Homestead
SEW-01176			Cabin Remains	Historic	Residence/Homestead
No AHRS #	776		Grayling Lake Tie Hacker's Cabin	Historic: 1916-1923	Transportation: Railroad
No AHRS #		NLUR #1 (#16?)*	Primrose Landing	Historic: 1912-1966	Residence/Homestead
No AHRS #		NLUR #2	Old-timer's Cabin	Historic: 1910s	Residence/Homestead
No AHRS #		NLUR #3	Ferry Slip	Historic: 1920s	Transportation
No AHRS #		NLUR#4*	Andy Simon's Cabin	Historic: 1908-	Residence/Homestead
No AHRS #		NLUR#5*	White Roadhouse	Historic: 1910s	Transportation:Roadhouse
No AHRS #		NLUR #6 (at SEW-116)	Mile-18 Roadhouse	Historic: 1926-1938	Transportation:Roadhouse
No AHRS #		NLUR #7 (at SEW-116)	Natural Gas Testing	Historic: 1918-1920	Historic: Other
No AHRS #		NLUR #8	Tie-Hacker's Cabin	Historic	Transportation: Railroad
No AHRS #		NLUR–B	Cabin Ruins	Historic	Residence/Homestead
No AHRS #		NLUR #9	Sled	Historic: 1950s	Transportation
No AHRS #		NLUR #10	Mile-12 Roadhouse	Historic: 1910s	Transportation:Roadhouse
No AHRS #		NLUR #11	Crib & Guying Mechanism	Historic: 1940s-1950s	Historic: Other
No AHRS #		NLUR#17*	Hunting Stand	Historic	Historic: Other
No AHRS #		S – 208*	Grayson Lode Prospect	Historic: 1911	Mining
No AHRS #		S – 209	Mitzpah Ledge Prospect	Historic: 1911	Mining
No AHRS #		S – 210	Hale, Peel, Lyngholm	Historic: 1915	Mining
No AHRS #		S – 211	Porcupine Quartz No. 1	Historic: 1911	Mining
No AHRS #		S – 215	Porcupine/Graystone/Homestake	Historic: 1911	Mining
No AHRS #		No #	Paradise Valley Trail	Historic: 1930s	Transportation: Trail
No AHRS #		No #	Divide Ski Trail	Historic: 1939-1940s	Transportation: Trail
No AHRS #		No #	Snow River Trail	Historic: 1920s	Transportation: Trail

*Sites located just outside of the project area.

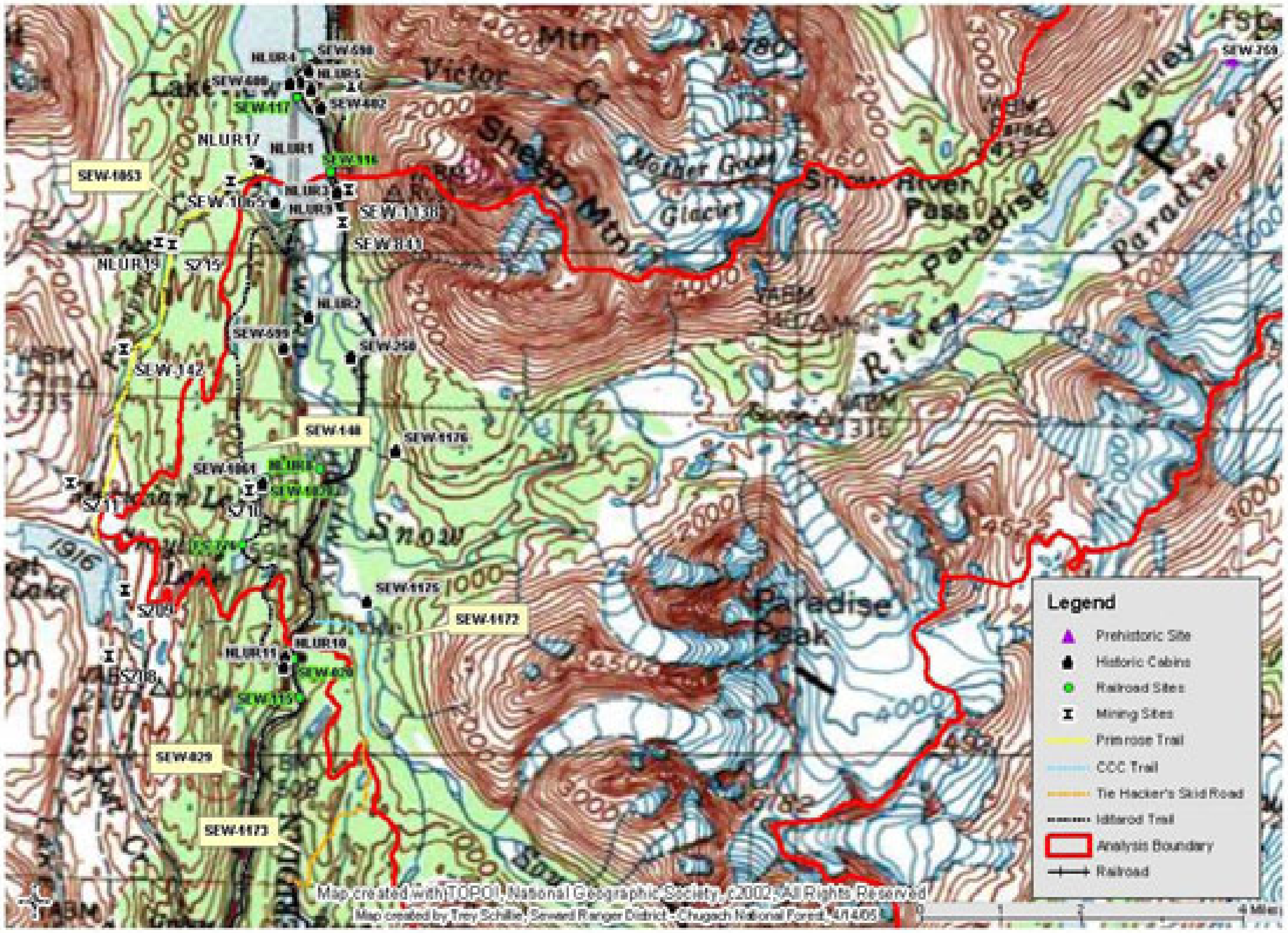

Figure 4.15. Archeological sites in the Snow River Landscape Assessment area.

Prehistoric Sites

SEW-00759 / FS-625 / Upper Paradise Lake Artifact: A single prehistoric projectile point fragment was turned into the Chugach National Forest by a member of the public in 1975. It was found on the north shore of Upper Paradise Lake. In 1976 the area where it was reportedly found was investigated by Gerald Clark, Regional Archaeologist. In 2001 a Chugach National Forest crew surveyed 300 acres around Upper Paradise Lake and conducted subsurface testing in the vicinity of SEW-00759. This is the only known prehistoric site within the Snow River Watershed.

Historic Transportation: Railroad

SEW-00020 / FS-29 / Divide*: This early Alaska Northern Railway station was originally called Summit Station. Around 1917 the Alaska Railroad stationed section crews at this site, and the name was changed to Divide. This site is associated with the Alaska Railroad (SEW-00029) and the INHT (SEW-00148). According to the Alaska Heritage Resource Survey (AHRS) database for the State of Alaska, no above ground structures remain at this site. No subsurface testing has occurred.

SEW-00029 / FS-167 / Alaska Railroad: Initial surveys for the Alaska Central Railroad (what would eventually become the Alaska Railroad) began in 1902, and by 1906 the railroad had reached an extremity of 46 miles (Barry, 1997). In 1909, the railroad company was reorganized as the Alaska Northern Railway. This company also went into bankruptcy in 1911, but not before finishing the line between Seward and Kern (71 miles). In 1912, a presidential commission began studying the potential for a future government railroad. The Alaska Engineering Commission, or AEC, was formed and assigned the tasks associated with the survey and construction of the new government railroad. In 1915, the remains of the Alaska Northern [Alaska Central] Railway were purchased by the federal government and rebuilt in preparation for connection with new lines coming south from what would become Anchorage (Wilson, 1982). In 1922 the new railroad was officially named the Alaska Railroad and was fully operational by 1923. The section of line in the Snow River Watershed was completed by the Alaska Central Railroad prior to 1905. Other sites associated with the railroad around the Snow River Watershed include SEW-00020, SEW-00115, SEW-00116, SEW-00117, SEW-01028, SEW-01173, and SEW-01174.

SEW-00115 / FS-41 / Tunnel O*: The 136-foot long railroad tunnel was originally constructed in November 1917 by the Alaska Engineering Commission to eliminate a curve on the Alaska Northern line. The tunnel was enlarged and retimbered in 1923, after a major cave-in in October 1922 (Brown, 1975). This site is also associated with SEW-00029 and SEW-00148, and may be eligible for listing on the National Register of Historic Places.

SEW-00116 / FS-30 / Primrose: The Primrose section house and warehouses were established in about 1917, and it was listed as a flag stop in 1919 (Brown, 1975). The AHRS file reports no remains at this site, but no recent surveys of this area are on file, and no subsurface testing has occurred.

SEW-00117 / Lakeview (Kenai R.R. Station)*: Known as the Kenai Station during the 1910s, this Alaska Railroad station was renamed "Lakeview" in about 1917. In 1919, the station included a sawmill, water tank and section buildings. New section quarters were constructed in 1927 (Brown, 1975). This site is another Alaska Railroad station with reportedly no evident remains, but no current survey is on file and no subsurface testing has occurred. This site is (SEW-00029) associated with the INHT (SEW-00148) as well.

<u>SEW-01028 / FS-677 / Tie Hacker's Camp on Meridian Lake:</u> This historic site dates from 1916 to 1923 and expands over a 15m by 15m area. The site includes the remains of a log structure, an outhouse, building outlines, two can dumps, wood sled runners, stove parts, various machine parts and metal artifacts. In addition there are quite a few prominent cut stumps in a fairly deteriorated state. The site is associated with the construction of the Railroad (SEW-00029) and the Iditarod Trail (SEW-00148).

<u>FS-776 / Grayling Lake Tie Hacker's Cabin:</u> This site is an historic railroad tie hacking camp that dates from 1910 to 1923. The cabin site has not been field verified, but there is evidence of historic tree harvesting at the lake from this time period.

<u>NLUR #8 / Tie-Hacker's Cabin:</u> A tie hacker's cabin is reported to be located in this area. The location was found in historic documents (Arndt, 1984).

Historic Transportation: Trails/Roads

<u>SEW-00148 / FS-49 / Iditarod Trail (Seward – Moose Pass):</u> The Iditarod Trail was the winter route used to transport mail and supplies from Seward to Nome during the early mining period. The trail consisted of a number of primary and connecting trails in use since the 1880s, but also during the Russian period and presumably prehistorically. After completion of the Alaska Railroad in 1923, portions of the trail fell into disuse (AHRS, 2005). The highway and railroad follow the primary route, though there were many peripheral branches to the trail. Additional segments of the Iditarod Trail in this analysis area include the Primrose Trail (SEW-01053), the CCC Trail Section (SEW-01172) and the Tie Hackers Skid Road (SEW-01172). The Iditarod Trail was designated a National Historic Trail by Congress in 1978.

<u>SEW-00600 / Manson-Ostburg Garage*:</u> This site, at Lakeview (SEW-00117), was built in 1951 by the Manson-Ostburg road contractors, during the construction, or possibly the re-surfacing, of the Seward Highway (Williams et al., 1996). The garage is the shape of a barn, and is made of a simple frame construction. It is one and a half stories high and about 30 feet by 60 feet. It is sided with rough cut vertical boards and has a simple gable roof (AHRS, 2005). This site may be significant to the history of transportation in this area.

<u>SEW-01053 / Primrose Trail*:</u> There are numerous historic references of travel routes through this area, from the south end of Kenai Lake to Lost Lake. The Primrose Trail may date back even to the 1800s as a Russian trade route (Barry, 1997). Starting around 1911, the trail was associated with the Primrose Mine (SEW-00142). The route is also documented as a connecting trail for the Iditarod National Historic Trail (SEW-00148).

<u>SEW-01172 / CCC Trail Section:</u> This trail segment meets with the Tie hackers Skid Road (SEW-1173). Low-lying areas along the trail have been bridged using corduroy logs, which are now badly rotted. This trail was reportedly constructed by the Civilian Conservation Corps (CCC) in the mid 1930s and was maintained through the 1940s. The trail is still in use by the public today. This route may have been used earlier by miners, and it is most likely associated with the Iditarod Trail (SEW-00148).

SEW-01173 / Railroad Tie Hackers Skid Road*: The road dates from 1905 to 1910 and was used by the railroad tiecutters during the construction of the line. The skid road has many feeder roads and trails along its length. Like the CCC Trail, the Tie Hackers Road has a number of corduroy crossing sections, used to cross low-lying and wet areas. The corduroy sections are constructed of unusually large timbers, probably to support heavy loads. There are a few cold deck stations along the length of the road, which were used to stack finished ties off of the ground. The stations are constructed of two logs that form a 90 degree angle. A 30-foot long trestle (SEW-01174) is located at the south end of the road, close to Bear Lake. This site is associated with the railroad (SEW-00029) and the Iditarod Trail (SEW-00148).

Snow River Trail: The Snow River Trail extended three miles up the North Fork of the Snow River at Mile-15.5 of the Alaska Railroad. At this time, it is unknown who constructed the trail and when, but it was in use by the early 1930s and was maintained by the Forest Service. The trail is not in use today.

Paradise Valley Trail: The Paradise Valley Trail was constructed by the Forest Service in 1933. It connected to the end of the Snow River Trail (see above). By the end of the field season in 1933, five miles of trail had been constructed from the junction with the Snow River Trail (a total of 8 miles from the tracks to the end of the trail). This trail was constructed to open up the Paradise Valley for public use and prospecting (Sherman 1932). The trail is not in use today.

Divide Ski Trail: Located at Mile-12, the trail was originally blazed by the Seward Ski Club in 1939 and connected to an existing CAT road. A tow rope and warming shelter were installed the following year. The CCC assisted with course construction in 1940. The US Army maintained the ski area during World War II for soldiers stationed in Seward. The area fell into disrepair after the war.

Historic Transportation: Roadhouses

NLUR #5* / White Roadhouse: Mrs. James (Grandma) White operated a roadhouse at Mile-20 until it was destroyed in a fire in 1920 (Barry, 1993). No testing for subsurface materials has occurred.

NLUR #6 / Mile-18 Roadhouse: Bob Carlson built a roadhouse at Mile-18 in 1926 and operated it until 1938 (Barry, 1993). It has not been determined if the structure still stands or if there are subsurface deposits.

NLUR #10 / Mile-12 Roadhouse: The roadhouse located at Mile-12 was initially owned by Mr. Coburn. He sold it to Abbott and Gary in 1911, who sold in the same year to Tom Tessier and Billy Patterson (Braund and Associates, 1993). It is assumed that this structure was not the same as the section house at Mile-12 (Divide, SEW-00020).

Historic Transportation: Other

NLUR #3 / Ferry Slip: A ferry slip on the south side of Kenai Lake was used from 1911 to 1937 to connect the railroad to the south to the Hope Highway and Cooper Landing Truck Road. Use discontinued once the gap between the routes was closed (Barry, 1993).

NLUR #9 / Sled: A wood sled within the power line corridor is estimated to date from the construction of the line in 1955 (Arndt, 1984).

Historic Residences/Homesteads

SEW-00250 / FS-492 / Minnie Andacher Homestead: The Minnie Andacher homestead represents the first efforts toward the permanent settlement of the area. Features include saddle-notched outbuildings, a garden area and a log cabin with rough walls, a wooden floor and a wood plank roof covered with tar paper and metal. One corner of the cabin has squared logs, and the remaining three are saddle-notched. This site is found along the Seward - Moose Pass Trail (SEW-00148) and is associated with the Iditarod NHT (AHRS, 2005).

SEW-00598 / Cabin and Log Garage*: This site is located near Lakeview (SEW-00117), with an estimated construction date between 1922 and 1932. The cabin is constructed of small size, unpeeled logs with log purlins. There is also a vertical log outbuilding nearby (Williams et al., 1996).

SEW-00599 / AYH Hostel: The current American Youth Hostel was built by Aaron Wicklund in the 1950s, and might have been built on a US Forest Service homesite. The building is a typical cottage from the 1950s. The property also includes a garage, matching house in style and construction, and a very small log cabin back in the woods built as a scenic attraction.

SEW-00602 / Knopik Cabin And Garage*: At Lakeview (SEW-117), the cabin appears to have been constructed in the early 1930s (Williams et al., 1996). The cabin is a typical log construction with a gable roof, and there is a frame garage, which may not be original to the site. The cabin is approximately 18 feet by 12 feet, with possible additions to the south end and the roof (AHRS, 2005).

SEW-01061 / FS-678 / Meridian Lake Trespass Cabin (Muktuk Martin Cabin): The cabin was reportedly constructed by “Muktuk Martin”. The cabin was a 12 foot by 14 foot saddle-notched cabin with some recent improvements. The Forest Service burned the cabin in the 1990s. All that currently remains at this spot is a cleared area, just off the trail, with a rectangular stain where the cabin stood and the depression for the sauna. There are also some scattered metal remains, a small, decomposing pile of cut logs on the lakeshore, and cut stumps around the clearing. No subsurface deposits have been located.

SEW-01175 and SEW-01176 / Cabin Remains: These remains were located via an aerial reconnaissance by the Forest Service. No survey or ground investigation of these two sites has been conducted. It would be valuable to document more information about these sites and their significance, especially since SEW-01176 is located adjacent to the historic Paradise Valley Trail.

NLUR – B / Cabin Remains: Cabin remains were reported, but have not been field verified at this location. Construction of the turnout on the Seward Highway at the Grayling Lakes trailhead may have disturbed the remains (Williams et al., 1996).

NLUR #1 (#16)* / Primrose Landing: Charles Hubbard purchased an interest in Primrose Mine in 1912, as well as a storehouse at the mouth of Falls Creek [Primrose Creek] on the shore of Kenai Lake. This locality was known as Primrose Landing at one time, and was Mr. Hubbard’s home in 1966 (Barry, 1997).

NLUR #2 / Old-timer's Cabin: The location was described by Charles Hubbard during an interview in his cabin at Primrose Landing. The location on the map is an estimate and needs to be field verified.

NLUR #4* / Andy Simon's Cabin: Andy Simons was one of the early hunting guides on the Kenai Peninsula. He was issued an honorary game license with the number "1" on it in 1910 and retained that number as long as the numbering system was used. He built his cabin in 1908 and lived there until his death in 1962. The cabin was destroyed in the 1964 earthquake. Subsurface deposits remains and have not been tested.

Historic Mining Sites

SEW-00142 / FS-42 / S–214 / Primrose Mine*: Originally staked in 1911 by John Rice, the mine was taken over by the Primrose Mining Company in 1912. Charles G. Hubbard purchased an interest in the mine in 1912. Remains include a complex of four log buildings, only one of which is standing and occupied. Two large connected buildings have collapsed since 1975. A hip-roofed building has also recently collapsed. Additional features include two adits, three buildings, an outhouse, two concentration tables, a ball mill, an ore car landing and track, and trails to the creek. In 1990, the State Historic Preservation Officer (SHPO) determined that the Primrose mine was eligible for the NRHP, based on its association with Charles Hubbard and its period of significance, 1911 to 1942. It is also associated with the Iditarod NHT.

SEW-00163 / Victor Creek Prospect*: Historically, Vickery (Victor) Creek has claims dating back to Joseph Cooper in 1896. This was part of the first group of Americans who explored the Kenai Peninsula and established the Lake Mining District around Kenai Lake (Barry, 1997). Site features include the remains of a cabin, platform and two large collapsed prospect shafts. There is one open shaft, 5 feet tall by 5 feet wide by 12 feet deep, which is log-lined and has a metal roof.

SEW-00841 / Devil's Club Ledge Adit: AHRS file: This mining site dates from the early to mid-1900s. The only feature is a 70m by 70m adit, dug 2m deep into an outcropping of bedrock. There is some lumber associated with the adit, but no other cultural materials are present.

SEW-01065 / Primrose Mine Pit*: The mining pit is located adjacent to the Primrose Trail (SEW-01053). The mining pit measures 6 feet deep and is 11 feet by 11 feet in diameter. The site dates to the early 1900s and is associated with both SEW-00142 and SEW-01053.

SEW-01138 / Hubbard Mine: This site is composed of a prospect pit, open adit and a waste rock pile. The prospect pit is 7 feet long, 81 to 110 inches wide, and 15 to 35 inches deep. The adit is 6 feet tall and 5 feet wide, with a small waste rock pile and a piece of metal piping at the entrance. This mine dates from about 1912, and is associated with Charles Hubbard, who also contributed to the Primrose Mine (SEW-00142).

S – 208 / Grayson Lode Prospect: Exploration was carried out here in 1911 and 1912 when a prospect pit and trench were dug. A minerals assessment was filed in 1980. No archeological field inventory has been conducted at this site.

S – 209 / Mitzpah Ledge Prospect: The Mitzpah Ledge was explored in 1911 by means of a trench and a 28-foot adit, producing a small pile of waste rock (USDA Forest Service, Chugach National Forest, 1994). The original locators were Kennedy, Pullen and Davis (Hoekzema and Sherman, 1985). No archeological field inventory has been conducted at this site.

S – 210 / Hale, Peel, Lyngholm: A claim was filed by Hale, Peel, and Lyngholm in 1915 and relocated by F. S. Pettyjohn in 1976 (Hoekzema and Sherman, 1985). No archeological field inventory has been conducted at this site.

S – 211 / Porcupine Quartz No. 1: This adit was mined in 1911. George Ross and John Dryer relocated the claim in 1958 (Hoekzema and Sherman, 1985). No archeological field inventory has been conducted at this site.

S – 215 / Porcupine/Graystone/Homestake: The original claims were filled in 1911 by Edward Frederick. An open cut was reported to be made but no production resulted (Jansons et al., 1984). No archeological field inventory has been conducted at this site.

Historic Other

NLUR #7 / Natural Gas Testing: E. H. Mathis conducted gas tests on the ice near Mile-18 in 1920 (Barry, 1993). Some trace of this activity may be preserved on the shoreline (Williams et al., 1996).

NLUR #11 / Crib & Guying Mechanism: A guying mechanism and crib supporting remains are believed to date to the construction of the transmission line in 1955 (Yarborough and Crowell, 1992).

NLUR #17* Hunt Stand: A notched log hunting stand that dates to the 1940s or 1950s (Williams et al., 1996).

4.8.2 Human Uses: Present

General Observations

Outdoor recreation is the fastest growing use on the national forests and grasslands across the United States, continuing a steady trend since before the 1950s (Cordell, 2004). Population has been, is, and will be the major driver of outdoor recreation participation growth in this country (Cordell, 2004). The Kenai Peninsula Borough is one of the most populated and fastest growing regions of Alaska, and the rate of recreation growth on the Chugach National Forest is likely to disproportionately increase the number of recreational users. Currently, well over 90% of Americans participate in at least one outdoor recreation activity (Cordell, 2004). Estimates of recreation days occurring in forest settings show (in order) walking for pleasure; viewing/photographing natural scenery, birds, flowers, and wildlife; day hiking; sightseeing; driving for pleasure; mountain biking; and visiting a wilderness or primitive area as the most actively engaged activities in 2000-2001 (Cordell, 2004).

Within the past 40 years, the concept of recreation itself has changed with the advancement of technology to include a wider range of recreation experiences. The development of new technology which is lighter in weight and more durable such as full-suspension mountain bikes, waterproof hiking boots and rain gear, synthetic clothing and sleeping bags, powerful snowmachines, four-season camping tents, backcountry telemark gear, and more versatile float planes have allowed recreationists to pursue new activities in the backcountry which are longer in duration and can be carried out year-round. New technology in the form of sport-utility vehicles, larger Recreation Vehicles (RV's) and 45 to 60-foot motor homes has also surpassed the original concept of frontcountry recreation that was envisioned for the recreationists of the 1960s and 1970s.

Many of the Forest Service campgrounds, day-use areas, trailheads and hiking trails built in the 1960s and 70s are not adequate for today's recreationists and have been or will eventually need to be upgraded, replaced or rebuilt to conform to the needs and desires of today's recreationists and to comply with current federal, state, and local laws, regulations, and guidelines. Many new facilities such as backcountry cabins, yurts, huts, campgrounds, and campground expansions are also being built, planned or proposed on National Forest System lands in general to meet the demand for recreation.

The overall result of new or modified recreational activities and the increase in the number of recreation visitors to the Kenai Peninsula has led to many new opportunities and challenges. The large number of visitors using the Kenai Peninsula has contributed to and changed the economy of many Kenai communities but has also led to the deterioration and loss of ecological and cultural resources and facilities. Foot traffic along the river banks can damaging fish rearing habitat, kill vegetation, compact and erode soil, impact wildlife, and damage tree roots.

Trails

There are seven recognized Forest Service trails or portions of Forest Service trails in the Snow River Watershed (Table 4.5). Only portions of the Primrose Trail, Snow River Winter Trail, and the INHT are located within the Snow River Watershed. The remaining four trails are short low use recreation trails (less than 1.5 miles) contained entirely within the Snow River Watershed.

Table 4.5. Existing recreation trails in the Snow River Watershed and use data for the monitored trails.

Recreation Trails	Length in the Snow River Watershed
Grayling Lake Trail	1.1 miles
Iditarod National Historic Trail (INHT)	1.6 miles
Leech Lake Trail	0.45 miles
Long Lake Trail	0.6 miles
Meridian Lake Trail	0.4 miles
Primrose Trail	0.45 miles
Snow River Winter Trail	10.7 miles

<table>
<tr><th colspan="2">Recreation Trail Use Data</th><th>2001</th><th>2002</th><th>2003</th><th>2004</th></tr>
<tr><td rowspan="2">Grayling Lake Trail</td><td>Groups</td><td>62</td><td>276</td><td>232</td><td>234</td></tr>
<tr><td>People</td><td>139</td><td>735</td><td>630</td><td>711</td></tr>
<tr><td rowspan="2">Primrose Trail</td><td>Groups</td><td>284</td><td>400</td><td>379</td><td>397</td></tr>
<tr><td>Visitors</td><td>1578</td><td>1130</td><td>1122</td><td>1179</td></tr>
</table>

Grayling Lake Trail, Leech Lake Trail, Long Lake Trail, and Meridian Lake Trail
These trails are described together because they are located in the same general area, are similar in length, receive a similar amount of use, and are managed with similar Forest Plan direction.

These point-to-point trails allow for non-motorized travel, and the destination is the respective lakes. There is currently relatively low use on these trails (Table 4.5), and the recreation use on these trails is mainly from recreation users seeking to fish in the Grayling, Leech, Long, or Meridian Lakes. However, other uses occurring on these trails consist of picnicking, hiking, and sightseeing. These trails are regularly maintained. Reconstruction is scheduled for 2006 in connection with the INHT construction.

Snow River Winter Trail
The Snow River Winter Trail is a winter motorized access route that leads to Nellie Juan Lake. This area is used as a snowmachine and skiing route along the South Fork Snow River. The level of recreation use along this trail varies yearly depending on snow conditions. This area receives little use during the spring and summer months because of difficult access related to the free flowing Snow River during the spring and summer months.

There is currently no planned maintenance or reconstruction for the Snow River Winter Trail. This is due to the fact that the trail is essentially a frozen river and does not lend itself well to maintenance projects; nor are there any plans to manage this trail for summer uses.

Iditarod National Historic Trail (INHT)
The INHT is a congressionally designated historic trail created under the National Trails System Act that spans from Seward to Nome. The Forest Service manages a portion of this larger trail, and of that portion only 1.6 miles of the INHT are in the Snow River Watershed.

The INHT has not been completed at this time, and construction of this trail on the Forest Service Lands is ongoing. The portion of the INHT contained within the Snow River Watershed is scheduled for construction in 2006.

When the portion of the INHT within the Snow River Watershed is completed, this trail will be open to motorized uses and is predicted to become a popular snowmachine and ski route.

Primrose Trail
The Snow River Watershed contains the beginning portion of the Primrose Trail. This portion of the trail includes the Primrose Trailhead and parking lot. Primrose Trail is the fourth most used trail on the Seward Ranger District (Table 4.5). This trail receives a high level of use because use occurs during the winter and summer seasons. Hiking and mountain biking are common in the summer while snowmachine use predominates during the winter.

Parking at the trailhead is typically adequate during the summer. However, parking can become difficult in the winter during periods of high snowmachine use because of the use of trailers. Currently, parking is considered adequate and there are no plans to expand parking capacity for the campground.

Cabins

The Snow River Watershed contains the Upper and Lower Paradise Lakes public-use cabins (Figure 4.6). These cabins can be rented for a fee of $45 per night. Users visit these cabins predominantly for fishing, hunting, scenic quality, and hiking. Cabin users contract with a flight service to provide access to these cabins. The Forest Service has not constructed any trails to or around the cabins. Although access is more costly to cabin users, these cabin receive a fair amount of summer use (Figure 4.6). Upper Paradise Cabin is occupied during roughly 61% of the 153 day operating season, and Lower Paradise Cabin is occupied during roughly 57% of this season.

Campgrounds

The Primrose Campground contains 10 sites and is located at the end of Primrose Landing Trail approximately 17 miles north of Seward. The campground contains a picnic area, a boat ramp, a dumpster, and a vaulted toilet.

Table 4.6. Existing Forest Service cabins and campgrounds in the Snow River Watershed and use data for cabins.

Recreation Cabins/Campgrounds	Location
Lower Paradise Forest Service Cabin	North end of Lower Paradise Lake
Upper Paradise Forest Service Cabin	West side of Upper Paradise Lake
Primrose Campground	Southern end of Kenai Lake along Primrose Landing Road

Public-Use Cabin Use Data		2000	2001	2002	2003
Upper Paradise Cabin	**Reservations**	27	28	28	28
	Visitors	71	83	84	91
Lower Paradise Cabin	**Reservations**	28	20	18	31
	Visitors	93	64	51	120

Seward Highway

The Seward Highway, constructed in 1951, is one of the most scenic highways in the country. It was designated a National Forest Scenic Byway in 1998 and an All-American Road in 2000. This highway is one of 15 roads recognized nationally for outstanding scenic, natural, historic, cultural, archeological and recreational qualities. The daily traffic counts for the Seward Highway averaged 1,770 vehicles through Moose Pass in 2001.

5 Reference conditions

This section documents the knowledge of past conditions in the Snow River Watershed. In order to understand the condition of the watershed and changes that have taken place, it is important to establish a frame of reference. For this analysis, the time frame for reference conditions varies based on times of important changes for particular resources. For some resource areas, little is known about changes over time, and proxy indicators are sought to help simulate what are thought to be reference conditions. In other cases, there are no good proxies for past conditions, and reference conditions may be based on knowledge of reference conditions of other watersheds, or knowledge of processes known to have taken place. Generally, reference conditions for the Snow River Watershed are those conditions that would be present if the watershed were operating without significant human influence, or those conditions that existed prior to about 1890. This is the time at which human development came into the valley, with the first use of the Iditarod Trail as a transportation route in the late 1890s and the construction of the Alaska Railroad in 1906. It is also important to note that many of the changes in the watershed since reference conditions are the result of natural geomorphic change.

5.1 Lands

Reference conditions for Lands existed prior to 1895. At that time people were utilizing the area for mining, hunting, fishing, and activities associated with subsistence use.

Following the purchase of Alaska from Russia in 1867, the lands surrounding Prince William Sound became the focus of mineral exploitation (Alaskan.com, 2000). An impending private monopoly on the reserves and transportation of its coal and copper motivated President Theodore Roosevelt to designate the lands of the Chugach National Forest in 1907, originally some 23 million acres in size (Alaskan.com, 2000).

During the last 40 to 50 years, the driving force in non-Federal land ownership occurred with the passage of ANILCA and ANCSA. These statutes allowed Native Corporations and the State of Alaska to select and hold title to Federal lands. These statutes are the reason the State of Alaska and CAC hold title to lands within the Snow River Watershed.

5.2 Geology, Minerals and Soils

5.2.1 Geology and Minerals

Gold is present on the Kenai Peninsula both as placer and lode deposits. The majority of the gold mined has been from placer deposits, but lode mines also exist. Most of the placer gold recovered has been concentrated by alluvial action in existing streams or in the benches formed by abandoned channels or old terraces (Jansons et al., 1984). This is not the case in this project area.

Lode gold occurs in quartz veins, which are relatively narrow and short but can contain high grades (Jansons et al., 1984). Copper has also been mined profitably on the Kenai

Peninsula, but neither copper, other base metals, coal, nor petroleum occurrences are shown within the project area on the 1984 Bureau of Mines maps (Jansons et al., 1984).

The Hope-Sunrise gold rush began in 1893, spurred by news of gold found by Al King between 1888 and 1890 (Buzzell and McMahan, 1986). In 1896 a party headed by Joseph M. Cooper reached Kenai Lake via the Kenai River, explored in the vicinity of the lake and organized the Kenai Lake Mining District. They established claims on Vickery [Victor Creek (Orth, 1967)] and Falls Creeks (Barry, 1973). In 1898 the Alaska Hydraulic Syndicate operated on "the north side of the lower end of Kenai Lake" (Buzzell, 1986), and perhaps on Falls Creek (Sleem, 1910). In this same year, lode gold was located in the Moose Pass area, although production was slow until 1911 (Smith et al., 1942). For many years, access to mining in Cook Inlet, especially in winter, was via Resurrection Bay, Salmon Creek, Snow River, Kenai Lake, and Quartz Creek to Sunrise (Barry, 1973; Buzzell, 1986). George Phelps was prospecting near Kenai Lake when he heard of the jobs available with the new Alaska Central Railroad in Seward in 1903 (Barry, 1986). In 1905 Skeen and Lechner prospected along the route of the railroad because of its ready access and presumed future ease of transportation. They found gold on Falls Creek in 1905 (Barry, 1973). There are no historic reports of gold production in the Snow River assessment area.

After a decline in activity during WWI, mining never recovered its former prominence (USDI, Bureau of Outdoor Recreation, 1977). In the Snow River area, a few placer mining claims were staked in the 1970s and 1980s, but they were generally abandoned within a year or two. By the 1990s, claims in the area were virtually nonexistent. This may have been due to ramifications of the 1993 Appropriations Act.

Historically, some 2,000 to 2,500 federal mining claims existed on the Chugach National Forest; nearly all of these on the Kenai Peninsula. This number held relatively steady for a number of years until the 1993 Appropriations Act for the Department of the Interior was passed which required a payment of $100 per claim in lieu of ($100 worth of) assessment work. After that, numbers of mining claims on the Forest began to decline. Within two years after the 1993 Act, the number of mining claims had dropped to a little over 800. Currently, there are about 475 to 500 mining claims on the Forest.

On the Kenai Peninsula, there are nearly 450 "recorded" mining claims, located mostly along known placer streams or over known lode prospects. Claims tend to be staked in easily accessible areas, and the majority of them are placer claims rather than lode. The number of mining claims at any particular time is subject to change as new claims are filed and existing claims are abandoned.

5.2.2 Soils and Erosion Processes

Reference conditions for soils existed prior to the establishment and development of the transportation corridor at the turn of the century, the point in time that represents a significant shift in accessibility. There have been no significant changes in the soil composition in the study area since that time. There has been a gradual exposure of new mineral surfaces as the glaciers receded, leaving behind fresh parent material for soil development in the form of exposed bedrock, glacial till, and outwash plains. The soil composition of the area will change gradually as soil development continues, particularly in those areas that remain stable. Soil development on these terraces is typically characterized by the movement of fine sediments vertically along the soil profile creating distinct layers, and a general increase in soil depth. Soil development is continuous throughout the study area, but at times it can be impeded or reinitiated by erosion.

Although human-induced erosion is not a significant issue at this time, it could change as access to the area continues to increase. Particularly vulnerable are streambanks, alpine regions, and wetland areas. Increasing foot and mechanical traffic has the potential of damaging the sensitive riparian vegetation, which then weakens the streambank from the loss of the root structure. The streambanks then become increasingly vulnerable to subsequent trampling and by the force of stream flows. The loss of even the surface layer is critical because of its productivity. The nutrients from decomposing organic material enrich the topsoil and provide a fertile bed for re-vegetation. Losing this layer requires that topsoil be brought in from elsewhere in order to reestablish the riparian vegetation and reinforce the streambanks. The wetland and alpine vegetation is similarly affected by foot and mechanical traffic. The vegetation in these areas is easily damaged which lessens their ability to hold mineral material together and consequently increases the rate of surface erosion.

5.3 Hydrology

Reference conditions for hydrology in the Snow River Watershed existed prior to about 1890, when human development came into the valley. Episodes of extensive glaciation and recession have occurred in Southcentral Alaska in the past 2 million years, with the last peak of glaciation occurring in the late Pleistocene (20,000 to 25,000 years ago), when glaciers filled the entire Snow River Valley. The glacier that filled the North Fork Snow River Valley fed into a larger complex of glaciers that occupied what is now Kenai Lake and the lower Snow River Valley. Rapid melting occurred in the Holocene, beginning about 12,000 years ago, accompanied by numerous episodes of small glacial advances and retreats. After the glaciers receded, the North Fork Snow River Valley was left as a hanging valley to the larger Kenai Lake basin.

Although glaciers sculpted the Snow River Valley, subsequent fluvial erosion shaped portions of the valley. Fluvial erosion is the major force that created the gorge at the lower end of the North Fork Snow River Valley. Sediment from the Snow River Glacier deposited in the lower Snow River has gradually filled in the fiord-like valley at the head of Kenai Lake. The prograding Snow River delta has slowly been advancing into Kenai Lake, resulting in a flat valley floor on which the lower Snow River now meanders.

The last glacial advance of the Snow River Glacier probably occurred at some point during the Little Ice Age. Prior to about 100 years ago, it is likely that the outburst system that currently operates on the Snow River Glacier did not exist. At this time, the basin in which the outburst lake now exists was filled by glacial ice. It is possible that other glacial outburst systems existed at that time, but the size and extent of these systems are unknown. During the glacial recession following the glacial advance of the Little Ice Age, streamflows were considerably larger than those of the present conditions as a result of melting glacial ice. Glacial outburst floods may have occurred during this time, but their occurrence is unknown.

Prior to 1890, the lower Snow River was a wide, braided glacial outwash channel. It is likely that the outwash plain had considerably less vegetation than it does today. With higher streamflows and higher sediment loads associated with more extensive glaciation and glacial advance, the lower Snow River channel was likely very dynamic. Sediment loads in the Snow River during this time were probably very high as a result of extensive glaciation and glacial advance, although no data exist. Human-related water quality impairment was probably non-existent because of the lack of development in the watershed and minimal use in the area at that time.

5.4 Vegetation and Ecology

This landscape, because of the relatively low human use both presently and historically, remains in nearly pristine condition in many cases. Reference conditions can be declared at any point in the past, but probably the best case is to consider conditions prior to the Iditarod Trail development and gold rush era. Movement did exist up this valley but use was less than that of less harsh passages. With the exception of the cabin construction, overflights by small aircraft, and snowmachine use in the winter to access areas of Prince William Sound, not much has changed since this era.

5.5 Fire

The forests in the project area are part of a maritime ecosystem. Historically, most fires in maritime ecosystems were small and probably of little ecological significance. However large stand-replacing fires occurred at long intervals, usually ranging between 250 to 500 years. The spruce bark beetle epidemic on the Kenai Peninsula may well play a natural complementary role in normal fire/ spruce dynamics. The fire history data for the Seward Ranger District has shown that there has been one fire in the watershed which amounted to 350 acres. This fire occurred around 1953, but there are no data specifying cause or location.

5.6 Aquatic Species and Habitats

Historically the Snow River Watershed was a destination for spawning and rearing salmonid species such as coho, sockeye, and chinook salmon, as well as Dolly Varden char. Arctic grayling may have inhabited the area prior to construction of the railroad and highway systems, but there is no corroborating evidence to support this other than the initial stocking of arctic grayling in Upper Paradise Lake in the early nineteen sixties (Berkhahn, 2005). The Snow River is bound by the Seward Scenic Highway to the west and the Alaska Railroad to the east. Little documentation exists concerning aquatic species and habitats prior to 1890. Winter travel through the area consisted of the Iditarod Trail in the 1890s with the possibility of ice fishing. The construction of the railroad in 1906 and the highway in the 1930s and 1940s opened the area to further human settlement and possibly fishing.

5.7 Terrestrial Species and Habitats

Although the existing array and distribution of habitats appears to be within the range of normal variation for the region, there are no quantitative data on pre-European settlement conditions. There apparently has been a shift in the populations of some large game animals in response to natural shifts in habitat patterns that have occurred since European settlement. It is appears that these shifts are part of natural successional changes in habitat that occur in cycles as well as human influences. Although little information is available, some inferences can be made regarding reference or pre-European settlement conditions.

Past populations of wildlife in the Snow River Watershed are unknown, except that moose are now present, and there is no evidence of moose in the past. This is likely due to extensive expansion of hardwoods due to human caused fires at the turn of the century. It is likely that other species that use hardwoods such as lynx and birds have increased, and potentially species such as brown and black bear that prey on moose may have increased as well. Hunting and trapping pressure has likely influenced populations locally in the past by native people and the Russians. Impacts to wildlife are unknown, but may have been heavy at times. With greater numbers of people inhabiting the watershed now, we can assume there is greater hunting and trapping pressure overall, but this may be in a more sustained but regulated fashion due to fish and game management. How this has changed animal numbers or species composition from the past is unknown. Current management focuses on increasing moose numbers and will continue to do so. Reference conditions specific to Sensitive, Management Indicator, and Species of Special Interest are discussed in the following sections.

5.7.1 Sensitive Species

Trumpeter Swans

Little to no data exist on reference conditions for swans. It is likely that if natural conditions for swan nesting habitat have remained stable, human disturbance, especially from float planes, has increased and may have affected swan numbers over time. It is possible that swans are expanding their range from the wildlife refuge to the east.

Osprey

Little to no data exist on reference conditions for osprey.

5.7.2 Management Indicator Species

Moose

Very limited information is available to describe reference conditions for moose in the Snow River Watershed. No evidence exists suggesting that moose were present on the Kenai Peninsula until 150 years ago (Largaespada, 2005). Some sources indicate that prior to the turn of the century, caribou were the more abundant ungulate species on the peninsula. It is unknown if caribou once existed in the watershed, but they are not present now. There has been little habitat alteration by humans since the reference period, and the watershed remains in a fairly pristine state. The main source of habitat alteration is the jökulhlaup flood, occurring every 2 to 4 years. This ice dam flood results in extensive scouring and channel alteration of the Snow River, altering the vegetation and increasing the amount of early successional forests, which may lead to an increase in the moose population. The occurrence, timing, and magnitude of these floods during reference conditions prior to the first recorded outburst flood on the Snow River in 1911 are unknown.

Mountain Goat

No quantitative data exists to indicate what reference conditions were for mountain goats in this watershed. Increased hunting pressure after initial European contact may have reduced mountain goat populations; however mountain goat habitat has probably remained relatively unchanged.

Brown Bear

Data on reference conditions of brown bear is very limited to nonexistent. It is assumed that historic populations of brown bear were higher, and that European contact decreased brown bear populations through habitat loss, hunting and DLPs, although potential increases in fisheries, moose populations could have increased bear populations. The more recent increase in fishing and recreation in the watershed probably has resulted in some habitat encroachment and increased DLP mortalities.

5.7.3 Species of Special Interest

Wolverine

Little to no data exist on reference conditions for wolverine.

Northern Goshawk

No quantitative information exists on reference conditions for goshawks. Undoubtedly, goshawks have been impacted by the spruce bark beetle infestation, causing reduction in potential nesting habitat.

River Otter

No quantitative data exist for river otter reference conditions. Reports from the 1920s indicate Peninsula-wide scarcities, more than likely a result of increased trapping pressure after European contact. It is unclear how recreation and increased human use along the Snow River may affect river otter populations.

Lynx

Quantitative data regarding reference conditions for lynx are nonexistent. Reports from the 1920s (Culver, 1923) indicate lynx were widespread on the Kenai Peninsula. As with all fur-bearers, populations are thought to have decreased after European contact due to the increase in hunting and trapping.

Marbled Murrelet

Quantitative data regarding reference conditions for marbled murrelet are nonexistent. The watershed overall appears warmer and drier than other watersheds on the Seward

Ranger District, and site quality tends to be lower. If conditions over time have remained fairly stable, conditions were never likely to have provided high quality nesting habitat for murrelets.

Townsend's Warblers

Data on reference conditions are unavailable. Forest Service surveys from the late 1970s indicate that Townsend's warblers were the most abundant species in older forests and were not abundant in recently burned forests. European contact may have decreased Townsend's warbler populations if older forests were altered, but overall impacts on the population were probably minimal. Forest fires and the spruce bark beetle over the last 100 years may have also reduced available habitat over time.

Gray Wolf

No data exist on reference conditions for gray wolf in this watershed. The wolf population more than likely suffered declines after the influx of European settlers, as hunting pressure of all fur bearers increased at this time. However, wolf populations may have increased with the increase in the moose population beginning 150 years ago.

Historically, the caribou population was much larger and more widely distributed. Moose were likely less abundant and restricted to riparian and subalpine areas as documented by Lutz (1960). Brown bear, wolf, black bear, wolverine, marten and other carnivore populations were likely larger due to less human-induced mortality and disturbance. Northern goshawk density would have been lower due to less diversity in feeding habitat.

5.8 Human Uses

5.8.1 Human Uses: Past

The reference conditions for this landscape analysis area begin around the late 1800s. Historically this region has been an important segment of early transportation and trade routes dating to the prehistoric record. As early as the mid-1800s, a Russian transportation route led from the south end of Kenai Lake through Lost Lake and into the Resurrection Bay shipyard (Barry, 1997). Another Russian trail came up the Kenai River, by Primrose Landing, above the Primrose mine and over the flats to Seward (Barry, 1997). Many of these routes followed the existing Native trade routes between the Kenaitze and Suqpiaq Native groups on the Kenai Peninsula and into Prince William Sound. By the late 1800s, early miners began to travel in winter up from Resurrection Bay through the valleys of Salmon Creek and Snow River to reach Kenai Lake and onward to Hope and Sunrise (Barry, 1997). In 1898, the U.S. military explored a route from Resurrection Bay to Turnagain Arm, which passed down Snow River to Kenai Lake (Mendenhall, 1899). By 1899, wagon trails existed from Seward to Kenai Lake along the west side of the Snow River (Barry, 1986).

Mining has been one of the primary influences on the history of this region and the Kenai Peninsula as a whole. In 1909, the Seward Gateway reported strikes and claims at Mile-12, Mile-20, and Victor Creek (Williams et al., 1996). The Primrose Lode Mine on the southern tip of Kenai Lake, associated with miner Charles Hubbard, began around 1912 (Barry, 1997).

With the early gold prospectors came an increasing number of merchants and residents on the peninsula. At the beginning of the 1900s, mail and goods were being transported along the old Russian and military trails within the Snow River Watershed, especially in winter. The Alaska Road Commission (ARC) eventually blazed many of these trails into the well-known Iditarod Trail, which was the winter route used to transport mail and supplies during this early mining period (SEW-00148). The southern end of the trail followed the railroad line to approximately Mile-54 (USDI, Bureau of Outdoor Recreation, 1977). By 1910 the ARC had upgraded the trail enough to accommodate pack horses and dog sleds. The trail became mainly a mail route, once the first mail contract was awarded in 1914 (Williams et al., 1996). Starting around 1918, the Seward end of the trail began to fall into disuse as the Alaska Railroad linked Seward with Anchorage and Wasilla (USDI, Bureau of Outdoor Recreation, 1977; Braund & Associates, 1993). In January 1923 a new trail was contracted from north of Seward to Kenai Lake, which would shorten the route for the mail (Barry, 1993).

As the trail system was being developed, roadhouses began to appear in this area and accommodated homesteaders and adventurous travelers. At Mile-12, a roadhouse (NLUR #10) was owned and operated by Mr. Colburn. Mrs. White ran a roadhouse at Mile-20 (NLUR #5), and Bob Carson's Mile-18 roadhouse (NLUR #6) was open under various owners from 1926 to 1938.

Guided hunting began to gain popularity in the early 1900s. Andy Simons, who had a cabin (NLUR #4) located near Mile-20 of the railroad in 1908 (Barry 1986), became one of the first trophy hunting guides of the area (Williams et al., 1996). The south end of Kenai Lake became a popular scenic resort and fishing spot. Around Mile-18 of the highway, roadhouses, cabins, and homes began to show up by the 1920s (Barry, 1993). The Minnie Andacher Homestead (SEW-250, AHRS file) was constructed in the 1920s, and sits on the banks of the Snow River.

With more and more permanent non-Native settlers populating the area, the need for larger shipments of goods and supplies also grew. As a result, around the same time as the Iditarod was being developed, the Alaska Central Railroad also began to realize their plans to build a rail line from Seward to the interior of Alaska. The cleared right-of-way began to be used for travel, recreation, and transport until other routes, like the Iditarod Trail, were built (Barry, 1986). By 1904 the track was laid from Seward to Snow River, and by 1905 it had reached Kenai Lake (Barry, 1997). In 1909 re-organization of the railroad took place and it became the Alaska Northern Railway. In 1910, the railroad announced the construction of the Summit Station at Mile-12 (Williams et al., 1996). Unfortunately, the privately-owned railway company could not turn a profit and lasted only a few years before going bankrupt (Barry, 1986). The U.S. Government took over the venture in 1915 and began to survey possible reroutes and purchased the remains of the Alaska Northern track and equipment (Williams et al., 1996).

As construction of the new Alaska Railroad progressed, section houses were built at points along the line to house "section" men who maintained the track. In 1917, section crews were stationed at Mile-12 (Summit Station) and Mile-20 (Lakeview). The station on Mile-12 was re-named Divide (SEW-00020). A station known as Primrose was established also around 1917 at Mile-18 on the east side of the tracks (SEW-00116).

Tunnel 0 at Mile-11.3 was constructed the same year to eliminate a curve in the old line (SEW-00115).

In 1918 E. H. Mathis conducted field investigations for oil and gas along the railroad corridor. He noted gas bubbles rising from Kenai Lake between Miles 18.5 and 22.5. Testing was performed in March 1920 on the ice near Mile-18 (NLUR #7) by sinking tanks (Barry, 1993).

The Forest Service constructed or assisted in the maintenance for numerous trails and roads in the analysis area during the first half of the 1900s. This included the Primrose Road [Trail], Snow River Trail, Paradise Valley Trail, Divide Ski Trail, CCC Trail Section and Skid Road near Mile-12 to Bear Lake. Additionally, there were trails constructed by the railroad for tie hacking activities at Meridian and Grayling Lakes.

The Snow River Watershed area, especially along the highway, has seen significant growth during the reference period of the early 1900s. Much of the history of this area can be even more fully understood with more archeological investigation, documentation, and preservation of the historic remains that still exist within this project area.

5.8.2 Human Uses: Present

Reference conditions for recreational uses existed prior to 1895, when there was no recreation use, as we know it today, occurring within the analysis area. However, people were utilizing the area for mining, hunting, fishing, and activities associated with subsistence use.

Recreation, in the form of leisure time off work, really did not occur until after World War II. Generally, nationwide and to some extent within the analysis area, the thought of camping, hiking and fishing for fun, instead of for subsistence, became more and more popular after 1942.

During the 1960s and 1970s, outdoor recreation expanded exponentially nationwide. Southcentral Alaska's population rose from 50,000 in 1950, to 110,000 in 1970, to 300,000 in 1985. Alaska residents continually seek recreation activities in a natural setting, while expanding tourism continues to attract many more visitors to Alaska. The Forest Service expanded and improved campgrounds, trails, and trailheads on the Seward Ranger District during the 1960s and 1970s in response to the increased public demand. The Snow River Watershed was primarily used as a transportation route for early miners.

Various human developments in the area have increased the number of people utilizing the Snow River Watershed. These developments include the Seward Highway construction, Upper and Lower Paradise Lake cabin construction, construction of the Primrose Campground, and general development in the adjacent communities of Seward, Moose Pass, and Anchorage.

6 Synthesis and Interpretation

The most important changes occurring in the Snow River Watershed fall into two general categories, the effects due to natural disturbance and climate change, and the effects due to human recreation and development. This chapter briefly summarizes the differences between the reference and current conditions presented in Chapters 4 and 5 for the most important key questions, and those key questions that can be influenced by management activities.

6.1 Lands

Increased human uses

Various human developments, including the Seward Highway construction in the mid-1950s and the construction of the Primrose Campground and other recreation trails, have increased the number of people using the Snow River Watershed. Increased human uses in the area have led to increased attention to the lands in and near the vicinity of the analysis area. The lands near the western boundary of the Snow River Watershed are a mixture of NFS lands, CAC lands, State lands, and private lands. Forest Service special use permits are held by the City of Seward for the powerline, the Alaska Railroad for a communication site, the Alaska Railroad for a dike adjacent to a bridge, the State of Alaska for a communication site, and a private individual for driveway access off the Primrose Road.

Lands development

The potential development of CAC selected lands on the western end of the Snow River Watershed could result in an increase in requested special use permits, land exchanges and conveyances, rights-of-way, and other lands developments. The existing City of Seward powerline location would also be utilized for any new future utility corridor requests such as the installation of fiber-optic lines. Due to the unforeseeable development that could occur on non-National Forest lands, it is important to monitor for development, uses, and associated impacts on Forest Service lands when conducting Forest planning and documenting environmental effects.

6.2 Geology, Minerals, and Soils

Mining activity and potential

The Snow River Watershed area has been the subject of both lode and placer prospecting for over 100 years. To date, no viable production has occurred, but the practice of intermittent claim-staking based on speculation is expected to continue. Mineral material needs are expected to increase in the future. The stream gravels occurring along the lower reaches of the Snow River have a high potential for mineral development. If future testing confirms the quality of the material to be suitable for highway projects, this source would be a desirable location for development.

Soil erosion from human uses

The primary soil erosion concern in the watershed is related to increased human access. The influx of users may have the effect of creating erosion problems along streambanks, in the wetland areas, and in the alpine regions. The accelerated degradation of these areas has far-reaching implications that affect soil productivity, riparian vegetation, water quality, fish habitat, and recreation. The riparian vegetation that occurs along streams stabilizes the bank by reinforcing the soil with its root systems. The soils that support this vegetation along all the major streams in the study area are formed on deep alluvial deposits of silt, sand and gravel, but it is the very thin top layer that has the organic materials essential for growth. Damaging either the riparian, wetland, or alpine vegetation will leave these areas susceptible to increased rates of erosion until the vegetation gradually recovers.

6.3 Hydrology

Climate change

Changes in climate have had and will continue to have considerable effects on the watershed. The trend of warming temperatures has caused glaciers and icefields to decrease in size, leading to altered hydrologic regimes and channel processes in the Snow River and its tributaries. Climate change can also affect vegetation, fire, fisheries, and wildlife. The effects and significance of climate change should be considered during the planning stage for future projects.

Impacts and changes associated with glacial outburst floods

The Snow River glacial outburst floods have considerable effects on the natural processes in the Snow River Watershed and also affect human uses, structures, and transportation routes. With the gradually warming climate, outburst floods from the Snow River Glacier continue to occur, although flood magnitudes appear to be decreasing as the glacier recedes and thins. The present flow regime of the outburst floods is a relatively recent phenomenon, having occurred at this magnitude for only the last 50 years. These floods are likely to continue in the near future, and these natural disturbances affect many resources, including riparian vegetation, wildlife, and fisheries. Dynamic changes in the Snow River channel and deposition of sediment and debris in Kenai Lake are some of the natural geomorphic processes occurring with the floods. Impacts to human uses from these processes include erosion along the highway and railroad along the lower Snow River, and flooding risk on property along Kenai Lake.

Effects of human uses on water resources

Human uses in the Snow River Watershed have relatively few effects on hydrologic processes. Because of the limited amount of development or human uses in the Snow River Watershed, human-related effects on the environment are generally small. These effects are concentrated primarily in the lower Snow River Valley, where the Seward Highway, Alaska Railroad, and hiking trails provide access for recreation. Effects related to the transportation corridor include impacts on channel morphology from a railroad bridge on an alluvial fan at Mile-16.6, as well as potential water quality concerns from the Alaska Railroad and the Seward Highway. Potential effects related to recreation include water quality concerns from hydrocarbon emissions from motorized use at Paradise Lakes and in the South Fork Snow River Valley.

6.4 Vegetation and Ecology

Unique nature of pristine area

Most of the Snow River Watershed is of a relatively pristine nature. The lack or low level of trails, roads, invasive or non-native species, access, recreational structures, and use of this area have created a de facto wilderness area which is of great value for conservation concerns, biodiversity preservation, and for maintaining an area of reference conditions in terms of ecosystem structure and function. With careful development, this area could be highlighted for these very characteristics. Overuse would likely degrade the quality of this pristine ecosystem.

Stand structure composition and distribution

Stand structure in the Snow River Watershed is typical of large watersheds of this region on the Kenai Peninsula, with broad changes from rock and ice mountaintops to flat meandering riparian zones at the base of the valley. Structure of forested areas is typical of dynamic areas, with a high level of natural disturbance, such that there are protected pockets of larger old growth size classes, but also a high proportion of forested stands in younger stand development classes (Oliver and Larsen, 1996). Distribution of these types reveals that older stands are located in areas not prone to avalanche, flooding, or other major disturbances. Stand structure in other areas reflects the time since disturbance. By percentage, there is less forested cover type in this watershed than in other comparably sized watersheds because of the dynamic nature of this area.

Effects of Spruce bark beetle on vegetation

The lack of severe spruce bark beetle effects to this area provides an interesting contrast to other areas on the Kenai Peninsula that are heavily affected by the beetle. The lack of spruce bark beetle activity has allowed the forested areas to continue on a successional pathway in the absence of this type of disturbance. As a result, more complex forest structures and less downed woody debris are found in this area. This area may be less prone to catastrophic wildfires as a result, although the overall probability of wildfire is low in the entire region.

6.5 Fire

Effects of the spruce bark beetle on wildfire

Spruce bark beetle infestation has led to increased risk of fire and a short-term increase in large woody debris recruitment potential. The beetle infestation has not affected recreation significantly, though it has raised the risk of wildfire in areas which are frequented by humans. Although the increased risk of wildfire is not quantified, it may still be a concern to the residents living in and around the Primrose area. Efforts are currently underway to reduce the risk of wildfire. However, because there is no identified feasible way to rid the beetle from the watershed, the need for additional treatment appears to be unwarranted.

Effects of human uses on wildfire

The increase in recreational usage could lead to increased risk of wildfire. The Snow River Watershed has considerable human accessibility because it is crossed by the Seward Highway, which provides access to Primrose Campground and a limited number of residences. Recreational use of the area is relatively high as well, including hikers and campers along the Grayling Lake, Meridian Lakes, and Primrose trails. Because of this human use, the potential for human-caused fires is relatively high.

6.6 Aquatic Species and Habitats

Increased angler pressure and fishing opportunities

Increased recreational use on the west side of the Seward Highway could increase the need for further enhancement of fishing opportunities in lakes. With an increase in recreation in the area, angler pressure may increase and the need top keep these lakes on the Alaska Department of Fish and Game stocking plan will be critical to meet the demand for angler satisfaction.

6.7 Terrestrial Species and Habitats

Influences on wildlife and habitat

Primary factors affecting wildlife and habitat in the past and present include the following:

- Changes in vegetation and structure (habitat) due to climate change and natural disturbance (jökulhlaups, flooding, avalanches, fire, and the spruce bark beetle).
- Human use of the watershed for recreation, hunting, and trapping.
- Human travel corridors (highway, railroad).

The eastern and western portions of the watershed have experienced different effects and changes over time to wildlife and habitat, based on differences in natural and human caused factors.

Vegetative succession and habitat east of the Seward Highway

The Snow River Watershed is very dynamic, with regular flood events as well as other disturbance regimes. The eastern portion of the watershed that drains into Kenai Lake is mainly affected by these dynamic forces. Jökulhlaups affect vegetation and habitat within the Snow River floodplain, creating and maintaining early seral stages and favorable habitat for moose. A delta is expanding at the head of Kenai Lake, forming new land at the mouth of the Snow River and increasing early seral vegetation. Avalanches also contribute to promoting early seral stages of hardwoods. While human management has been limited and the effects of the spruce bark beetle and wildfire have had minimal impacts on habitat, habitat is always changing in and adjacent to the floodplain due to natural forces. Over time, if outburst floods decrease in occurrence and magnitude, vegetative succession may increase. Such a change would decrease habitat for early seral species such as moose and lynx and increase habitat for late seral species such as eagles, goshawks, murrelets, and mountain goats.

Human effects on wildlife east of the Seward Highway

This eastern portion of the watershed is mainly inaccessible to humans except by aircraft. Increased trail access to this area has been proposed in the past, but never realized. Development in this area is limited to the two Forest Service public-use cabins on Upper and Lower Paradise Lakes. Recreation in this pristine area can have some effects on wildlife and habitat. Aircraft, unregulated by Forest Service permits, are providing increased access for recreation, wildlife viewing, flight-seeing, and flight instruction. Aircraft use the Paradise Lakes to practice touch-and-go landings for flight instruction and float plane ratings. Aircraft have the potential to cause disturbance to a variety of wildlife species, depending on the altitude and frequency of use. Float planes can affect species such as trumpeter swans, and helicopters and fixed wing aircraft can affect mountain goats and Dall sheep. Some effects to habitat and wildlife are occurring in the vicinity of the cabins, where disturbance and hunting pressure are likely higher. As human use increases, potentially negative bear/human interactions and other impacts to wildlife and habitat will likely increase as well. Bears have been sighted near and at the cabins, but negative encounters have not been reported.

Wildlife and habitat changes west of and adjacent to the Seward Highway
The area west of and adjacent to the Seward Highway has experienced the effects of flooding and vegetation change, the effects of the spruce bark beetle and wildfires, and the effects of a major human travel corridor running through the area. Access from the railroad and Seward Highway has promoted the development of a campground, trails, mining claims, powerlines, and private land as land ownership has changed from the Kenaitze Indians to a mixture of owners such as CAC, state, private, railroad, and Forest Service. These developments have removed wildlife habitat, reduced habitat quality, promoted disturbance and fragmentation, and increased access for hunting and trapping. On the other hand, the South Fork Snow River was once a human travel corridor during the reference period but is no longer in use. Effects on habitat by humans may have decreased over time in this area.

Effects of fish populations on wildlife
Fish populations provide valuable food for wildlife and introduce nutrients into the watershed. Stocked lakes since 1962 increase fish numbers, yet commercial fisheries may have decreased salmon numbers over time, causing marine nutrients in the watershed to decrease. The stocking of lakes for recreational fishing has introduced new species such as grayling and rainbow trout. Fewer salmon and nutrients entering the watershed now may be decreasing habitat quality for species such as brown bear and bald eagles that depend on salmon. The addition of new species may provide food for wildlife, but nutrient content is likely different. These effects may be occurring in the entire watershed.

6.8 Human Uses

6.8.1 Human Uses : Past

Human development in the watershed
Historic documents and known sites show that development in the analysis area was greater in the past than today. The number of residences, roadhouses, section houses and trails has decreased significantly. The now defunct Snow River Trail, Paradise Valley Trail, Divide Ski Area, CCC Trail and numerous tie hacking trails have focused the public on the remaining historic routes. In addition, the Minnie Andacher homestead is now public land, and multiple mining cabins, roadhouses and residences that are no longer standing were not replaced with newer structures.

Effects of human use on cultural resources
The number of people visiting the watershed is expected to increase over time. This increase is focused on a smaller number of trails and access points than historically noted. Cultural resource sites and features are susceptible to many altering elements, which may adversely affect their integrity. Focusing the trail use can lead to additional

direct and indirect effects that will need to be addressed. Significant cultural resources exist that need documentation and protection. In addition, the probability of discovering additional historic properties is high within the assessment area. It is important to preserve our heritage, and to do this we must consider the effects that human use, as well as the environment, may have on these resources.

6.8.2 Human Uses: Present

Snow River area recreation trends

Recreation use in the Snow River Watershed has increased over the past 40 years. Various human developments, including the construction of the Seward Highway and the Primrose Campground, have increased the number of people using the Snow River Watershed. Although recreation trends are increasing and are essentially a function of population growth, the Snow River Watershed has not experienced the same increase in recreation use as other areas on the Seward Ranger District like the Russian River Watershed, where up to 45,000 visitors per year use the Russian River Campground (USDA Forest Service, Chugach National Forest, 2004). The public has indicated that they desire the Forest Service to restrict the amount of development occurring in the Snow River Watershed. The proposal by the Alaska Mountain Wilderness Huts Association to construct a hut-to-hut system in the Snow River area was withdrawn from consideration because of strong public sentiment expressing a desire not to construct additional recreation facilities in the backcountry portions of the Snow River area. It is not expected that recreation will increase in the majority of the Snow River Watershed beyond population growth rates. This is mainly the result of the lack of access into the watershed and the lack of planned development in this area. Recreation along the road system (Primrose Campground and various trail use) could increase at a greater rate, and it is likely that this will occur for the reasons stated above.

Snow River area recreation conflicts

Generally, the main sources of recreation conflicts occur between different or similar user groups. These conflicts can occur because recreation users feel crowded by other users or because different uses are perceived as incompatible. Potential recreation conflicts in the Snow River Watershed include interactivity conflicts between bikers and hikers on the Primrose Trail, multiple campsites at the Primrose campground, and motorized and non-motorized users in the Snow River corridor. At this time, the Forest Service has not received strong information that any areas contained within the watershed are experiencing persistent recreation conflicts. Currently, the environmental analysis is underway to determine winter motorized access on the Seward Ranger District. The project area for this analysis encompasses most of the Snow River Watershed. The outcome of this decision may influence the number of recreation conflicts occurring in the Snow River Watershed and provide information on public perception of this area.

6.9 Summary

Eastern Portion

The portion of the watershed east of the Seward Highway is characterized by a lack of roads, human developments, and developed recreation facilities. This large area encompasses a majority of the watershed. It can be considered relatively pristine, and the dynamic changes occurring in the watershed are primarily the result of natural forces and climatic changes.

The public has expressed a desire for the Forest Service to restrict increasing development in this area. The agency also realizes the value of this area in its relatively pristine condition for conservation concerns, biodiversity preservation, and for maintaining an area of reference conditions for ecosystem structure and function.

The main management issue pertains to increasing recreation in the area, and the effects of the existing recreation on resources. Increasing recreation may lead to accelerated erosion and may serve as a vector for the spread of invasive and non-native species, both of which have the potential to negatively impact a variety of natural resources. This portion of the watershed is generally inaccessible except by aircraft-assisted transportation to the Forest Service cabins on Upper and Lower Paradise Lakes. Aircraft use has the potential to cause disturbance to a wide variety of wildlife. Increased recreation and aircraft use may lead to an increase in negative human/wildlife interactions and increased disturbance to wildlife.

Western Portion

The portion of the watershed which lies west of the Alaska Railroad and the Seward Highway is characterized by a high level of human use, and development and is more fragmented by development and varied landownership. Although this area of the watershed comprises a small percentage of the overall area, it receives a disproportionate amount of use due to the transportation corridor. Unlike the eastern portion of the watershed, this area has and will continue to be influenced heavily by human activities. This portion of the watershed also has been impacted by the spruce bark beetle along the lower elevation spruce stands adjacent to residential areas.

The main management issues in this portion of the watershed are increasing recreation and land development. It will be important to monitor recreation uses and development in the watershed to assess impacts to National Forest lands. Increasing recreation and development may affect a variety of natural resources and increase the risk of wildfire.

7 Desired Condition, Opportunities, Management Strategies, Data Gaps, Monitoring and Research Needs

7.1 Lands

The following incorporates management direction from the Revised Forest Plan, (page 3-13) (USDA Forest Service, Chugach National Forest, 2002a):

Desired Condition	The Seward Highway and the Alaska Railroad will continue to provide transportation between Anchorage and Seward and will also provide access to scenery and recreation opportunities on the Chugach National Forest.
Management Strategies	The Chugach National Forest will remain involved in reconstruction efforts planned for the Seward Highway and examine the role the Alaska Railroad could have in recreation planning.
Desired Condition	Private land inholdings will have development consistent with their economic potential and will have minimal impact on the surrounding Forest. Private landowners with inholdings and holders of valid mining claims will have reasonable access to their lands. The means of access will be consistent with management area direction and emphasis in the Revised Forest Plan.
Management Strategies	The Chugach National Forest will work with permitees during application processes and conduct site-specific NEPA as needed.
Desired Condition	Scenery along the Seward Highway All-American Road and other major travel corridors will be managed to maintain the natural appearance of the landscape.
Management Strategies	Roads, structures, utilities, and other facilities will repeat naturally occurring line, form, color, and texture to the extent it is safe and practical.
Monitoring and Research Needs	Continue monitoring of existing land use permits.

7.2 Geology, Minerals, and Soils

7.2.1 Geology

Because geologic conditions in the Snow River Watershed are generally not influenced by management, there are no desired conditions, opportunities, or management strategies for geology.

7.2.2 Minerals

Desired Condition	Lands in the Snow River Watershed will remain open to mineral entry.
Desired Condition	Sand and gravel production from the Snow River alluvial gravels along the highway route may be developed.
Management Strategies	The Forest Service will work with the State of Alaska, Department of Transportation, to conduct exploration of gravel resources along the Snow River between Mile-18 and Mile-25 in order to confirm the quality of the material. If the material proves to be desirable for highway projects, this source will be developed.

7.2.3 Soils

Desired Condition	Soil erosion rates will not increase over current levels, which are predominantly the result of natural processes.
Management Strategies	The Chugach National Forest will conduct careful planning and monitoring of soil erosion as access to this area increases over time.
Data gaps	Detailed soil information is limited to a narrow stretch along the Seward Highway corridor. The soils information for the remainder of the study area is inferred from generalizations based on work done elsewhere on the Chugach National Forest. More soils data are needed in areas that are sensitive to disturbance, such as wetland areas and alpine regions.
Monitoring/ Research Needs	Conduct a soil survey of alpine regions and wetland environments.

7.3 Hydrology

Natural processes are the primary controls on hydrologic conditions in the Snow River Watershed. Management cannot influence processes such as climate change, glacial recession, and the dynamic landscape changes associated with glacial outburst floods. Because of its pristine character, much of the Snow River Watershed is currently in its desired condition, although the current conditions are changing relatively rapidly.

Desired Condition	The water quality of lakes, streams, and wetlands in the watershed will remain at acceptable levels as defined by the State of Alaska (Alaska Department of Environmental Conservation, 2003). Water quality conditions will be predominantly influenced by natural processes. Although human uses within the Snow River Watershed potentially have some impact on water quality in localized areas, it is likely that the watershed currently meets this desired condition.
Opportunities	Ensure that existing human uses are not causing water quality degradation.
Management strategies	Ensure that the construction and maintenance of the Iditarod National Historic Trail comply with Best Management Practices (BMPs) as defined in the R10 Soil and Water Conservation Handbook (USDA Forest Service, Alaska Region, 1996) to prevent water quality degradation. BMP Monitoring is also a monitoring item in the Forest Plan (USDA Forest Service, Chugach National Forest, 2002a).
Data gaps	Very little water quality data exist for the watershed, and no data on hydrocarbon concentrations are available for water bodies within the watershed.
Monitoring and Research Needs	▪ Monitor water quality in Upper and Lower Paradise Lakes for hydrocarbons that may be present from summer floatplane use. Monitoring should occur during the peak season in the summer, and baseline data should also be collected prior to the summer. ▪ Ensure that maintenance of Forest Service trails and the Chugach Electric Powerline access roads comply with Best Management Practices (BMPs) as defined in the R10 Soil and Water Conservation Handbook (USDA Forest Service, Alaska Region, 1996) to prevent water quality degradation.
Desired Condition	The stream channels and floodplains in the Snow River Watershed will be influenced predominantly by natural processes. Channels and floodplains along the lower Snow River will be influenced by dynamic changes and high sediment loads associated with periodic glacial outburst floods. These flood events will continue to have considerable effects on fish habitat, vegetation dynamics, and wildlife uses in the area. Most of the stream channels in the Snow River Watershed are currently in their desired condition.
Opportunities	Little can be done to influence the dynamic nature of the stream and river channels in the Snow River Watershed. However, management may be necessary where human structures affect or are affected by these processes.

Management strategies	▪ Aggradation of the alluvial fan channel at Mile-16.6 of the Alaska Railroad is an on-going maintenance issue. Future maintenance should be conducted in a way that minimizes water quality degradation and results in a self-maintaining channel that passes the large sediment loads delivered from this drainage. This area is maintained by the Alaska Railroad Corporation. ▪ Bank erosion is occurring in localized areas where the Snow River flows adjacent to the Seward Highway. Bank stabilization efforts may be required in the future to protect the road. These areas are within the highway corridor maintained by the Alaska Department of Transportation. ▪ With the predictable nature of the Snow River jökulhlaup, interpretive signs and materials could be created to allow people to view and understand this unique natural phenomenon. Viewing opportunities exist along the Seward Highway.

7.4 Vegetation and Ecology

Desired Conditions	▪ The watershed will be free of non-native and invasive species. ▪ The vegetation will contain a mosaic of different stand development classes. ▪ The ecology of the watershed will exist in a proper functioning condition in terms of vegetation cover and hydrology. ▪ Pristine habitat for sensitive plants and native vegetation will be retained throughout much of the landscape. ▪ Recreational development will be carefully planned to balance user needs with current pristine watershed condition.

7.5 Fire

Desired Condition	The predominant conditions on the Chugach National Forest will be those that result from natural processes. Conditions that result from active management or restoration will be present in selected locations (USDA Forest Service, Chugach National Forest, 2002a, pg. 3-13).
Opportunities	Apply Fire Regime Condition Class (FRCC) or other models to determine fire risk, fire return intervals, potential fire spread, and strategies to deal with fire in the watershed. Future options for the planning area should include a fire use program within the limited suppression boundary. This will allow natural fire to play a role in shaping the ecosystem while reducing impacts and costs associated with fire suppression activities.

Management Strategies	▪ Restoration activities, such as prescribed fire and mechanical treatments, in these areas and small-scale forest management activities along the road corridors will create opportunities for the utilization of forest products. ▪ Prescribed fires will occur on a limited basis each year for fuel reduction, improvement of wildlife habitat and restoration to desired vegetative conditions. Catastrophic wildland fires are projected to be infrequent and, when they occur, will most likely be distant from major highway corridors and other centers of human activity. Smoke levels will be within state standards for particulate material, except when catastrophic fires occur (USDA Forest Service, Chugach National Forest 2002a, pg. 3-15).
Data Gaps	▪ Fire regime condition class (FRCC) mapping of the project area to ascertain departures from historic levels does not exist. ▪ Fuel characteristic classification system (FCCS) mapping for the project area to determine the rate of spread and severity of fire within the project area does not exist. ▪ Stand data for input into fire behavior models and future treatment areas near highways and homes do not exist. ▪ Current digital elevation models and 1-meter digital color orthoquads are needed for future limited fire suppression strategies or wildland fire use for resource benefit planning. ▪ Accurate weather observations and patterns are needed within the Snow River area to manage fire under appropriate fire suppression strategies.
Monitoring and Research Needs	▪ Monitor the effects of increased use and fire occurrence within the watershed. ▪ Monitor first order and secondary fire effects of prescribed and natural fire within the project area.

7.6 Aquatic Species and Habitats

Desired Conditions	▪ Healthy spawning habitat for salmon and char will be maintained. ▪ The Snow River Watershed will remain mostly in a pristine condition. ▪ Fish populations for sport angling will be maintained as a sustainable recreational fishery.
Opportunities	Interpretive signs can be placed along trails and at day use areas directing visitors to stocked lakes in the area. Stocking of rainbow trout can continue in lakes of the watershed. The effects of outfitter/guide use in the Snow River watershed on fisheries resources should be monitored.
Management Strategies	Maintain a low level of recreational development on the west side of the Seward Highway, and use a more passive strategy for development on the east side of the highway.

Data Gaps	▪ Limnological data do not exist for barren lakes in Paradise Valley and on the west side of the highway. ▪ High quality spawning habitat areas have not been surveyed in the watershed.
Monitoring and Research Needs	▪ Monitor the effects of recreational use on fish habitat, including the effects of increased use on the Iditarod Trail on stocked lakes. ▪ Determine fish population structures of lakes in the watershed, and monitor sport fish use in stocked lakes. ▪ Monitor the effects of outfitter/guide use on fish habitat in the South Fork Snow River. ▪ Monitor the stock status of Snow River salmon.

7.7 Terrestrial Species and Habitats

Desired Condition	Bear/human interactions are minimal, and the potential for wildlife habituation of bears and eagles is reduced.
Opportunity	Maintain low negative bear/human interactions.
Management Strategies	▪ Increase awareness with interpretation and education. Develop a bear safety guide and information on reducing habituation of bears and eagles for the backcountry cabins at Upper and Lower Paradise Lakes. ▪ Provide additional bear-proof food lockers in backcountry areas.
Desired Condition	Recreational opportunities include responsible consumptive and non-consumptive uses within an acceptable range of impacts.
Management Strategies	▪ Identify important habitat areas and determine if they are being impacted by current recreation use such as aircraft, snowmachines, and non-motorized winter and summer recreation. ▪ Develop a wildlife interpretive/education plan to promote responsible consumptive and non-consumptive use. ▪ Inventory and monitor existing MIS, TES, SSI species and habitats and potential impacts from recreational activities. ▪ Conduct trumpeter swan nest habitat surveys and develop a management plan. ▪ Determine areas of overlap of motorized and non-motorized use areas with high quality habitat such as potential brown bear and wolverine denning areas, moose winter range, and mountain goat and sheep winter range. Develop recreation strategies to reduce impacts.
Desired Condition	Disturbance to wildlife from aircraft is minimal or within an acceptable range.
Opportunity	Monitor current aircraft use in the watershed, and identify potential disturbance to wildlife.

Management Strategies	▪ Identify important habitat areas and determine if they are being impacted by aircraft. ▪ Adjust special use permits to reduce impacts. ▪ Increase awareness of potential impacts to outfitter/guides and flight instructors, and ask for voluntary compliance with recommendations. ▪ Develop no-fly zones for goat and sheep.
Desired Condition	A diversity of vegetation types and structure provides a wide range of habitats for wildlife, including at least 20% in early seral stages.
Opportunity	Identify current vegetation and structure, and identify projects to promote structural diversity on the west side of the watershed.
Management Strategies	▪ Obtain and interpret IKONOS imagery to determine existing vegetation type and structure, and incorporate into existing GIS data. Identify areas impacted by the spruce bark beetle on the west side of the watershed. ▪ Identify opportunities for mechanical and prescribed burn treatments to increase browse for moose in the Snow River watershed. If early seral habitat declines, consider habitat improvement projects such as burning or mechanical treatments to maintain at least 20% in early seral stages. Look for opportunities to promote northern goshawk and marbled murrelet nesting habitat. Identify opportunities to reduce risk of fire to wildlife habitat in cooperation with hazardous fuel reduction efforts near Primrose Campground and private land. ▪ Coordinate with ARRC, State of Alaska, and ADOT to develop habitat treatments which enhance wildlife habitat away from transportation corridors to assist in reducing animal mortalities.
Desired Condition	The risk of loss of habitat due to fire is minimal.
Opportunity	Reduce fuels in high-risk areas for wildfire.
Management Strategies	▪ Conduct mechanical or prescribed burns in high risk areas (bark beetle impacted areas near structures, trails, and campgrounds). ▪ Monitor spruce bark beetle impacts in the eastern watershed. If impacts spread or increase, determine potential prescribed burn areas to improve wildlife habitat.
Desired Condition	Salmon numbers are at historical levels or higher to provide high quality food for wildlife and distribute nutrients into the watershed within the natural range of variability.
Opportunity	Monitor current salmon numbers and nutrient flow. If these are lower than historic levels, consider options for increasing salmon numbers.
Management Strategies	▪ Develop a monitoring plan for fisheries and nutrients. ▪ Monitor brown bear and bald eagle numbers and habitat use of the watershed.

Data Gaps	▪ Existing populations, population trends, and existing and potential habitat are not known for all sensitive species, management indicator species, species of special interest, and other species of interest such as Dall sheep. ▪ Brown bear population size and structure, core areas of spring and summer feeding habitat and winter denning habitat, and the effects of existing human activities on these areas are not known. ▪ The effects of human activities on all sensitive species, management indicator species, species of special interest, and other species of interest such as Dall sheep are unknown. Levels of acceptable adverse impacts to wildlife or habitat must be determined ▪ The locations of trumpeter swan nesting and rearing habitat, and the impacts that float planes and other activities are having on these habitats are unknown. ▪ The current vegetation composition and structure, and potential habitat for all species are unknown. ▪ The impacts of the spruce bark beetle on habitat and wildlife such as goshawks are not known.
Monitoring and Research Needs	▪ Monitor the effects of recreation activities and aircraft on wildlife in the watershed. ▪ Monitor salmon numbers and nutrient flow in the watershed, and determine the effects on brown bear and bald eagles.

7.8 Human Uses

7.8.1 Human Uses: Past

Desired Condition	All obligations the Chugach National Forest has under various laws to Heritage resources will be achieved. These include completing a cultural resource inventory of the watershed; documentation and evaluation of all known cultural resources for the National Register; rehabilitation of historic buildings, which would be available for administrative or public use; interpretation and signage of archeological sites, archeological districts and cultural landscapes for the public; and archeological site protection and interpretation through stewardship programs.
Opportunities	▪ Few people are aware that human occupation in the analysis area was greater in the past. There are potential interpretation opportunities along existing trails, at archeological sites and at road pullouts. There is the potential for stewardship opportunities within the watershed. These could be developed to assist with the monitoring of heritage resources and education of the public. ▪ The completion of the watershed inventory would assist in the development and testing of a predictive model for cultural resources in the region.

Management Strategies	▪ The National Historic Preservation Act (NHPA) of 1966 requires the identification and preservation of significant historic and prehistoric sites on Federal lands, and the mitigation of both direct and indirect impacts of federal undertakings on sites that are eligible for the National Register of Historic Places. Archeological surveys would continue in support of federal projects, under Section 106 of the NHPA. Historic properties and cultural landscapes would be evaluated for the National Register of Historic Places for management purposes. Adverse effects to historic properties would be avoided where possible. ▪ Develop partnerships and stewardships with interested parties for documentation, preservation, and interpretation of prehistoric and historic sites, cultural landscapes, and rehabilitation of historic buildings. Identify educational and interpretational opportunities for the public. ▪ Continue to work towards the completion of federally mandated inventory surveys for the entire watershed.
Data Gaps	97% of the analysis area has not been archeologically inventoried, and the majority of the known cultural resources are not evaluated for the National Register of Historic Places and may need further documentation.
Monitoring and Research Needs	▪ Monitor all known archeological sites in the Snow River Watershed. ▪ Complete the federally mandated cultural inventory surveys for the entire analysis area. ▪ Complete the Snowrose Timber Sale cultural resources survey report for 34 units (2000 acres) in the Snow River watershed.

7.8.2 Human Uses: Present

Desired Condition	There is a balance between human uses for recreation and resource use and the degradation of or acceptable change in natural resources.
Opportunity	Determine an appropriate level of human use and resource degradation.
Management Strategies	Conduct a public survey on acceptable recreation development and recreation access in the Snow River Watershed. Some of this information could be provided during the Kenai Winter Access Management Plan NEPA process being conducted in 2005 and 2006.
Desired Condition	Human uses and impacts are concentrated in certain areas rather than spread out, and impacts are within an acceptable range.
Opportunity	Determine appropriate locations for recreational development where impacts have no adverse effects and/or can be easily mitigated.
Management strategies	Develop a plan to determine levels of human use and an acceptable range of use throughout the watershed, and identify sufficient management actions when an unacceptable range is reached.

8 Recommendations

8.1 Recommended Actions

1. **Develop an integrated <u>Resource and Recreation Management Plan</u>** for the Snow River Watershed that includes coordination with the Alaska Department of Fish and Game, US Forest Service, CIRI, CAC, ARRC, Chugach Electric Corporation (CEA), Alaska Department of Transportation (ADOT), private landowners, and outfitter/guides. The plan should address the following items:

   - A strategy to determine and quantify existing and acceptable levels of human use for different portions of the watershed and sufficient management actions when an unacceptable range is reached. Identify appropriate locations for recreational development where impacts have no adverse effects and/or can be easily mitigated.
   - Recommendations for facilities to maintain the natural appearance of the landscape along the Seward Highway All-American Road.
   - A management strategy for minimizing soil erosion along new and existing trails, as well as other areas impacted by human use.
   - A strategy for dealing with wildfire in the watershed. Apply Fire Regime Condition Class (FRCC) or other models to determine fire risk, fire return intervals, and potential fire spread.
   - A prescribed burn plan and mechanical treatment plan to create and maintain a desired mosaic of stand composition and structure, which would help meet desired future conditions and improve wildlife habitat.
   - Guidelines from the Chugach Exotic Species Management Plan for reducing or eliminating the spread of non-native plant species.
   - Guidelines for reducing wildlife habituation at Forest Service public-use cabins.
   - Guidelines for reducing recreation impacts to trumpeter swan nesting areas, if shown to be necessary.
   - A management plan for identifying, protecting, and interpreting cultural resource sites in cooperation with CIRI, CAC, ARRC, CEA, DOT, the State, and outfitter/guides. The plan should incorporate stewardship agreements with outfitter/guides.
   - A monitoring plan for aircraft as well as motorized and non-motorized summer and winter recreation use in the watershed. The results will identify areas of overlap and potential effects to important wildlife habitat.
   - An interpretive plan that includes the following:
     - Interpretive signs or materials for good fishing areas and techniques at lakes.
     - Interpretive signs and materials on reducing negative bear human encounters.
     - Interpretive signs on fish and wildlife viewing opportunities and viewing ethics.
     - Interpretive signs and information on prehistoric and historic sites.
     - Interpretive information for the Snow River outburst floods along the Seward Highway.

2. **Continue processing land use permit applications** to meet public demand and support the Revised Land and Resource Management Plan (USDA Forest Service, Chugach National Forest, 2002a).

3. **Continue to cooperate with the State of Alaska and the Alaska Railroad** to identify and process sand and gravel extraction sites for the benefit of the public.

4. **Conduct the following inventory, monitoring, and research to support the recommendations listed above:**

8.2 Inventory

- Inventory the alpine soils and wetland resources for type and extent within the watershed.
- Conduct a more thorough inventory of the vascular plant flora, particularly in areas sensitive to disturbance, such as alpine sites and wetland areas. Surveys for sensitive and non-native plant species should be conducted in all areas of proposed development.
- Inventory and monitor existing and potential habitat for MIS, TES, and SSI species, identifying important habitat areas where potential impacts from recreation activities may be occurring. Conduct trumpeter swan nest habitat surveys and mountain goat and Dall sheep winter and summer habitat use and movement surveys. Identify areas of potential impacts from recreation use.

8.3 Monitoring

- Monitor soil erosion rates as access to the study area increases, particularly in sensitive areas such as wetlands and in the alpine regions.
- Monitor rates of soil and streambank erosion along trails and in areas where development is likely to occur.
- Conduct long-term monitoring of developed sites to track the establishment and spread of non-native plant species. These species are disturbance-driven and will no doubt start to appear with increased human presence. Monitoring will be useful for tracking species composition of non-natives and will ensure that the more aggressive invasive species do not become established in these areas.
- Continue monitoring of trumpeter swan nesting habitat and reproduction.
- Continue monitoring of bald eagle nest sites.
- Monitor aircraft use in the watershed. Develop guidelines if necessary for reducing recreation impacts to trumpeter swan nesting areas and mountain goats and Dall sheep for non-permitted users to promote voluntary compliance.
- Monitor winter motorized and non-motorized use of the watershed and identify areas of overlap with important wildlife habitat for brown bears, wolverine, goats, sheep, and moose.
- Develop a wildlife/recreational use plan that identifies acceptable levels of use for the watershed.

8.4 Research

- Identify brown bear, mountain goat, and Dall sheep numbers, movements, and important habitat areas in the watershed in relation to human use and areas of concern where recreation impacts may be occurring.
- Identify moose numbers, movements, and important habitat areas in the watershed and the importance of this area to overall moose population numbers on the Seward Ranger District.
- Identify current vegetation and structure through IKONOS imagery, aerial photos, landsat imagery or other methods.
- Identify current vegetation and structure, as well as spruce bark beetle impacts over time, and develop a vegetation/habitat management plan to maintain a diversity of vegetative structures and reduce wildfire risk.

9 APPENDIX A: Land Stability Analysis Process on the Chugach National Forest

Assembled by Dean F. Davidson, Forest Soil Scientist

A land stability analysis is done on all major land disturbing activities proposed for sites that contain properties that frequent landslides. Red flags are fine texture soils of lacustrine origin, soils in or underlain with glacial till or outwash, poorly drained soils on slopes over 56 percent, shallow soils over an impermeable layer such as bedrock or compact glacial till.

The Standards and Guidelines in the Chugach Land Management Plan state "an analysis will be done for all major soil-disturbing activities greater than one-half acre in size, proposed on slopes from 56 to 72 percent, and one-tenth acre in size on slopes greater that 72 percent. Initially a preliminary analysis is done in the office using available information. If sufficient indicators are thought to be present on the site, the office analysis will be followed with an on-site inspection and analysis. The analysis process used on the Chugach NF was developed by Hicks (1982). This system uses the presence of features characteristic of landslides for the identification of landslides of all relative ages.

The Hicks risk assessment consists of identification of the presence of past and present landslides or landforms and soils with characteristics that normally contribute to a landslide. Aerial photography and available soils and landform data are good sources for information to help make the determination. The following categories are used to identify the risk for a landslide. Some characteristics for landslide identification are also included in the definitions.

Levels of Landslide Activity and Indicators

Active	Currently active or active in the very recent past. May have fresh scarp or cracks. Leaning trees may indicate recent movements; such as a straight, healthy conifer leaning from the base can dictate recent movement. Broadly bowed, living conifer indicates movement over a period of time. Hummocky terrain with terrace-like slopes which are not deeply weathered may indicate recent movement.
Possibly Active	No clear indications of recent movement but landforms indicate movement in the past. Landslide features not so heavily weathered as to indicate long-term stability. More subtle features often without obvious scarps or cracks. Possible low, constant creep rate that is currently creeping at a rate sufficiently slow that obvious cracks do not form.
Inactive	No indication of movement is discernable from aerial photo interpretation or from field observation. However, significant soil removal, deep cuts from roads, tree removal or increase in water content as a result of management activities could accelerate or increase the potential for landslides or soil creep.

Stable	No indication of movement is discernable from aerial photo interpretation or field observation. Landform and soil factors are not conducive to landslides or soil creep.

The more analytical Forest-wide standardization approach used by Douglas N. Swanston (1997) for hazard assessment for the Tongass Land Management Plan is used, with some minor adjustments, for on-site analysis on the Chugach National Forest. This system uses data that is easily collectable in the field; such as soil properties that include soil texture, parent material, depth, drainage; and specific topographic characteristics such as slope shape, length, gradient, and drainage density. The risk assessment weighs each of the characteristics as to their relative importance in landslide production, and provides a relative numerical landslide failure rating for the site.

Risk Assessment Categories

High to Extreme	Natural failures are often frequent and large, and there is a high risk of management-induced failure. Standard management practices can be expected to have only limited success, and on-the-ground assessment is necessary to determine the need for mitigating measures.
Moderate	Natural failures are usually small and infrequent, but there is a moderate risk of management-induced failure. Standard and the best management practices are usually successful but on-the-ground investigation is still recommended. Mitigation measure may occasionally be needed.
Low	Natural failures are usually rare or small. There is a low risk of management-induced failures except on unstable micro-sites such as scarps, V-notches, and stream banks. Standard best management practices that control stream flows and surface disturbances can be expected to be highly successful.

Used together the Hicks and Swanston risk assessment systems provide a solid basis to determine the potential for a landslide. One system is based on visual characteristics used to identify landslides and other system uses the analytical approach with data easily collected at the site.

The spreadsheet below shows the different criteria and the weighting that is used on the Chugach National Forest. The numerical rating is categorized into four ranges to give a relative potential derived from a repeatable process. The spreadsheet allows you to adjust a value and see what it would take to increase or reduce the potential for landslide occurrence, and hence estimate the effects of the proposed management activity.

Criteria	1	2	3	4	Criteria Value	Weighting Factor	Rating
Landform							
Slope shape	Vertical	Broken	Convex	Concave -straight	x	5	=
Slope length (ft)	0-300	301-700	701-1500	>1500	x	5	=
Slope gradient (%)	0-35	36-55	56-72	>72	x	20	=
Drainage features:							=
Drainage density (% of area)	0-10	10-129	20-39	>40	x	10	=
Soils and Geology							
Soil drainage class	WD	MWD	SPD	VP,PD	x	10	=
Soil Depth (inches)	>40	not applicable	20-40	<20	x	5	=
Parent material	Carbonate, colluvium, alluvium	Noncarbonate, granitics, glacial till	Compact till, marine sediments	Volcanic ash	x	5	=
Textural class	Sand, gravel, fragmental loam	loam	silt	silty clay	x	5	=
Total of Ratings							
Failure Hazard Rating							*

***** ≥ 63 - High; 62-50 - Moderate; 28-49; low; <28 - None

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