Trail River Landscape Assessment

Prepared by the

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TRAIL RIVER LANDSCAPE ASSESSMENT 2007

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1.0 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, 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.

We divided the document 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

We discuss the following topics 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 Trail River Watershed covers about 124,400 acres (194 square miles) on the eastern Kenai Peninsula, on the Seward Ranger District of the Chugach National Forest. The watershed is about 50 miles southeast of Anchorage, Alaska, and about 25 miles north of Seward, Alaska (Figure 1.1). It lies within the Kenai Mountains, and Trail River is a major tributary of the upper Kenai River. The Seward Highway and the Alaska Railroad provide access to much of the watershed, and the community of Moose Pass lies near the mouth of Trail River.

The watershed is characterized by glacially sculpted valleys flowing southwest and draining into Kenai Lake. Much of the watershed is undeveloped backcountry, where activities are limited by the difficult access and lack of maintained trails. The land adjacent to the Seward Highway and Alaska Railroad is more developed, and provides recreational opportunities for skiing, hiking, hunting, fishing, and snow machining.

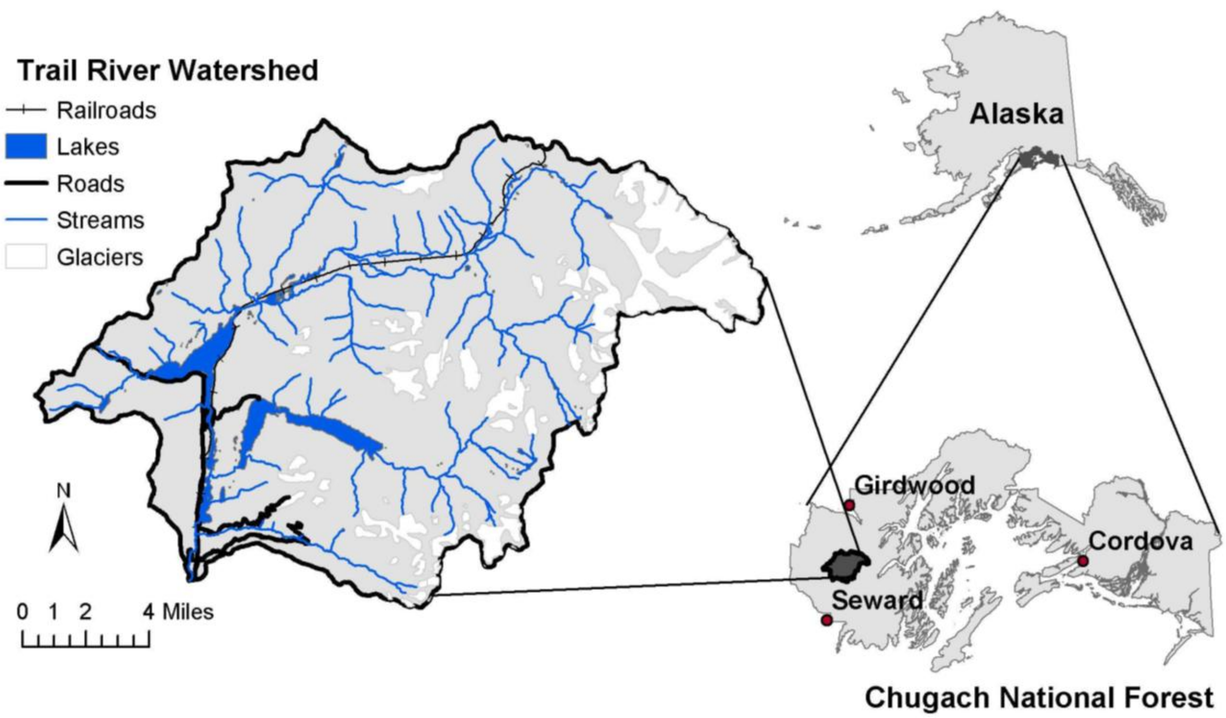

Figure 1.1. Location of the Trail River Watershed.

2.0 WATERSHED CHARACTERIZATION

2.1 Lands

The US Forest Service manages the majority of the land in the Trail River Watershed (approximately 110,360 acres or 89% of the watershed). The State of Alaska, Kenai Peninsula Borough, and private landowners own approximately 13,450 acres (11%). The Alaska Railroad Corporation owns approximately 602 acres (<1%).

The privately developed lands are concentrated around the Seward Highway corridor in the community of Moose Pass. One additional private parcel is located at the junction of Trail Creek and Upper Trail Lake. The Alaska Railroad property bisects the watershed, generally following Trail Creek, the east shore of Upper Trail Lake, and the west shore of Lower Trail Lake.

2.2 Geology, Minerals, and Soils

2.2.1 Geology and Minerals

The geology in the Trail River Landscape Assessment (Trail River LA) area is generally conductive to Chugach-Type (lode) gold deposits. Placer gold deposits have formed in some of the streams and rivers. Historical lode gold and placer gold mining has occurred mainly in the southern half of the area, from Falls Creek to Grant Lake. Present day mining is small-scale and sporadic.

Regional Geology

The TRAIL RIVER LA area lies within the Upper Cretaceous Valdez Group (Chugach Terrane) metamorphic sequence of rocks (Tysdal and Case, 1979; Nelson et al., 1985). 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[1]) sequence (Attachment 2, Regional Geology). These rocks formed from sediments deposited by turbidity currents in a marine environment. Later they were swept into a subduction trench and metamorphose. It is speculated that these rocks accreted to the southern Alaska mainland during late Cretaceous and early Tertiary time (Hoekzema, 1985). The thickness of the Valdez Group is unknown, but is believed to be at least several miles thick.

Winkler et al. (1984) reported that the deformation and metamorphism of the Valdez Group occurred between 65 and 50 million years ago. The metamorphic grade of Valdez Group rocks ranges from prehnite-pumpellyite to amphibolite facies, with rocks of the lower greenschist facies being widespread and particularly well displayed in pelitic or volcanic sequences.

[1] A collection of marine sediments shed by a rising mountain chain as it is uplifted and eroded. The sediments are mainly silt and sand.

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, longitudal faults. These faults are diagonal-slip faults. The Placer River and the Eagle River faults are of this type. The Placer River fault extends from the head of the Twenty Mile River valley, continues through the Placer River valley, and then continues south ending at about the South Fork River, east of Seward. The Eagle River fault marks the boundary of the Cretaceous Valdez Group and the McHugh Formation along the west side of the Forest. 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 close-spaced (50 to 500 feet) west- to northwest-striking, steeply dipping transverse faults.

Local Geology

Bedrock in the Trail River Watershed is Upper Cretaceous Valdez Group metasedimentary rock (Kvs). It is composed of rhythmically interbedded slate and greywacke sandstone. Rock layers are generally a few inches to a few feet thick, but thicker massive sandstone layers may occur.

The most common types of mineral deposition in the Trail River Watershed are small, sometimes high-grade, lode gold (Chugach-gold) deposits that occur as epigenetic hydrothermal quartz veins formed along well-defined fractures in the Valdez Group and placers. They are derived from the erosion of these veins. Most notably, mineralized quartz veins occur near Crown Point Glacier on both the north and south sides, south of Crown Point Glacier above Falls Creek, and the north side of the west end of Grant Lake. Placer gold occurs in Falls Creek.

A prominent set of faults within the Trail River Watershed consist of closely spaced (hundreds of feet), parallel faults (shear zones), that are recognized throughout the area. Locally, older faults occur as relatively close-spaced (50 to 500 feet), west- to northwest-striking, steeply dipping transverse faults.

Unconsolidated Quaternary-age surficial deposits in the Trail River Watershed consist predominantly of alluvium deposited by nonglacial streams and outwash deposited by glacial melt water (Nelson et al., 1985). They consist of sand and gravel; terminal, lateral, and ground moraines composed of unsorted deposits of boulders, cobbles, gravel and sand left by the retreat of alpine, valley and regional glaciers; and talus and landslide deposits consisting of coarse angular rock debris derived from adjacent bedrock. Significant alluvial deposits occur primarily along Trail Creek, Placer River, Moose Creek and Johnson Creek. Additionally there is an extensive alluvial deposit on the northwest side of Trail Lake. These alluvial deposits are potential sources of sand and gravel, and in some places, placer gold. Falls Creek is a placer gold producing stream.

Mineral Potential

The U.S. Geological Survey assessed the mineral resource potential for the Chugach National Forest for the Forest Plan Revision, resulting in the publication of Assessment of mineral resource tracts in the Chugach National Forest (Nelson et al. 1985, See Figure 2.1). The report focused strictly on locatable mineral resources. It did not cover leasable resources such as coal, oil and gas, or salable resources such as common variety rock, gravel, and sand. According to this report, a little over 50% of the TRAIL RIVER LA is not within an identified tract (undesignated) which means it either lacks geologic criteria indicating potential for resources, contains resources not addressed in the report, or contains deposits having a low probability of future development activity. The four deposit types evaluated in Nelson and Miller's report are as follows: 1) Cyprus-type massive sulfide (copper, lead, zinc, gold and silver); 2) Chugach-type low-sulfide gold quartz veins (gold and silver); 3) placer gold; and 4) polymetallic veins (copper, zinc, lead, gold and silver). Deposit types 2 and 3 occur in the TRAIL RIVER LA. The yellow hatched area is the Blackstone Glacier Mineral Resource Tract (BG Tract) and the red crosshatched area and the orange hatched area is within the Kenai Lake Mineral Resource Tract (KL Tract).

The KL Tract is defined by the presence of identified resources of gold from both placer and Chugach-gold deposits. Within the TRAIL RIVER LA, about ½ the tract is highly favorable for mineral development and production, and the other ½ of the tract is considered moderately favorable.

The BG Tract has both placer and lode gold potential. The tract is considered highly favorable for containing undiscovered resources of gold from both placer and Chugach-gold deposits based on the presence of favorable host rocks, observed mineral occurrences, and supportive geochemical data.

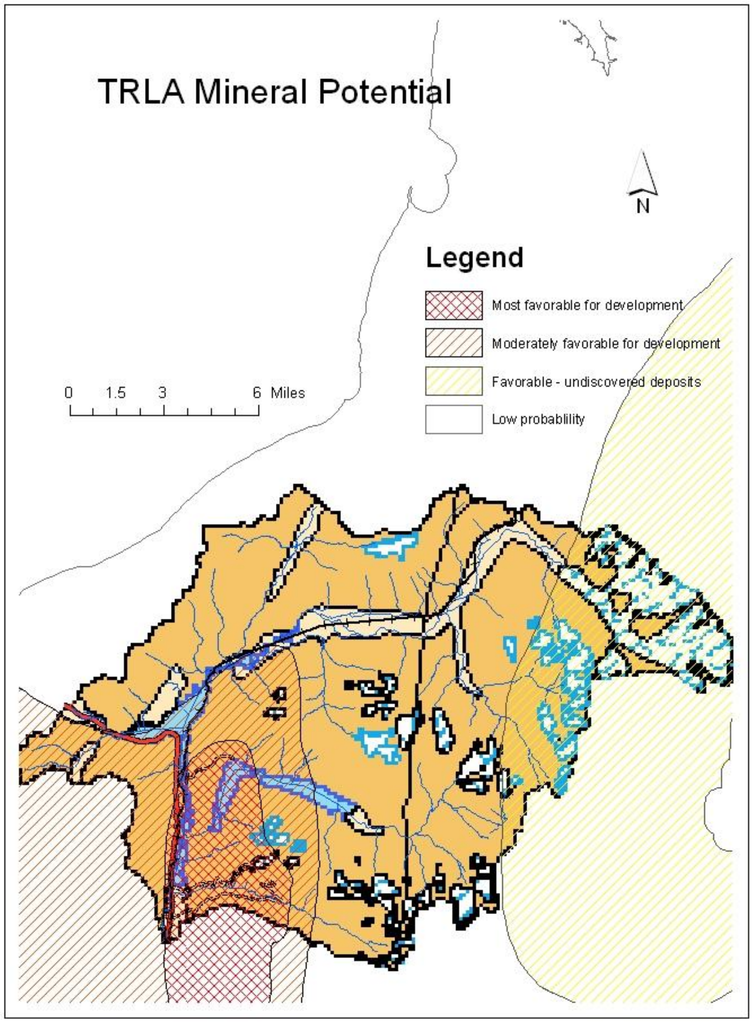

Figure 2.1 – Trail River Analysis Area Mineral Potential Tracts

2.2.2 Soils

Geologic and Geomorphic Setting

Numerous glaciers have shaped this area extensively over the last couple of million years. Many of the upper sideslopes and uplands, which are severely limited by the harsh climate, are now in the early stages of soil development. The soils on the lower sideslopes and the valley bottoms are also in the early stages of development, due to the recent recession of the glaciers and the exposure of the gravels and dirt to the soil developing processes. The sideslopes tend to be underlain with compact glacial till, which can restrict water movement and are able to support wetlands and associated hydric soils of level terrain. The bedrock lithology can be the primary influence on soil characteristics in areas not overlain by deeper deposits of colluvium, alluvium, or glacial deposits, and results in soils with properties different from those in alluvial soils. In areas where geologic or geomorphic properties restrict water movement, the influences on soils will be indirect by creating anaerobic conditions that support the formation of organic soils.

Ecological Subsections

Map units on the Chugach National Forest are delineated using the National Hierarchal Framework of Ecological Units (USDA, 1993). This system stratifies land masses into progressively smaller areas of increasingly more uniform ecological similarities. The largest delineation used from management on the Chugach NF is the subsection. This Landscape Assessment is contained in the Eastern Kenai Mountains and the Chugach Icefields Subsections. A description of each subsection follows.

Eastern Kenai Mountains Subsection

Valleys overlaid with glacial till on the sideslopes and glacial outwash in the valleys. The climate in this subsection still produces sufficient amounts of snow to retain alpine glaciers in the upper ends of the valleys. Precipitation ranges from 30 inches in the valleys to 80 inches in the alpine and respectively a 40 to 120 inch snowpack. The characteristic vegetation the alpine and some of the mountain sidelopes is dominated by dwarf scrublands and herbaceous vegetation types. The remainder of the sideslopes and the valley bottoms are covered with a needle-leaf forest or a mixed needle-leaf/broad-leaf forest.

Chugach Icefields Subsection

This subsection includes ice fields, glaciers, and rugged, rocky mountains that perimeter Prince William Sound. Most of the precipitation, which ranges from 140 to 220 inches, falls as snow to produce and annual snow pack ranging from 80 to 320 inches in depth.

Ecological land-type Map Units

The Land-types mapping level is the most detailed level of the hierarchy that has been 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” (Davis, et al. 1980). Soils in the analysis area can be described in terms of where they lie on the landscape since the geomorphic processes that formed the different land-types are intricately related to the pedogenic processes that formed the soil on those sites (Soil Survey Division Staff, 1993). Descriptions of soil mapping units are provided if they have been developed for particular land-types in the analysis area. The mapping units located in the major road corridors have been described in detail where each mapping unit typically has one major soil with inclusions or a complex of two or three soils where they are too difficult to separate (Davidson, 1989). The ecological land-type map units are described below with the mapping unit symbol, name, and description (Figure 2.2 and Table 2.1).

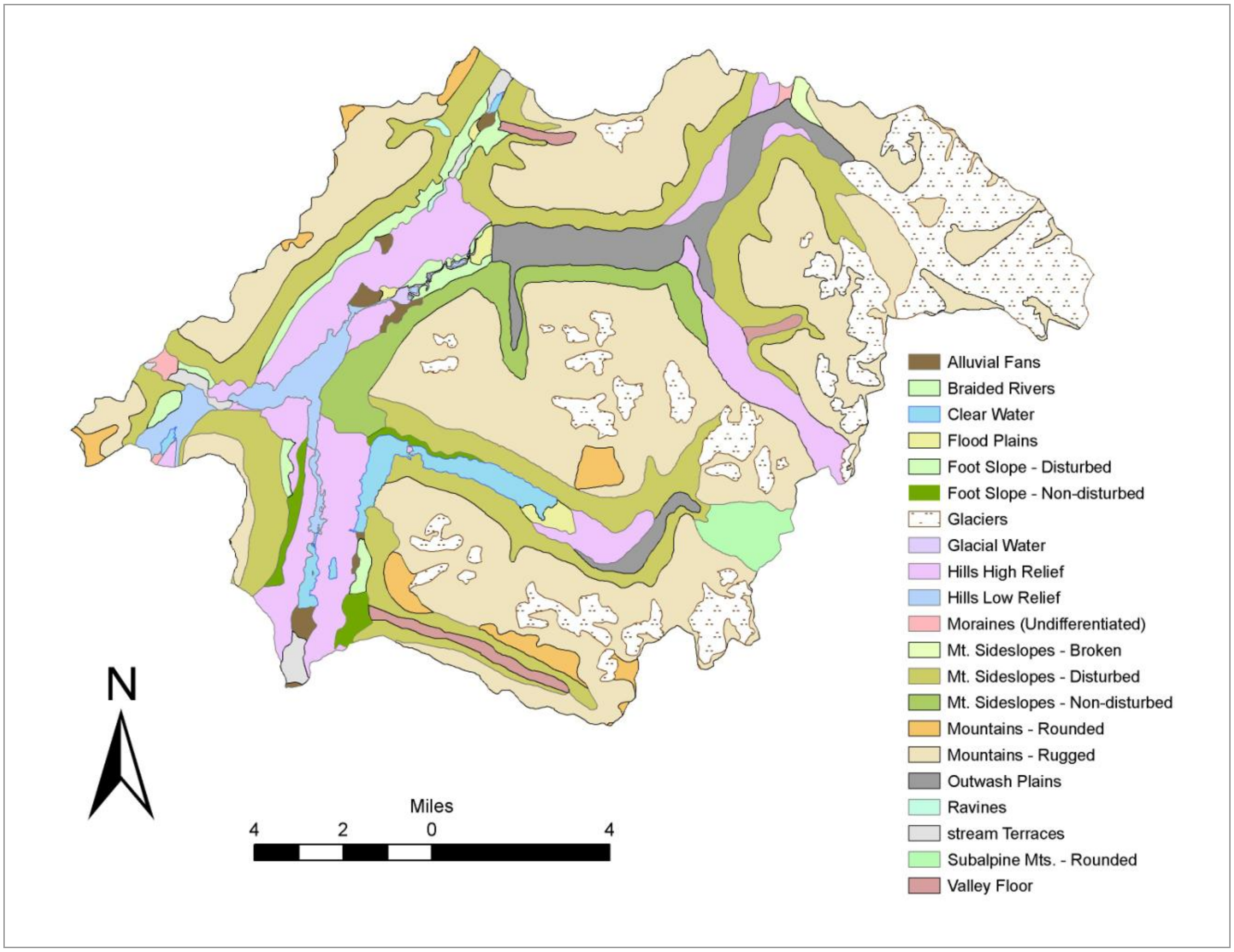

Figure 2.2. Land-types of the Trail Lake Landscape Assessment Area.

Table 2.1. Acreage for Ecological Landtypes in the Landscape Assessment Area.

Ecological Land-type	Acres	% of Total
Alluvial Fans	703	0.6
River Bars R	533	0.4
Clear Water	1,997	1.6
Flood Plains	578	0.5
Foot-slopes Disturbed	2,071	1.7
Foot-slopes Non-disturbed	1,023	0.8
Glaciers	15,740	12.7
Glacial Water	155	0.1
Hills High Relief	13,623	10.9
Hills Low Relief	2,313	1.9
Moraines Undifferentiated	269	0.2
Mr. Sideslopes - Broken	227	0.2
Mt. Sideslopes Disturbed	21,076	16.9
Mt. Sideslopes Non-disturbed	4,374	3.5
Mountains - Rounded	2,424	1.9
Mountains - Rugged	48,646	39.1
Outwash Plains	5,141	4.1
Ravines	113	0.1
Stream Terraces	786	0.6
Subalpine Mountains - Rounded	1,458	1.2
Valley Floor	1,166	0.9
Total	**124,414**	**100.0**

Alluvial Fans

This map unit includes the fan shaped alluvial landform that is located at the mouth of valley streams where the slope gradient decreases resulting in the deposition of transported sediment. This landform is very unstable because of the constant migration of the stream channel due to the continuous deposition of sediments and high water events resulting from heavy precipitation at higher elevations at the upper portions of the contributing valley. The alluvial soil is deep, moderately to somewhat excessively drained, sand, gravel, and cobbles with very rapid permeability. Slope gradient is usually less than 25 % and external relief is less than 100 vertical feet.

River Bars

This map unit includes the large constantly changing aggrading glacial river channels and the river bars and terraces that are flooded annually. The water transports large quantities of silt and fine sand, which is deposited in areas of less movement causing the river to constantly change channels. The slope gradient is less than 5 % and external relief is less than 20 feet. The soil has no development, is poorly to excessively drained, sand, gravel and cobbles, with moderate to rapid permeability. The vegetation consists of pioneer species of willow, cottonwood, fireweed and other herbaceous and grass species.

Clear Water; streams, lakes and ponds

Flood Plains

This map unit includes the broad plains that are susceptible to periodic spring and early summer floods from snow run off in adjacent non-glacial clear water streams. The slope gradient is less than 5 %. The stream pattern is typically meandering or braided. The soils are typically young, poorly to well drained, loamy to loamy skeletal, with moderate to rapid permeability.

Foot-slopes – Disturbed

This map unit includes the mostly tree covered lower, concave portion of the glaciated side slopes that are the result of glacial carving and the deposition of subsequent colluvium from the above sideslopes. The average slope gradient is less than 35 %. Greater than 40 % of the land-type is vegetated with trees. The soils are dominated by deep well to moderately well drained, loamy skeletal textures, with rapid permeability. There are some locations with more poorly drained, finer texture soils, which may pond or perch ground water running off the upper slopes. The vegetation is typically a spruce/hemlock forest separated by spaces of grass/forbs with clumps of alder.

Foot-slopes – Non-disturbed

This map unit includes the mostly tree covered lower, concave portion of the glaciated side slopes that are the result of glacial carving and the deposition of subsequent colluvium from the above sideslopes. The average slope gradient is less than 35 %. Greater than 40 % of the land-type is vegetated with trees. The soils are dominated by deep well to moderately well drained, loamy skeletal textures, with rapid permeability. There are some locations with more poorly drained, finer texture soils, which may pond or perch ground water running off the upper slopes. The vegetation is typically a spruce/hemlock forest separated by spaces of grass/forbs with alder clumps.

Glaciers

This map unit includes those landscapes that are covered by perennial glaciers or snowfields where the only exposed ground is typically bedrock nunataks, peaks, or ridges or loose talus. The slope gradient ranges from horizontal to vertical and external relief 100 to 1000's of feet. There is rarely any exposed soil or vegetation.

Glacial Water

Streams and lakes at the toe of glaciers that contain high amounts of glacial silt, so very little, if any, light penetrates the water.

Hills – High Relief

This map unit includes bedrock controlled hills of moderate relief that are characterized by longer and steeper slopes and fewer ponds than found in the Hills – Low Relief map unit. The slope gradient is usually greater than 35 % and external relief ranges from 200 to 1000 feet. The soils range from moderately well to well drained, moderately deep-to-deep, loamy to loamy skeletal on the slopes and organic soils in the basins. The slopes are normally dominated by spruce/hemlock forest types and the low basins with low shrub, wetland sedges and forbs.

Hills – Low Relief

This map unit includes bedrock controlled undulating hills and shallow basins, frequently formed by glaciers. The slope gradient is usually greater than 35 % and external relief ranges from 50 to 200 feet. The soils range from poorly drained, moderately deep, fine to coarse loams and organic soils in the basins to moderately well to well drained, deep, loamy to loamy skeletal soils on the slopes. The slopes are normally vegetated with poorly growing spruce/hemlock forest and the basins with low shrub, wetland sedges and forbs.

Moraines (Undifferentiated)

This map unit includes terminal, lateral and medial glacial moraines left by receded glaciers. These landforms typically form in the valley bottoms previously occupied by glaciers. The slope gradient ranges from 35 to 65 %, and the external relief is usually less than 200 feet. The soils are deep, well drained, and have loamy-skeletal textures with moderate to rapid permeability. The vegetation ranges from shrubs to well developed spruce/hemlock forests depending on the age of the landform.

Mountain Sideslopes - Broken

This map unit includes the long sideslopes that occur below alpine landscapes where the parallel drainage pattern is broken by bedrock benches or knobs. These slopes may or may not be frequented by avalanches, rock falls, etc. The slope gradient is greater than 65 % except on the benches or knobs where the slope may be less than 35 feet. External relief is usually greater than 1000 feet. The soils range from shallow on the upper slopes to deep on the lower slopes. They are typically well drained, loamy to loamy-skeletal, with moderate to rapid permeability. The vegetation ranges from subalpine forbs, grasses and shrubs to a well-developed spruce/hemlock forests on the lower protected slopes.

Mountain Sideslopes – Disturbed

This map unit includes the long sideslopes of high relief that occur below alpine landscapes that are dominated by rock fall, slides, and avalanches. The slope gradient ranges from 35 to 75 %, and the external relief is greater than 1000 feet. Avalanches and slides dominate greater than 40 % of this map unit. The soils range from deep on the upper slopes to deep on the lower slopes. The soils are well drained, loamy to loamy-skeletal, with moderate to rapid permeability. The vegetation is consists of shrubs, grasses and forbs in those areas of frequent slides, and mature spruce/hemlock forests in those areas protected from slides.

Mountain Sideslopes – Non-disturbed

This map unit includes the long sideslopes of high relief that occur below alpine landscapes that are NOT dominated by rock fall, slides, and avalanches. The slope gradient ranges from 35 to 75 %, and the external relief is greater than 1000 feet. Avalanches and slides dominate less than 40 % of this map unit. The soils range from deep on the upper slopes to deep on the lower slopes. The soils are well drained, loamy to loamy-skeletal, with moderate to rapid permeability. The vegetation is consists of shrubs, grasses and forbs in those areas of frequent slides, and mature spruce/hemlock forests in those areas protected from slides.

Mountains – Rounded

This map unit includes the rounded ridges and summits and associated shoulder slopes that have been smoothed by overriding glaciers or in place frost wedging and weathering. This unit does not include glaciers or perennial snow fields greater than 40 acres. The slope gradient is usually less than 65 %, and internal relief is less than 100 feet. The soils are shallow to moderately deep, loamy or loamy-skeletal, with moderate permeability. The vegetation consists of grasses, sedges, forbs and low shrubs.

Mountains – Rugged

This map unit includes the jagged rocky ridges, peaks, associated sideslopes, cirque basins, headwalls, and rock glaciers that are the result of past or present alpine glaciation and frost wedging and weathering. This unit does not include glaciers or perennial snow fields greater than 40 acres. The slope gradient is usually greater than 65 % and the internal relief is greater than 100 feet. Exposed bedrock and un-vegetated talus comprise greater than 50 % of the map unit. The soils are shallow, well drained, loamy or sandy skeletal, with rapid permeability. The vegetation is typically sparse, low grasses, sedges, forbs, and shrubs.

Outwash Plains

The mapping unit includes low and relatively level plains at the base of glaciers that are subject to periodic mid to late summer flooding from nearby glacial rivers. The slope gradient is less that 5 % except on the steep short cut-banks of old channels. The soil is a poorly developed, poorly to somewhat poorly drained deep alluvial silt, sand, gravel, and cobble. The vegetation normally consists of herbaceous plants and shrubs.

Ravines

Very steep sided, deeply incised cuts where water erosion has cut into the underlying bedrock or alluvium. This map unit is restricted to mountain or hill slopes. The slope gradient is greater than 65 %. External relief is usually between 50 and 200 feet. The vegetation is usually sparse and limited to the primary invaders such as grass, sedge, and shrubs because of the continuous raveling.

Stream Terraces

This map unit includes the river terraces that are normally found in valleys where rivers have eroded incised channels in previously deposited alluvium. Thee terraces have sufficient relief so they are not affected by floods or annual fluctuations of the water table or adjacent streams. The soils consist of well-drained, deep, alluvial sands, gravels, and cobbles. Upper slope gradient is less than 5 % and the adjacent water cut slopes may range up to 65 %. External relief is normally less than 15 %. The vegetation consists of primary species such as alder, cottonwood, willow, grasses and some herbaceous plants.

Subalpine Mountains – rounded

This map unit includes the mostly rounded ridges, hill tops, and plateaus the typically occur at lower elevations than the alpine land-types. These areas have likely been smoothed by overriding glacial ice fields and have not been influenced by subsequent alpine glaciation such as the alpine mountains. This unit does not have any perennial snow fields or glaciers. Internal relief is usually less than 100 feet and slope gradient is less than 45 %. Soils are shallow to moderately deep, moderately to poorly drained and loamy to loamy skeletal in texture. Vegetation is typically wet grasses, sedges, and forbs, low shrubs and some krummholz type hemlock.

Valley Floors

This map unit includes the deposition landforms typically found in small, narrow valley bottoms that are too small to be delineated separately at this mapping scale. These landforms include stream terraces, flood plains, moraines, and alluvial fans. The map unit also includes active streams and ponds. The soils are typically deep, moderately well to well drained, and loamy or sandy skeletal in texture. Vegetation typically consists of grasses, forbs, and medium high willows and alder shrubs.

Soils and Erosion

The three ways soil and landform characteristics are measured relative to impacts from various management activities are soil productivity, erosion potential, and mass movements. Soil productivity is measured by the thickness of the surface soil organic layer and the amount and type of vegetation supported on the soil. The decomposition, which makes nutrients available for plant growth, occurs in this layer. Other factors common to the more productive sites include soils that are at least moderately deep and well drained. These soils usually produce stands of large trees. Soils become less productive with thinner organic surface layers, poorer drainage, shallower depths, or they have disturbance site characteristics such as avalanches, bedrock outcrops, or landslides. These soils will most often be vegetated with shrubs and herbaceous vegetation. Some soils are located on active floodplains where continual erosion will likely erode them prior to vegetative development. Other soils have low productivity due to poor drainage or saturation by water. They are normally vegetated with herbaceous, grass, and hydric vegetation. Alpine areas with rock outcrops, snowfields, and glaciers have a climate and other ecological conditions that are too harsh and unsuited for abundant vegetative growth. These are usually un-vegetated or have minor amounts of moss or alpine vegetation.

Erosion can be looked at in terms of landslides and surface erosion. Surface erosion occurs on soils that are not vegetated. This erosion is dependent on slope, soil texture, cohesion, exposure to wind and water. These areas will be located on exposed talus and bedrock, slopes recently exposed from receding glaciers, and on flood plains, river bars, and terraces. Avalanches can also contribute to erosion through removal of the protective vegetative cover or the physical movement of the soil or rock.

Landslides do occur in the Trail River Assessment Area. There are critical slope stability factors that must be evaluated when a management activity is considered. The major factors include slope, topographic position, soil texture and drainage, and any subsurface restrictions that impair the flow of water. These criteria can be individually estimated to determine a relative indication of the slope stability (Appendix A). Naturally occurring landslides due to high precipitation, steep slopes, poorly drained shallow soils, and continuous undercutting of sideslopes by streams may occur in the study area. The landslide potential increases as the slope increases, or when the amount of soil/vegetation disturbance increases. Slope stability may also be reduced where roads are constructed across slopes through poorly drained soils with fine textures or a high amorphous component (Figure 2.3).

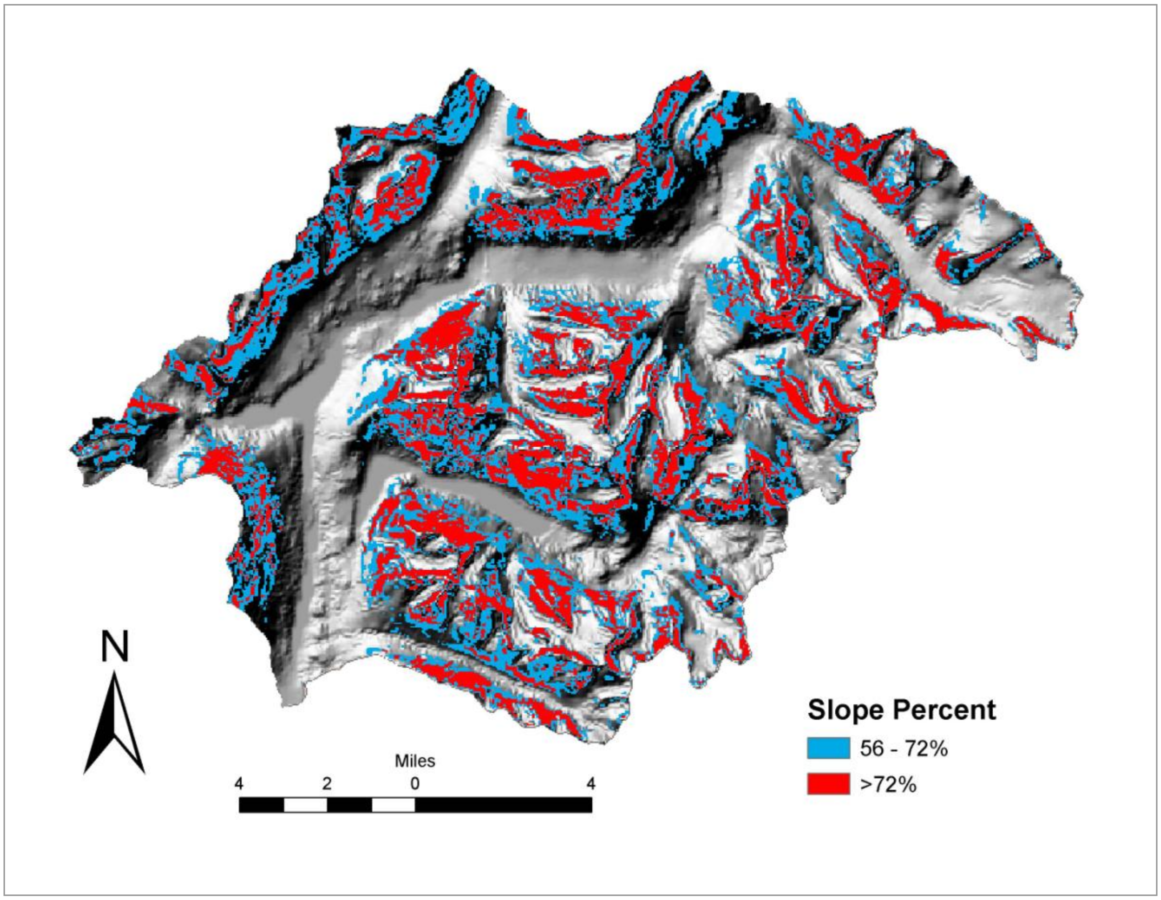

Figure 2.3 Slope categories of the Trail River Landscape Assessment Area.

Landslides on forested land are dependent on several factors. Douglas N. Swanston (1997) developed a rating system for slope stability on the Tongass National Forest (N.F.), which factored in topographic attributes, soil properties, geology, and hydrologic conditions. This system was later modified for use on the Chugach N.F. by Dean Davidson (Appendix A). Slope gradient tends to be the most critical factor. Landslides most frequently occur on slopes greater than 72% (Swanston, 1997) and 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. The Mountain Sideslopes and Ravines mapping units are 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 the upper soil ºlayers become saturated. Overlapping the mountain sideslope land-types with areas that have slopes greater than 56% can give a preliminary overview of potentially unstable sites. One can see the slopes that are greater than 72% and between 56 and 72%.

2.3 Hydrology

2.3.1 Climate

The climate of the Trail River Watershed is cool and moist. The average daily temperature at Moose Pass is approximately 36º F, and temperatures decrease with elevation. The average maximum July temperature at Moose Pass reaches about 67º F, and the average minimum January temperature is about 6º F (Table 2.2) (Western Regional Climate Center, 2006).

Table 2.2. Climate statistics for weather stations and snow courses in and near the Trail River Watershed.

		Moose Pass 3 NW	Moose Pass	Grand-view	Wolver-ine Glacier A	Wolver-ine Glacier B	Wolver-ine Glacier C
Location	Elevation (ft)	480	700	1100	1950	3610	4430
	Latitude	60º30'	60º31'	60º36'	60º23'	60º25'	60º25'
	Longitude	149º26'	149º30'	149º04'	148º55'	148º55'	148º55'
	# of years of data	47	36	25	21*	19*	20*
Temp	Average Daily Temp (F)	35.6	-	-	-	-	-
	Average Max July Temp (F)	66.6	-	-	-	-	-
	Average Min Jan Temp (F)	6.2	-	-	-	-	-
Precip	Average Annual Precip (in)	28.2	-	63.0	-	-	-
	Average Annual Snowfall (in)	82.1	-	-	-	-	-
	Average Feb 1 Snow Depth (in)	-	18	64	100	146	199
	Ave. Feb 1 Snow Water Equivalent (in)	-	4.6	18.9	46	64	86
	Average April 1 Snow Depth (in)	-	21	83	93	169	230
	Ave. April 1 Snow Water Equivalent (in)	-	7.1	27.8	37	68	98
	Maximum snowpack of record (in)	-	45	127	193	275	472
	Max. Snow Water Equiv. of record (in)	-	16.8	62.9	104	127	213

Data from Western Regional Climate Center (2006); USDA Natural Resources Conservation Service (2006).
**Wolverine Glacier sites have limited data available each year.*

Precipitation in the watershed increases dramatically with elevation. Because storms typically circulate in a counterclockwise direction in the Gulf of Alaska, storms generally approach the area from the east. The high elevation areas in the eastern portion of the watershed receive the most precipitation. Average annual precipitation ranges from less than 30 inches at Moose Pass 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.

Snowpack and snowfall in the Trail River Watershed increase dramatically with elevation and to the east. Average February 1 snowpack depths range from 18 inches at Moose Pass in the lower portion of the watershed to 64 inches at Grandview (Table 2.2). The high elevation areas near the head of Trail Glacier may have average February 1 snowpack depths of as much as 200 inches, based on measurements on the nearby Wolverine Glacier (USDA Natural Resources Conservation Service, 2006). Snowfall at the mouth of the watershed accounts for about 30% of the total annual precipitation. The high elevation glaciated areas receive very heavy snowfall, contributing to numerous glaciers and accounting for over 60% of the total annual precipitation.

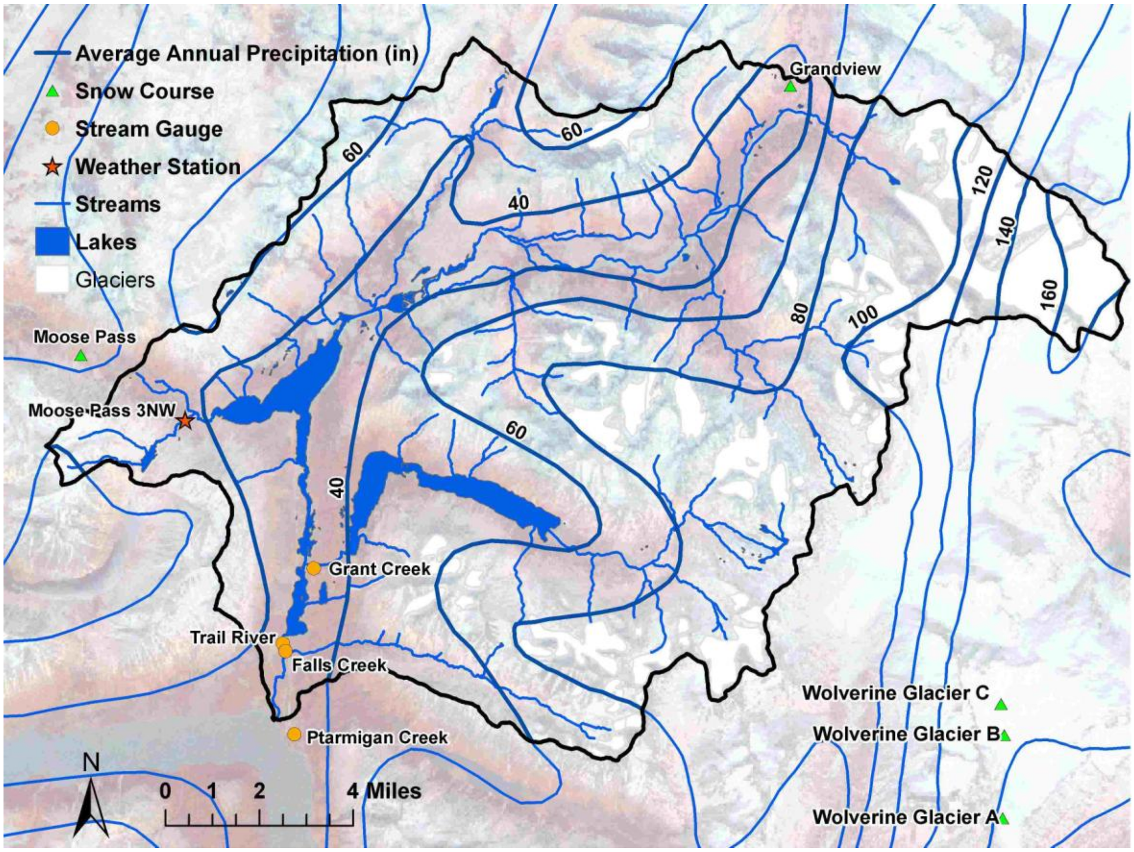

Figure 2.4. Average annual precipitation for the Trail River Watershed.

2.3.2 Watershed Morphometry

The Trail River Watershed is a 5th-level watershed with a length of about 20 miles. Trail Glacier is the origin of Trail River, which flows southwest into Kenai Lake. Elevations in the watershed range from 436 feet at Kenai Lake to 6,532 feet north of Trail Glacier (Figure 2.5).

The Trail River valley was sculpted by several major glacial episodes in the Pleistocene. At this time, glaciers filled the entire valley. Because of the extensive past glaciations, the valley has a relatively flat bottom and oversteepened valley sides. Upper Trail Lake, Lower Trail Lake, and Grant Lake occupy basins formed because of glacial scour. Glaciers currently cover about 15,000 acres (24 square miles), or 12% of the Trail River Watershed. The 7000-acre (11-square mile) Trail Glacier lies in the northeastern portion of the watershed. The combination of high peaks and abundant precipitation results in numerous glaciers along the eastern boundary of the watershed. Tributaries from the east are generally influenced by glacial activity, whereas tributaries from the west are not. The Trail Glacier is currently thinning and receding.

Lakes cover about 4000 acres (6.2 square miles), or 3% of the watershed. Upper and Lower Trail Lakes are natural lakes on the Trail River, covering 2000 acres. Upper Trail Lake is the larger of these lakes, with a mean depth of 54 feet and a maximum depth of

146 feet, and Lower Trail Lake is a smaller lake with a mean depth of 25 feet and a maximum depth of 42 feet (Spafard and Edmundson, 2000). Grant Lake is a 1580-acre natural lake in the Grant Creek drainage, a major tributary draining the southeast portion of the watershed. Because steep valley sides confine it, Grant Lake has a mean depth of 141 feet and a maximum depth of 312 feet.

Avalanches are common along the steep valley sides of the Trail River Watershed. Two notable avalanche paths are situated above the Seward Highway at Mile-29 and Mile-39.4 (March and Robertson, 1982), with vertical falls of 3000 to 4000 feet. One of these is situated above the community of Moose Pass.

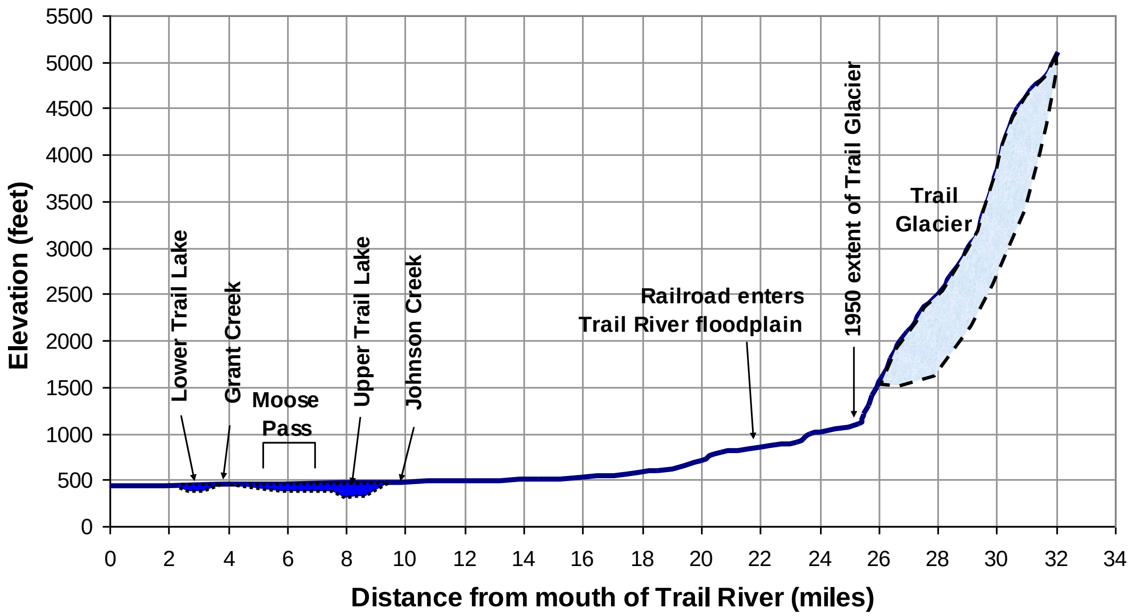

Figure 2.5. Trail River longitudinal profile (17X vertical exaggeration).

2.3.3 Streams

A total of about 178 miles of mapped streams lie in the Trail 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). About 50% of the streams are High Gradient Contained (HC) channels, draining the steep valley sides throughout the watershed. About 17% of the streams are Glacial Outwash (GO) channels, consisting predominantly of the Trail River channel between Trail Glacier and Upper Trail Lake. About 12% of the total stream length in the watershed is comprised of natural lakes. Smaller percentages of Moderate Gradient Mixed Control (MM), Alluvial Fan (AF), Moderate Gradient Contained (MC), and Floodplain (FP) channels also exist in the watershed. Palustrine (PA) and Large Contained (LC) channels are rare in this area.

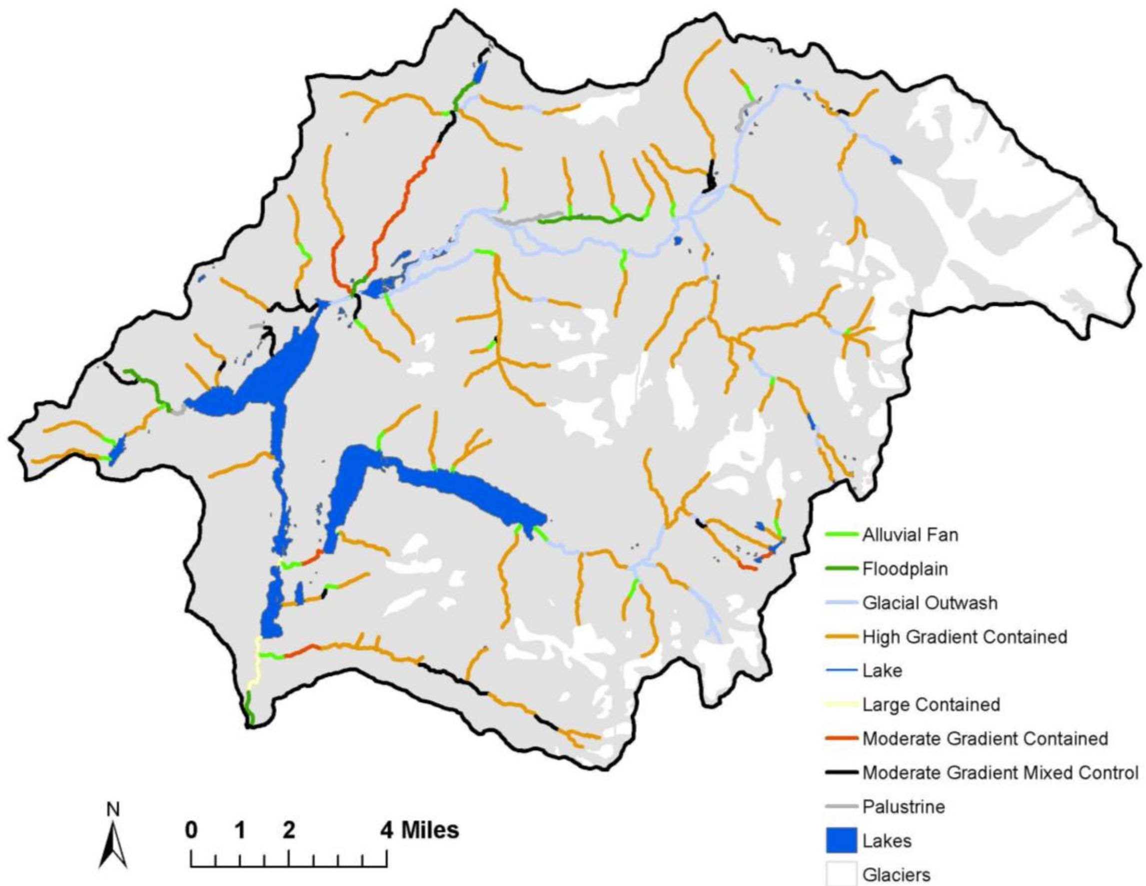

Figure 2.6. Stream channel process groups in the Trail River Watershed. Data from USDA Forest Service.

Upstream of Upper Trail Lake, the Trail River is largely influenced by glacial processes, with high sediment loads and dynamic, shifting channels. Much of the lower Trail River flows through Upper and Lower Trail Lakes, which allows all of the sediment load except the suspended load to settle. A delta exists at the upstream end of Upper Trail Lake. Downstream of Lower Trail Lake, the Trail River is a large low gradient river. Some degree of confinement exists between terraces in this area, and the river maintains a single channel. Tributaries to the Trail River are generally contained channels within moderate to steep valleys.

2.3.4 Wetlands

Wetlands cover about 7060 acres, or 11% of the watershed. With three large lakes and scattered smaller lakes in the watershed, Lacustrine wetlands are the most common, comprising about half of the total wetlands. About 2450 acres of Palustrine wetlands, or areas associated with swamps, bogs, ponds, beaver ponds, and floodplains, are located along the floodplain of the upper Trail River and in scattered locations on the hillslopes around Upper and Lower Trail Lakes. About 875 acres of Riverine wetlands exist along the Trail River.

2.3.5 Streamflows

Continuous daily streamflow data are available for Trail River from 1947 to 1974 and Grant Creek from 1947 to 1958. Peak flows are available for Falls Creek between 1963 and 1976, and continuous daily streamflow data are available for Ptarmigan Creek, just south of the Trail River Watershed, from 1947 to 1958 (US Geological Survey, 2006).

Streamflows in the Trail River Watershed are controlled by a combination of glacial melt, snowmelt, and rainfall. Spring snowmelt runoff in the Trail River generally begins in early May, and flows gradually rise into July (Figure 2.7). Summer peak flows generally occur in mid-July, with average flows near the mouth of about 2300 cubic feet per second (cfs). These peak flows result from a combination of snowmelt and glacial melt. Glacial melt causes flows to remain high through much of August. Extreme flood events occur in September and October, because of fall rainstorms, with peak flows reaching over 6000 cfs and exceeding the summer peak flows. Fall rainstorms that occur during times of elevated flows from glacial melting have the potential to create the largest flood events. Winter flows from December through April remain very low, generally less than 200 cfs, because of freezing temperatures and minimal glacial melting.

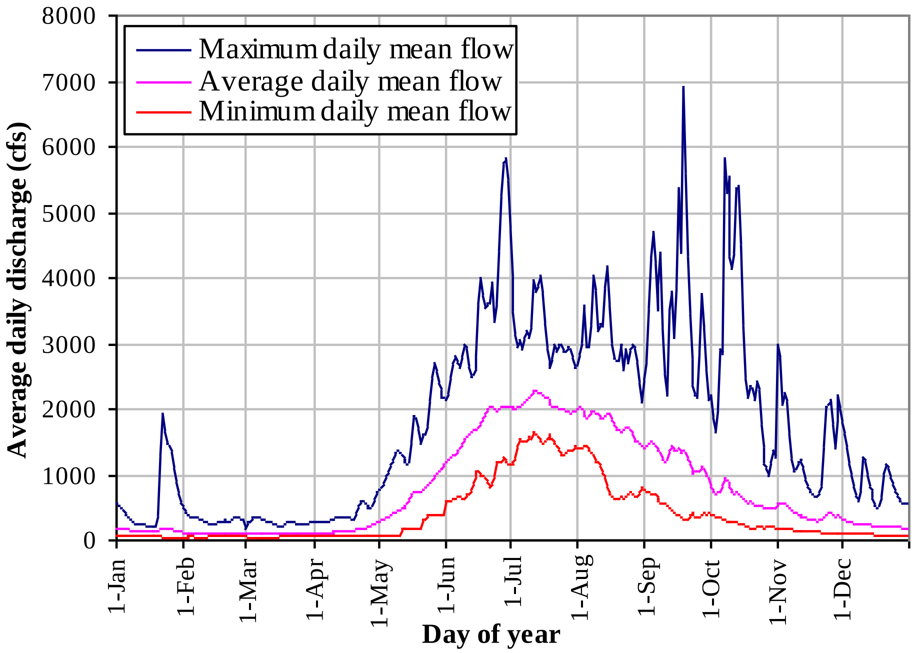

Figure 2.7. Average daily streamflows for Trail River, USGS station 15248000. Period of record 1947 to 1974.

Because Upper and Lower Trail Lakes attenuate floods in the Trail River, floods in the lower Trail River are not as flashy as those in some of the steeper tributaries that do not have large lakes. The magnitude of the 10-year flood on the Trail River is about 5700 cfs (Curran et al., 2003). Ten-year floods for streams in the Trail River Watershed generally range from about 25 to 55 cfs per square mile of drainage area (Table 2.3).

Table 2.3. Streamflow statistics for streams in and near the Trail River Watershed.

	Ptarmigan Creek at Lawing AK	Grant Creek nr Moose Pass AK	Trail River nr Lawing AK	Falls Creek nr Lawing
USGS Station #	15244000	15246000	15248000	15250000
Years of data	1947-1958 (10)	1947-1958 (10)	1947-1974 (30)	1963-1976 (10)
Drainage area (sq mi)	32.6	44.2	181	11.8
Ave annual flow (cfs)	109	192	778	~
Ave June flow (cfs)	247	448	1716	~
Ave March flow (cfs)	14	20	99	~
2-year flow (cfs)	523	936	3670	242
Flow per sq. mi for Q_2	16	21	20	21
10-year flow (cfs)	832	1660	5700	642
Flow per sq. mi for Q_{10}	26	38	31	54
Record peak flow (cfs)	980	2230	7480	693
Year of record peak flow	1953	1953	1967	1966

2.3.6 Water Quality

Water quality data from 1949 to 1974 are available for Trail River near its mouth, Grant Creek, Falls Creek, and Ptarmigan Creek (US Geological Survey, 2006). These data indicate that water quality conditions at that time were relatively pristine. The data fell within the Alaska State standards (Alaska Department of Environmental Conservation, 2003), with the exception of low values of pH on Trail River, Grant Creek, and Ptarmigan Creek, reaching as low as 5.9. The Upper Trail River carries considerably higher sediment loads than the Trail River downstream of Trail Lakes, and much of this sediment settles in the lakes. Suspended sediment concentrations reached 40 mg/L at high flows of 4100 cfs on the Lower Trail River in 1967.

Although most of the watershed likely has good conditions of water quality because of only localized development and limited use in many of the backcountry areas, some areas have a higher potential for water quality issues. The Seward Highway and Alaska Railroad corridors both pose a risk of oil, gasoline, or chemical spills into the Trail River and its tributaries, especially where the Alaska Railroad lies within the dynamic Trail River floodplain. Development in the community of Moose Pass also has the potential to introduce toxic chemicals such as hydrocarbons to the water, as well as to increase sediment loads from roads, trails, and cleared areas. However, because the percentage of the watershed that is affected by these uses is very low and high sediment loads are naturally present in the Trail River, land use in the Moose Pass area likely has very little affect on sediment loads in the Trail River. No known water quality issues are related to septic systems in Moose Pass. Recreational uses may pose a slight potential for water quality impairment, including hydrocarbons from motorized use and sedimentation from drainage along primitive roads in the Falls Creek and Crown Point areas. The Trail Lakes Fish Hatchery discharges effluent into Upper Trail Lake, but this is treated and filtered prior to discharge.

2.4 Vegetation and Ecology

A variety of plant community types occur throughout the Trail River Assessment Area, influenced by both natural and man-made disturbances. Plant communities encompass a wide range of habitats, including coniferous forests, deciduous forest, mixed conifer/deciduous forest, tall shrub-lands, low shrub-lands, muskeg, riparian areas, stream banks, lake margins, ponds, alpine tundra areas, and grasslands. Coniferous forest habitats are generally Lutz spruce (*Picea x lutzii*, a hybrid between Sitka spruce [*P. sitchensis*] and white spruce [*P. glauca*]), black spruce (*P. mariana*), mountain hemlock (*Tsuga mertensiana*), or mixed spruce-hemlock stands. Hardwood forests include stands of cottonwood (*Populus balsamifera*), birch (*Betula papyrifera*), aspen (*Populus tremuloides*), and mixed aspen-birch stands. Mixed conifer/deciduous stands include birch, willow, spruce, and mountain hemlock. Non-forested communities include grasslands (including *Calamagrostis canadensis*, sedge meadows [*Carex spp.*], and other mixed graminoid vegetation types), alder (mainly *Alnus crispa*), willow (*Salix spp.*), and alpine tundra (including a variety of low forb species, lichens and sub-shrubs). Rock, along with snow and ice fields are present at higher elevations across the landscape.

2.6 Aquatic Species and Habitats

The upper reaches of the Kenai River watershed is comprised of the Trail River Watershed and Snow River watershed. The Trail River Watershed is home to all salmon species of salmon except for chum. Dolly Varden (*Salvelinus malma*) and rainbow trout (*Oncorhyncus mykiss*) also reside.

The channel types are grouped according to their formative geomorphic, hydrologic and vegetative processes. Lakes and ponds are included even though a classification system has not yet been developed for the Alaska Region.

Within this watershed there are 54 miles of Class I streams, defined by the R10 Aquatic Species Habitat Management Handbook, streams and lakes with anadromous or adfluvial fish or fish habitat; or, high quality resident fish waters.

There are 32 miles of Class II streams, defined as streams and lakes with resident fish or fish habitat and generally steep (6 to 25 percent or higher) gradients where no anadromous fish occur, and otherwise not meeting class I criteria.

There are also 92 miles of Class III streams defined as perennial and intermittent streams that have no fish populations or fish habitat, but have sufficient flow or sediment and debris transport to directly influence downstream water quality or fish habitat capability.

There are 178 stream miles and 3,704 acres of recreational lakes. Total lake acreage is 3,975.

2.7 Terrestrial Species and Habitats

Terrestrial habitats include a mosaic of wetland and upland habitats, which provide a diverse array of high quality habitat for nearly 200 species of wildlife 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 (*Ovis dalli*) 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 community types, often including devil's club. Early seral or stand initiation habitats (Oliver, 1996) provide feeding habitat for moose, wolves, snowshoe hare, and lynx, and nesting habitat for neotropical migrants such as sparrows and warblers. 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. Some larger diameter and/or old growth mountain hemlock and Lutz spruce trees are present on bench areas, lower slopes, and just below low ridges. The largest trees are located in the Lutz spruce/devils club community 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 Trail River, Trail Creek 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, and wolves. Wetlands provide important nesting and foraging habitat for sensitive species such as trumpeter swans, and other waterfowl.

Wildfire, spruce bark beetle ((*Dendroctonus rufipennis (Kby.)*) infestations, other natural processes such as avalanches, flooding, and human activities affect wildlife habitat and continue to be the factors that influence the structure, distribution, and functions of habitat throughout the watershed (See Section 4.7.2).

The human activities and development that affect wildlife habitat include: float plane activity, motorized and non-motorized use in both the summer and winter on and off existing trails by hikers, snowmachiners, hunters, and flight see-ers. Habitat alterations caused by human activities include the railroad corridor, Forest Service trail system and associated infrastructure, private residences and businesses along the Seward Highway, private cabins near Grant Lake, and utility and telephone corridors adjacent to the highway (See Section 2.8.2).

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 Trail River Watershed, as all listed species within the Chugach National Forest boundary are associated with marine environments.

One sensitive species, the trumpeter swan, was documented as occurring in the watershed in 2004, 2005 and 2006 although breeding status is unknown.

There are three documented management indicator species (brown bear, moose, and mountain goat).

Eight species of special interest (gray wolf, wolverine, lynx, river otter, bald eagle, northern goshawk, marbled murrelet and Townsend's warbler), may occur in the watershed. Wolves and bald eagles have been documented to occur.

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 cultural resources of the Trail River Watershed are comprised of prehistoric and historic features, including one historic property on the National Register of Historic Places (NRHP), The Iditarod National Historic Trail. Many of these recorded sites require field verification and monitoring through archaeological survey to meet the current standards as outlined in the Region 10 Programmatic Agreement (PA) with the Alaska State Historic Preservation Office. As required by the National Historic Preservation Act and Executive Order 11593, a complete analysis for cultural resources in the area is mandatory. Archaeological surveys on the Chugach National Forest have generally been limited to support for particular projects, as required by section 106, part 800 of the National Historic Preservation Act (NHPA). Surveys to locate, identify, and record cultural resources have been conducted since 1976 on the Chugach National Forest and have been ongoing within this watershed as new project proposals are revealed.

Only a small portion of the landscape has been investigated archaeologically, based on the area of potential effect for each project. Reports have been generated for archeological surveys in the area, but information on many surveys in the past 30 years is available only in field notes. Additionally, only a small number of known sites have been evaluated for the NRHP.

The characterization of the Trail River Watershed, refers to the conditions at a certain, project defined, reference time period. In following the reference conditions of past landscape analysis's, this period has been defined as the late 1800's to mid 1900's. As other resources define the usage of the watershed at this historic time, prehistoric use in the watershed has also been documented; human use and occupation of this landscape began thousands of years ago and continues to this day.

In terms of the defined reference period, the main impetus that brought humans to the Trail River Watershed were primarily industrial uses, in particular mining. Prehistorically, this area was used for subsistence transportation and trade routes. The town of Moose Pass was established in association with the railroad construction of 1904 and a roadhouse at milepost 29 in 1909. The first business to open in Moose Pass after the roadhouse was a water powered sawmill on Grant Lake, constructed by Al Solars. Additional resources of the area were exploited through time including hunting fish and wildlife, fishing and trapping from prehistoric times to today. This naissance further facilitated human interest, access, and exploitation of the watershed.

The Johnson Pass Trail, is a portion of the well known Iditarod National Historic Trail (INHT). This trail was originally a travel and trade route for native peoples, adopted by Russian explorers and early 20th century gold seekers. The trail became a road and was used as an alternate route to the Sunrise mining area. In 1920 the operation of this mining road went to the Bureau of Public Roads, and it was eventually turned over to the Forest Service, where it has returned to the function of a trail.

Intense mining in the area began in 1909, when there were three active mining claims working on Falls Creek; Skeen and Lechner Mines, California Alaska Mine, and the Stevenson Mine (Crown Point). Additional operations on Grant Lake commenced during this time as well. Frank Case owned and operated the Case Mine, which is still functioning today. Further advancements at Falls Creek, in 1912, diverted the headwaters so the ground on the lower portion of the creek could be mined (Barry 1993, 1997). These mines began the trend of mineral extraction in this area of the landscape.

2.8.2 Human Uses: Present

The Trail River Watershed contains Trail Creek, Upper and Lower Trail Lakes, Johnson Lake, Carter Lake, Grant Lake, Vagt Lake, and Falls Creek. In addition, Lark and Solars Mountains and Trail Glacier grace the watershed. The heart of Moose Pass (pop. 206) is located at mile 29 of the Seward Highway (an All-American Road and National Forest Scenic Highway), lies in the western part of this watershed. The Alaska Railroad parallels the Seward Highway from Mile 25.5 until diverging at the depot in Moose Pass, crossing the outlet of Upper Trail Lake, following the eastern lake shore of Upper Trail Lake and along the flow of Trail Creek up to Grandview. The area is picturesque.

The amount of recreation use in the Trail River Watershed is low relative to other areas on the Seward Ranger District. The majority of the recreation use in the Trail River Watershed occurs during the summer months (June-August) and coincides with the arrival of seasonal summer tourists. In winter, snowmachine use and cross-country skiing also occur on the Johnson Pass and Carter Lake Trails, Moose Pass - Cooper Landing Winter Route, Upper Trail Lake and Trail Creek corridors.

The recreation activities that take place in the Trail River Watershed are hiking, fishing, hunting, trapping, boating (including use of personal watercraft), biking, All Terrain Vehicle (ATV) riding, float plane flying, berry-picking, cross-country skiing, snow-machining, helicopter skiing, and ice skating. The predominate recreation activities are hiking, fishing, skiing, snow machining and ice-skating. The majority of the Forest Service trails in the watershed are located east of the Seward Highway. Recreational uses include snowmachine use throughout the watershed, floatplane use on the Trail Lakes and Grant Lake, summer motorized uses on the Falls Creek, Crown Point, and Grant Lake trails, and motorized boat use on Upper Trail Lake. Other uses include motorized activity on the Seward Highway and Alaska Railroad.

The City of Seward (pop. 3,040) is located approximately 30 miles south of Moose Pass (pop. 212). Anchorage, the largest city in Alaska (pop. 258,782) is located approximately 50 air miles (90 miles by road) north of Moose Pass.

3.0 KEY ISSUES AND QUESTIONS

The following issues and key questions are important for management of the Trail 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. Others are important management considerations and should be evaluated by a variety of resource specialists.

3.1 Lands

Issue: Potential impacts to National Forest System lands and resources (from development on private and state land.

Issue: Potential impacts to Forest resources (soil, water, fish, and wildlife) from authorized development on federal lands such as electronic sites, highway reconstruction, or access to private inholdings.

3.2 Geology, Minerals and Soils

3.2.1 Geology and Minerals

Question: Is additional mineral development likely or not? If so, will mining render the land unsuitable for certain uses, at least for a period of time?

Issue: Mine Hazards
Because there are mine workings in the Trail River Watershed that have been inactive for many years, there are safety concerns regarding public entry of these old workings (See Figure 3.1). Over time, un-maintained mine workings can become extremely unstable and dangerous. Easily accessible and highly visible mines can pose severe hazards. Unstable workings, abandoned unexpended explosives are commonly found at old mines which can be highly dangerous to move or even touch.

Figure 3.1 – Falls Creek Mine adit.

3.2.2 Soils

Issue: Surface soil erosion will occur anywhere the mineral soil is exposed to water drop splash and runoff. Most often, it is not a major concern until significant rills or gullies are formed indicating a large amount of soil is being transported, and a loss in soil productivity. If this sediment reaches a stream, especially a fish stream, it then becomes a higher priority to reduce or eliminate the sedimentation. Proposed development of trails, roads, and fuel reduction projects all have the potential to expose the mineral soil and cause erosion.

3.3 Hydrology

Issue: The climate in Alaska has been gradually warming over the past century.

Question: How are climatic trends affecting glaciers, stream flows, channel morphology, and water quality in the Trail River Watershed?

Issue: The upper Trail River is a dynamic system with high sediment loads from a glacial source, constantly shifting, braided channels, and a wide floodplain in the valley floor. The Alaska Railroad lies within the upper Trail River floodplain for about 10 miles between Grandview and Upper Trail Lake. Channel migration is encroaching on the railroad bed in two areas, and the Alaska Railroad Corporation has been working to redirect channels in these areas to protect the tracks. The railroad corridor in this dynamic area poses a risk of oil, gas, or chemical spills into Trail River.

Question: How are the channels of the upper Trail River and its tributaries changing, what are the future trends, and how do these changes affect the Alaska Railroad?

Issue: Human uses in the Trail River Watershed are concentrated in some areas of the watershed and have the potential to impact water quality (See Section 2.8).

Question: What are the existing and potential water quality effects of motorized uses, non-motorized uses, and community development in the Trail River Watershed?

Issue: The Trail River Watershed has a history of mining, and small-scale mining operations continue in some areas of the watershed. These activities have the potential to affect channel morphology and water quality. Past hydraulic mining operations on Falls Creek caused straightening of the channel, removal of vegetation, increased bank erosion, decreased pool habitat, and excluded floodplains.

Question: What are the remaining potential risks to water quality from abandoned mines in the watershed, including the Crown Point and Case Mines?

Question: What are the past and current impacts of placer mining activity to channel morphology and water quality on Falls Creek?

3.4 Vegetation and Ecology

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

Question: Will current and future recreational use patterns increase the population and spread of non-native plant species?

Question: How will current 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?

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.

Issue: Smoke related impacts to air quality and visibility

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 affect 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)

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 affect human health, particularly for the ground crews at the site.

Residents near the actual fire 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 air-sheds 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.

3.6 Aquatic Species and Habitats

Question: Where do the coho and chinook salmon go to spawn in this drainage? Knowing where the salmon spawn and their utilization of the existing habitat can be a way to determine carrying capacity for the system.

Question: Are there any unutilized sport-fishing opportunities not being developed in the Trail Creek area?

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. Swans have been documented in the Trail Creek Watershed during the breeding season in 2004, 2005 and 2006. On the Kenai National Wildlife Refuge, floatplanes have been documented to disturb nesting birds. Floatplanes use lakes in the watershed to practice “touch and go” landings and to provide access to several lakes in the watershed. Floatplanes 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 floatplanes 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 affecting 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, abundance and trends, and habitat conditions of management indicator species, and species of special interest? What was the likely historical (pre-European settlement) relative abundance and distribution of these species? Are human uses in the watershed having a significant impact on these species?

Question: How are recreation activities affecting these species? What are the expected recreation trends in the watershed?

Question: How has the spruce bark beetle infestation affected the watershed and the abundance and distribution of these species?

Question: What is the distribution and abundance of key habitat components such as old growth, thermal and hiding cover, snags, downed logs, hardwood browse, and travel corridors?

3.8 Human Uses

3.8.1 Human Uses: Past

Issue: Cultural sites located near areas of high recreational activity have an increased probability of negative impacts. Increased use and ground disturbing activities have a high potential to damage or destroy heritage resources.

Question: What are potential options to reduce impacts, such as management, partnerships, agreements, and educational/ interpretive materials?

Question: What management measures are currently working or not working?

Issue: Areas of un-surveyed land have a high potential to yield additional cultural sites and information. A lack of archaeological inventory of this landscape causes concern as recreational use continually increases and expands. Present archaeological surveys of the area have been limited in general and the potential for snowfield hunting camps has never been investigated.

Question: In what areas do we need more information/ survey?

3.8.2 Human Uses: Present

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

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

Question: Should there be an increase in commercially guided opportunities in the Trail River Watershed?

Issue: Participation increases in recreation activities may lead to increased user conflicts.

Question: Will further recreation development in the Trail River Watershed increase user conflicts between hikers, bikers, and other visitors?

4.0 CURRENT CONDITIONS

This portion of the landscape assessment discusses the current range, distribution, and condition of resources within the Trail 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 State of Alaska gained title to the majority of its holdings in the watershed in 1985. Under the Alaska Statehood Act of 1958, over 8500 acres transferred from federal to state ownership. Several smaller land selections were also transferred to the State during the early to mid 1990s. The land selections fulfilled the National Forest Community Grant land entitlement under Section 6(a) of the Alaska Statehood Act. These land selections were transferred out of federal ownership to allow for the further development and expansion of communities. The Grandview parcel, surrounding Alaska Railroad lands near Trail Glacier, was selected for its commercial recreation development potential.

Additionally in 1985, under the Alaska Railroad Transfer Act of 1982, the railroad right-of-way and related railroad parcels transferred to the State of Alaska. The railroad property is 100 feet each side of centerline of the main line and branch lines.

The Kenai Peninsula Borough, for community development and recreation purposes subsequently selected most of the state lands in the Moose Pass area. Borough land sales are generally done through a competitive bid process. Land sales have not yet taken place.

Several small parcels are managed as Mental Health Trust lands for the State of Alaska. These trust lands are managed as part of the statewide system for the benefit of Trust beneficiaries through revenue generating land sales. Land sales have not yet taken place.

The United States retained a number of easements through the state lands to provide continuing access to National Forest System lands. The following site easements and linear rights-of-ways were reserved:

- Johnson Pass Trail (25 feet wide)
- Johnson Pass Trailhead (4.54 acres)
- Carter Lake Trail (25 feet wide)
- Carter Lake Trailhead (3 acres)
- Trail Lake Boat Launch (9.92 acres), also known as the “ball diamond”
- Falls Creek Road (60 feet wide)
- Crown Point Trail & Road (60 feet wide)
- Grant Lake Road (60 feet wide)

- Iditarod National Historic Trail, primary & connecting trail segments (1000 feet wide)

The United States also retained several easements for administration through Alaska Railroad lands in the watershed. The easements include:

- Johnson Pass Trail (25 feet wide)
- Falls Creek Road (60 feet wide)
- Crown Point Road (60 feet wide)

A number of special use authorizations have been issued for use of National Forest System lands in the watershed. The current authorizations include:

- Alaska Railroad – avalanche control along the rail corridor
- Alaska Railroad – Snotel site near Grandview for avalanche weather forecasting
- Alaska Railroad – flood control dike on Trail Creek
- Alaska Railroad – explosive storage area adjacent to the rail corridor
- City of Seward – powerline adjacent to the Seward Highway
- Conit – trapper cabin Johnson Pass trail
- TelAlaska – telephone and fiber optic cable adjacent to the Seward Highway

4.2 Geology, Minerals and Soils

4.2.1 Geology and Minerals

Unpatented Federal Mining Claims
Within the Trail River Watershed, the lands are generally open to mineral entry (the staking of mining claims) and mining claims have been located on historically mined streams and historic mines, as shown in Figure 4.2. The mining claims information below is a snapshot in time; claims can be abandoned, located and relocated at any time. Claims tend to be relocated where minerals have been produced in the past.

Mining Activity
Although there are both lode and place mining claims within the Trail River Watershed, little active mining is occurring and that which is occurring consists of small-scale suction dredging and prospecting (Figure 4.1). Placer activity is primarily occurring primarily along Falls Creek although some suction dredging and gold panning may occur on other streams throughout the Trail River Watershed. Prospecting and sampling for lode gold is occurring at and above Falls Creek, at the Case Mine in the Grant Lake area and in the Crown Point Glacier area. Most of the suction dredging, hand sluicing, and gold panning activities are conducted under a notice of intent rather than a plan of operations. A plan of operations is only required where operations may cause significant disturbance of surface resources (Figure 4.2).

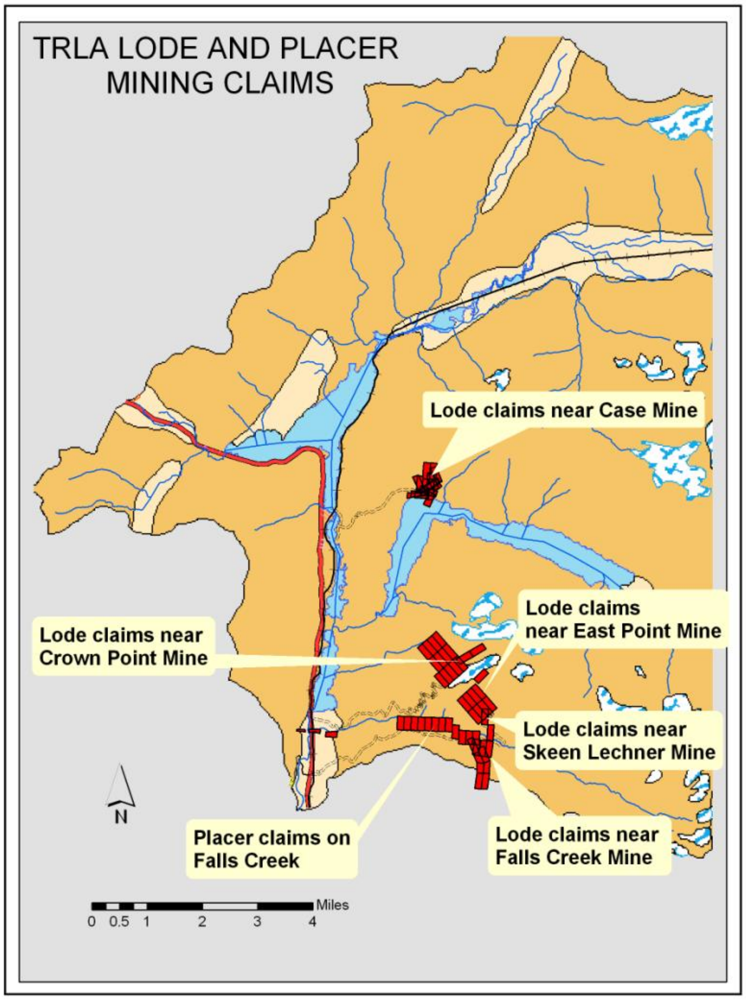

Figure 4.1. Mining claims within the TRAIL RIVER WATERSHED and their proximity to old mines.

Status of Historic Mines

Historically mined deposits are often a focal point for current mineral activities. Below is a review of old lode and placer mines and their current status.

The **Crown Point Mine.** The adits were evaluated, determined to be hazardous, and sealed. There are recorded mining claims present covering the old mine and surrounding area, but there is an adit located north of Falls Creek, 2 miles east of Vagt Lake, on the north side of a glacial cirque. It is situated in Sec. 9, T. 4N., R. 1E., SM at elevations between 4,100 and 4,600 feet. The original mill site was located at an elevation of 1,700 feet on a small tributary to Falls Creek. Access is by a narrow, eroded old mine road that is passable by ATV. There is no approved mining plan of operations. Prospecting occurs sporadically in the area. A good deal of debris (timbers) from past mining litters the slopes.

The **East Point mine** is located approximately 3 miles east of the Seward Highway and north of Falls Creek on the south side of a glacial cirque, at an elevation of 4,500 feet. It is about half a mile north of the Skeen-Lechner mine. It is situated in the SE1/4 section 9, T. 4 N., R. 1 E., of the Seward Meridian. There are recorded mining claims covering the mine and area around the mine, but no approved mining plan of operations. Access is by the same mine road that accesses the Crown Point mine but when the road ends access involves crossing a glacier and scaling a steep shale cliff. The old adit is hazardous but closing this adit was determined not to be feasible due to the difficult access.

The **Falls Creek Mine** is located on the south side of Falls Creek at an elevation of 2,100 feet. It is situated near the north boundary of the NE1/4 section 21, T. 4 N., R. 1 E., of the Seward Meridian. Access is by an old mine road that is suitable for ATV use. There are recorded mining claims covering the mine and area around the mine, but no approved mining plan of operations. Some minor prospecting activity is on going. The waterfall adit was evaluated for hazards and potential bat habitat; it remains open. Falls Creek is probably the most actively prospected mine in the TRAIL RIVER LA.

The **Skeen Lechner Mine** is located approximately 3 miles east of the Seward Highway on the north side of Falls Creek at an elevation of 3,200 feet. On the 1994 USGS Seward B-7 topographic map it is misnamed the Falls Creek mine. It is situated in the NE1/4 section 16, T. 4 N., R. 1 E., of the Seward Meridian. Workings are mostly collapsed and what is still open is unstable. Access is by the Falls Creek Mine road but then Falls Creek must be crossed and there is no bridge. Access by crossing Falls Creek is considered difficult.

Case Mine The mine is located in the NE1/4 section 29, T. 5 N., R. 1 E., of the Seward Meridian, on the north side of Grant Lake; the workings extend into the south half of section 20, T. 5 N., R 1 E., in the C-7 quadrangle. The workings are accessible from Moose Pass by the Grant Lake trail that begins at either the railroad bridge on the west shore of Upper Trail Lake or half a mile south of the railroad bridge on the west shore of Upper Trail Lake. (The public is not allowed to walk across to the trail (northern entrance) on the railroad bridge. The southern entrance to the trail is accessed by boat.) The mine camp is at an elevation of 700 feet. The mine workings are about half a mile north-northeast of the camp between elevations of 1,500 and 1,600 feet. There are recorded mining claims in the area and sporadic prospecting has been ongoing for many years. Several trespass (unapproved) cabins on the lakeshore comprise the old mining camp.

Potential for Future Mining

In the future, gold is the most likely mineral resource to be developed and mined for in the TRAIL RIVER LA with the exception of sand and gravel resources. In 2000, gold prices dropped to nearly $250/ounce, yet currently (2007) gold prices are around $725/ounce. Still, there is no lode gold mining occurring in the TRAIL RIVER LA and very little prospecting activity. That is significant, because formerly sub-economic gold deposits around the state are now being actively developed and mined. There must be a reason for this. The type of deposit found in the TRAIL RIVER LA is “Chugach-type Gold Deposit” defined by the USGS as small tonnage, sometimes high-grade, quartz vein gold deposits. The problem is the small tonnage, which cannot support the large capital investment needed today to develop a gold mine. Significant lode gold production is unlikely to occur in the near future in the TRAIL RIVER LA.

Placer gold production from small-scale suction dredging (also known as “mom and pop operations”) is likely to continue and may escalate if gold prices remain high. Much of this will occur in Falls Creek.

Mineral materials resources within the TRAIL RIVER LA are not situated where development would be likely, because the highway corridor is primarily state and private land.

Figure 4.2. Suction dredging

4.2.2 Soils

Geomorphic Processes

Land type disturbing processes within the watershed assessment area can be both natural and management related. Natural mass-wasting is known to occur in the watershed but these land types are not mapped. Presently, we do not know the status of existing, natural land slides within the assessment area.

Management related mass wasting slope failures have been associated with road construction, stream channel migration, and hydraulic mining in the watershed. Currently, old management-caused slope failures are stable with the exception of the Alaska Railroad encroachment of Trail River, described in section 4.3.3 and shown in figure 4.3. While there are several long-term ways of protecting the railroad grade, one permanent method of both protecting the grade and not interfering with the channel is to trestle the grade. The Forest plan requires that slope stability analysis be done preceding feasibility analysis for ground-disturbing activities on steep slopes (see Appendix A). Any proposed projects would go through the process described in the appendix.

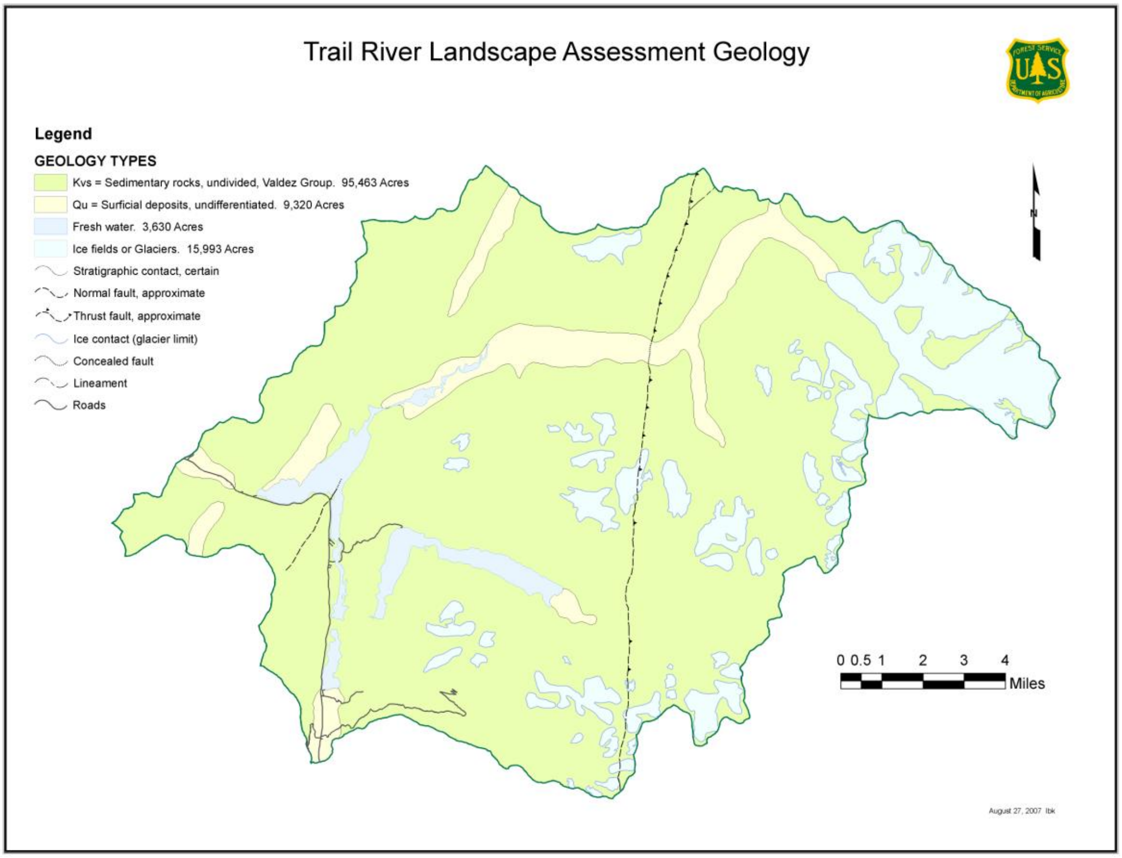

Figure 4.2.1. Trail River Landscape Assessment Geology

Other than landslides and the overall weathering rate, glacial recession is having the most effect on the geomorphic surface and soil development in the assessment area. There are several glaciers within the assessment area that have/are receding, including Trail Glacier (see figure 4.2.1, Trail River Landscape Assessment Geology). As glaciers recede, the area of land where soil is beginning to develop is increasing. Recently exposed glacial surfaces may have a head-start on soil development compared to some other recent surfaces, for example, volcanic flows, depending on the glacial history and parent material. Even though the surface is ice-free in these areas, fundamental soil ecosystem processes are in a rudimentary stage if the geomorphic surface is less than about ten years old. Over the next decade to about 150 years, identifiable soil processes are initiated and process rates increase to measurable levels. These processes include: changing of the below-ground temperature regime, chemical weathering and precipitation of soil minerals, colonization by bryophytes and early successional vascular plants, increasing chemical complexity, colonization and increasing complexity of soil wildlife and floral communities, and accumulation and transformation of soil organic carbon, among others. After the basic soil system components are established, nitrogen, carbon and other cycling reach a stage where they are functionally stable. Higher plant communities including trees and shrubs establish and develop, further increasing organic matter accumulation. By this time, (after approximately 10 to 150 years depending on initial conditions), soil changes are fairly dramatic. Soil bulk density has decreased by 60% or more, pH has decreased from near neutral or higher to about 6 or lower as the result of weathering, and pedogenic horizonization has progressed to the degree that the soil classification will change from its original “entisol” condition, and after an additional similar time period, the soil changes would likely cause classification to change again. Along with these changes, soil characteristics, behavior and responses to disturbance also change. For a complete review of soil development and surface age following glaciation, see for example, Crocker and Major (1952); Tisdale and Fosberg (1966); and Yoshitake, et al (2005). There are about 15,745 acres of glacier in the assessment area. Since the mid-1950’s, the average glacial recession of 67 glaciers in Alaska, including some on the Kenai Peninsula (see figure 4.2.2) has been 1.8 m yr^{-1} (Arendt, et al, 2002). There can be some ponding of melt water below the glacial front for example, the lake below Trail Glacier, but there is generally rock, rock debris and rock flour exposed. The Arendt recession rate equates to an average of about ninety meters of newly exposed surface for each glacier in the assessment area ranging in age from the present to fifty years old. Figure 4.2.3 shows global glacial change in thickness; it is inferred that the changes in Canada and Alaska have been even greater.

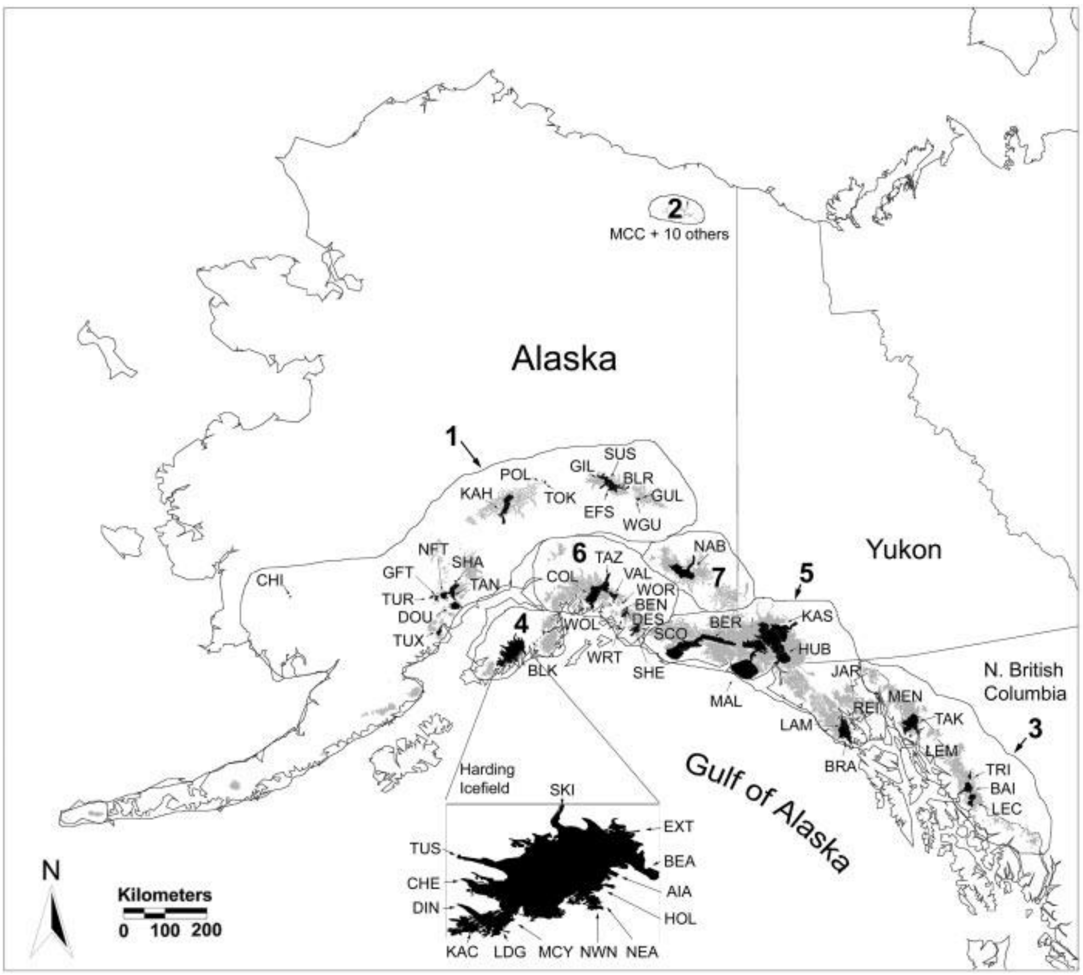

Figure 4.2.2. Location of 67 surveyed glaciers, shown in black, separated into seven geographic regions:
1, Alaska Range; 2, Brooks Range; 3, Coast Range; 4, Kenai Mountains; 5, St. Elias Mountains (includes Eastern Chugach Range); 6, Western Chugach Range; and 7, Wrangell Mountains. Glacier names associated with three-letter codes are in table S1.

Fifty-five glaciers are located entirely in Alaska, 11 span the border between Alaska and Canada (Yukon Territory and northwest British Columbia), and one is entirely located in Yukon Territory. The total surface area of glaciers in our sample is about 18,000 km2; the total area of glacier ice in Alaska, Yukon, and northwest British Columbia (north of 54°N latitude), shown in gray, is 90,000 km2. Glaciers outside the seven regions account for 0.2% of the total glacier area. (From Arendt, et al, 2002).

Glaciers in northwestern USA and southwestern Canada, Alaska, high mountain Asia, and the Patagonian ice fields have lost disproportionately large volumes of ice, relative to their surface area.

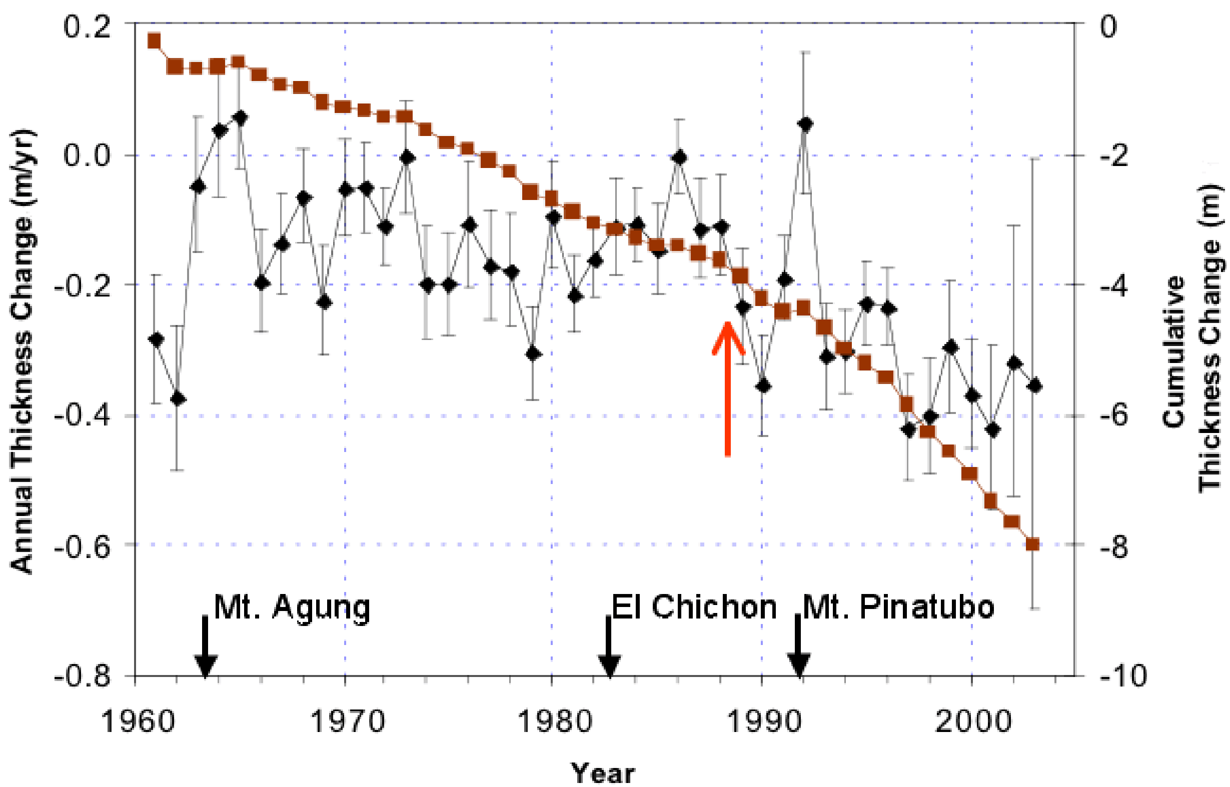

Figure 4.2.3. Measurements of Glacier Change

Annual change in global glacier thickness (left axis, meters of water equivalent, m/yr) and cumulative value (right axis, m), based on surface area-weighted mass balance observations. Dates of major volcanic eruptions are shown, since stratospheric aerosols have a cooling effect on climate. Red arrow highlights volume rate change (from NSIDC, 2003).

Soils

The Forest has Section, Subsection, Land type Association, and Land types mapped as part the National Hierarchy for land systems inventory and soil survey that cover the assessment area. These upper levels of geomorphic hierarchy are useful for a large-area assessment such as Trail River Landscape Assessment, and the review in section 2 utilizes this material. Most of the Forest, including the assessment area, lacks both descriptive and quantitative soil type mapping at any scale. The soil type scale would be needed to assess any project that may be proposed within the area. Figure 4.2.4 displays what is currently known and mapped within the watershed from the Forest GIS database. There are 483 inventoried acres out of the 124,406 assessment area. This is from work that was done by Dean Davidson in the Kenai road corridor. Some work has been done by the NRCS on the tip of the Lower Kenai near Homer, but it does not cover any of the assessment area. An electronic version of this older project has not been found, so rather than paste a scanned copy of the map legend that is not that good, please reference the hard copy for the legend and the map unit descriptions: Kenai Road Corridor Soil Survey (1989). A copy can be provided on request. This Survey does not meet Terrestrial Ecological Unit Inventory (TEUI) standards for soils (2005), or National Cooperative Soil Survey (NCSS) standards for soil inventory.

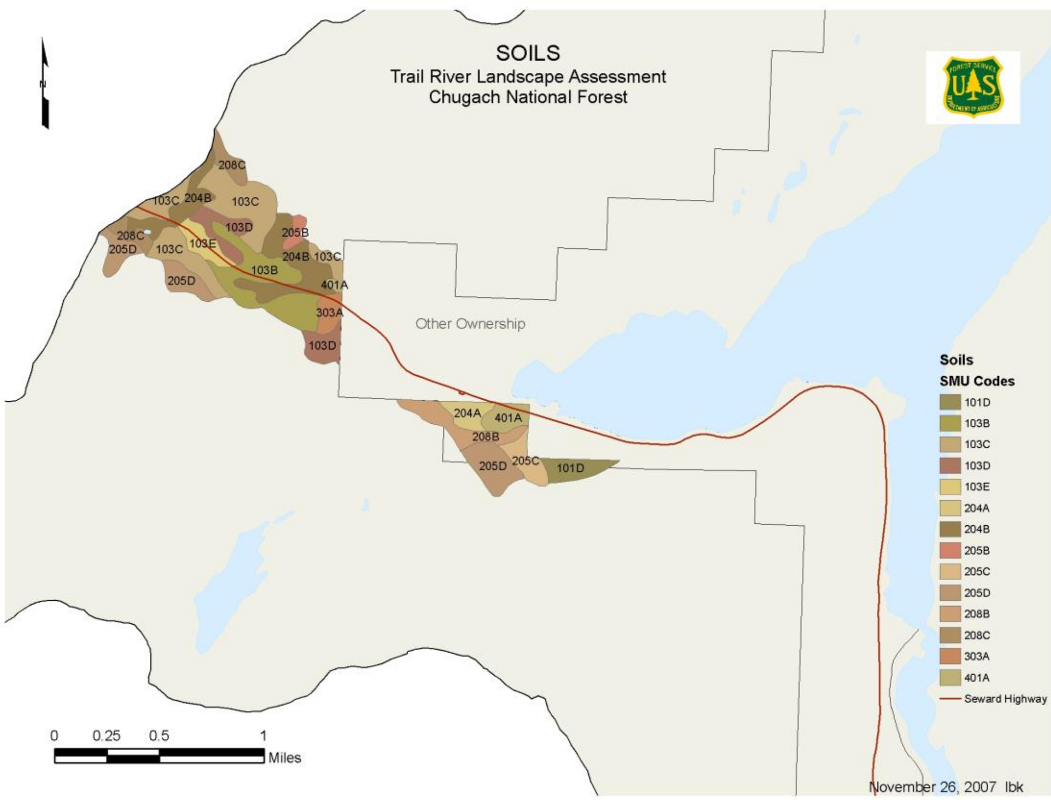

Figure 4.2.4. Mapped Soil Types in the Trail River Watershed.

Soil Erosion

The landscape characterization in Section 2 discusses soil erosion. Current conditions for landslides at the land type scale have been discussed earlier under Geomorphic Processes. Natural soil erosion rates vary largely by soil type, slope, mulch or litter cover, and climate. Typically, baseline erosion is within the range of about 0.1 to 0.001 tons acre^{-1} year^{-1}. Accelerated erosion from timber harvest-vegetation treatment, construction, severe wild fire, livestock grazing, or intensive agriculture can be over 800 tons per year. Within the Trail River Landscape Assessment area watershed, natural conditions produce only a baseline soil erosion rate. Recent management activities that could disturb the soil cover and accelerate erosion affect about 210 acres in the assessment area and include a gravel pit, timber and fire salvage (Table 4.2.1).

Table 4.2.1. Management activities that may allow accelerated soil erosion.

STAND_ID #	ACTIVITY_NAME	ACRES	Original Overstory	Treatment	Silv Systems	Proposed Treatmen	System	Regen Trt	Regen Mthod	Nat Regen	Plant Stock	Presc Burn	Slash Trt	Plant Stock
756	Mile 34 T S	34	3	1	3	1	3	3	2	6	1	8	3	1
761	Avalanche Acres 1	7	3	6	7	3	2	5	0	4	0	0	4	
763	Beaver Pond	9	7	1	3	5	1	5	0	6	0	0	4	
774	Gravel Pit Mile 33	10	7	1	3	5	1	5	0	6	0	0	4	
786	Moose Pass Fire Salvage	98	7	2	3	1	1	5	0	6	0	0	4	
788	L V Ray Salvage T S	43	7	3	3	1	1	3	2	6	1	8	3	1
849	Feller Buncher Log Decks	6	3	5	4	1	3	5	0	6	0	0	1	
874	Trail River CG TSI	1	1	4	7	3	2	0	0	0	0	0	4	
883	Trail R CG Svg Resale 4	2	3	5	6	1	3	5	0	6	0	8	3	

Data Dictionary

C:\WorkSpace\TrailRiver\datadic_n

4.3 Hydrology

4.3.1 Climate

The climate throughout Alaska has become warmer over the past century. Weather data suggest that the average annual temperature has increased by about 2º F over the last 50 years in Seward and Moose Pass (Western Regional Climate Center, 2006) (Figure 4.4). Winter temperatures have increased at a faster rate than summer temperatures. Kenai Lake generally freezes during the winter, but warm winter temperatures caused 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.

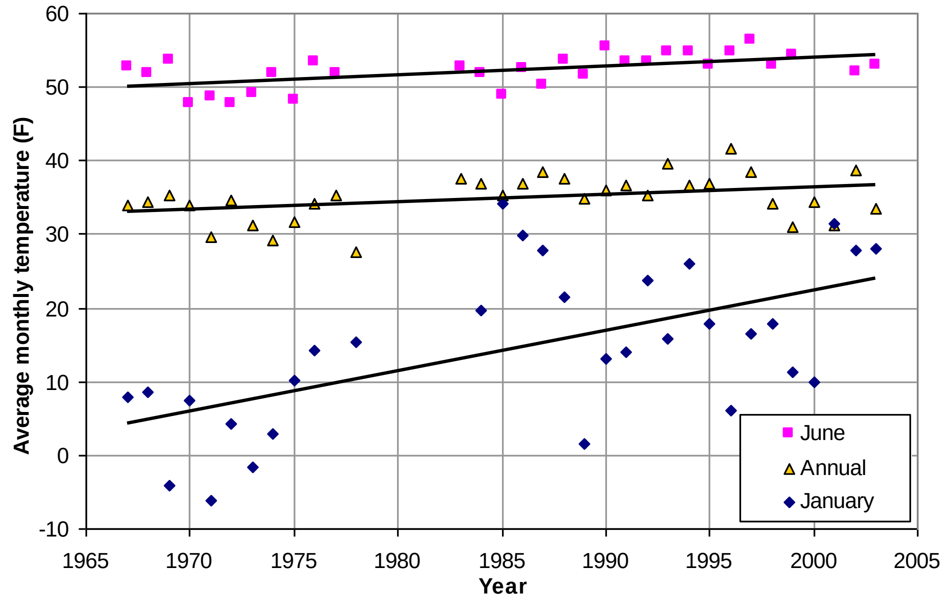

Figure 4.4. Average monthly and annual temperatures, 1967-2003, for Moose Pass, AK (Station #505894). Data from Western Regional Climate Center (2006).

4.3.2 Glaciers

As a response to the warming climate or changes in the distribution of precipitation, the Trail Glacier has been receding and thinning during the last century. This glacier follows the trend of most of the glaciers in the Kenai Peninsula and Prince William Sound areas. Since 1950, the Trail Glacier has receded about 4000 feet, and a 1600-foot long pro-glacial lake formed at its terminus between 1974 and 1997 (Figure 4.5). Currently, the terminus of the glacier lies at the upstream end of this lake basin. The position of the glacier has remained relatively static at this location for the past 10 years. Other smaller glaciers in the watershed have also thinned and receded, and glaciers that were once connected to the lower Trail Glacier now remain as hanging glaciers (Figure 4.5).

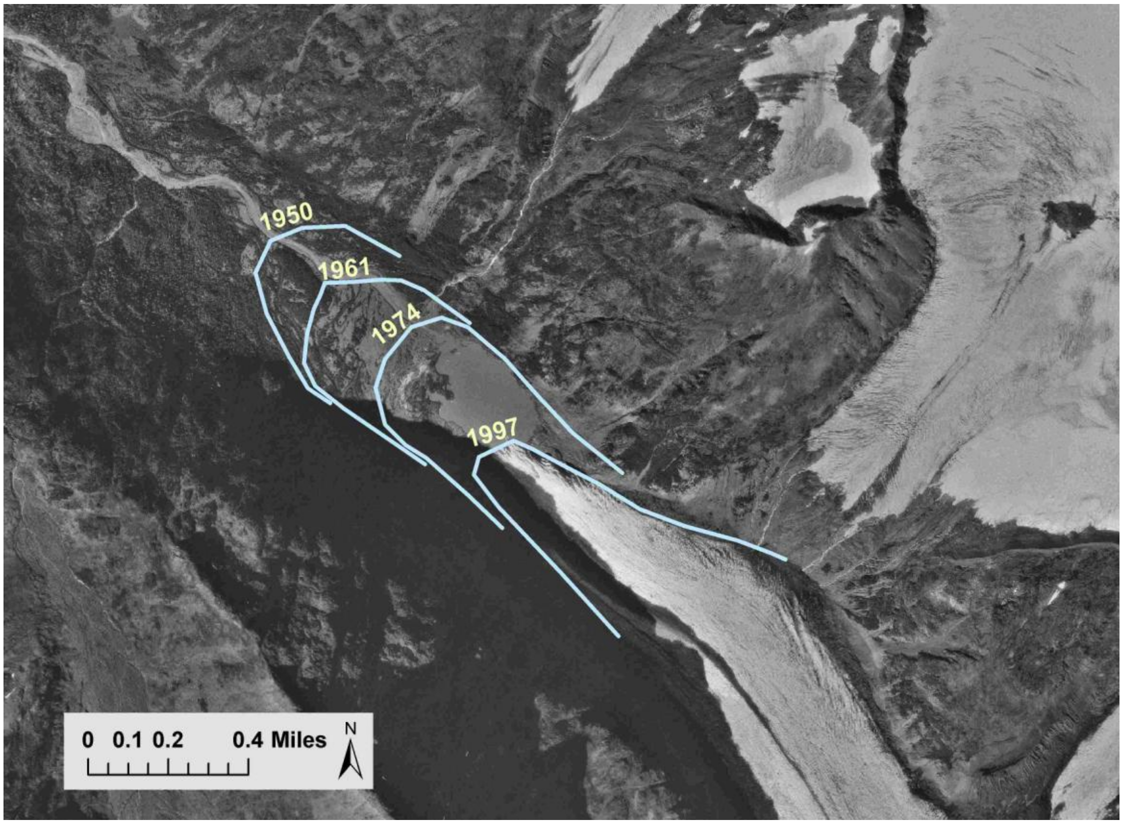

Figure 4.5. Approximate position of the Trail Glacier terminus between 1950 and 1997.

4.3.3 Stream Channel

Stream channel migration is a natural process, particularly in systems that have high sediment loads, glacial sources, and wide floodplains or outwash plains such as the Trail River. Several areas on the upper Trail River are experiencing dynamic channel changes that are affecting the bed of the Alaska Railroad, and the railroad bed is also controlling channel morphology in places (Figure 4.6). Where migrating channels encounter the railroad, rip-rap has been placed along the railroad bed as protection. This can cause channel straightening, increased flow velocities, decreased riparian vegetation, and decreased pool habitat. The railroad bed essentially acts as a linear barrier that restricts the amount of usable floodplain for the Trail River. In places, the railroad bed follows the center of the valley floor, bisecting the floodplain and decreasing the floodplain width by as much as half.

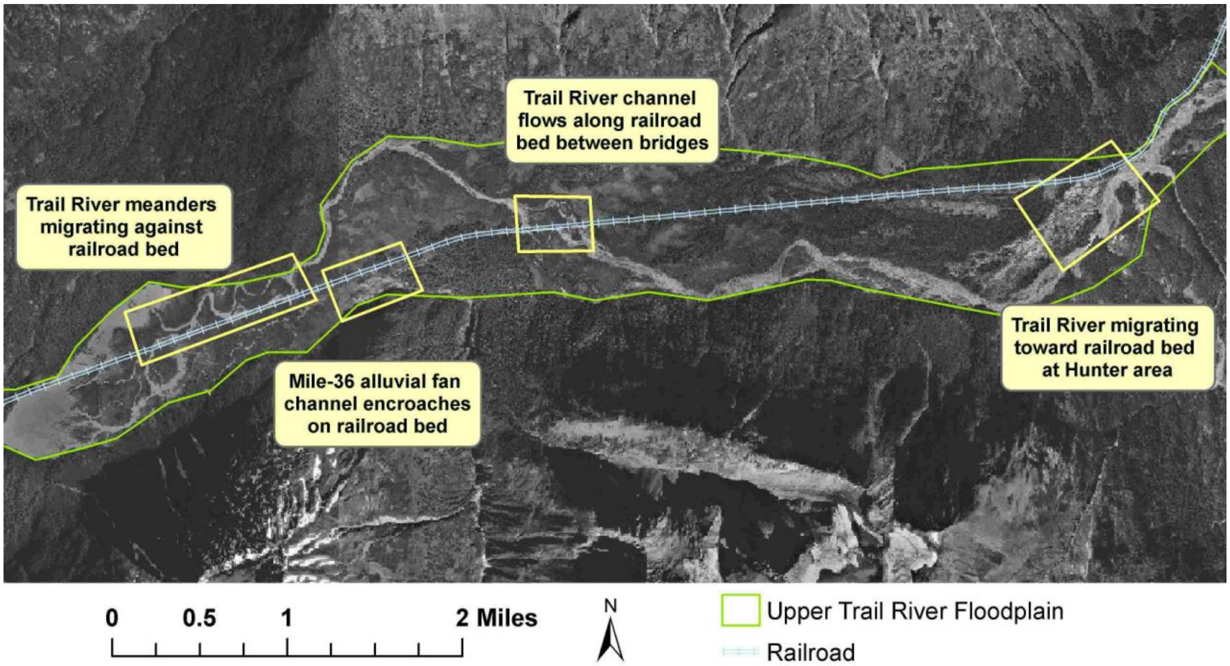

Figure 4.6. Upper Trail River floodplain, showing areas of concern along the Alaska Railroad. Flow is from right to left.

At Mile-36.6 of the Alaska Railroad, the Railroad crosses an unnamed tributary to Trail River (Figure 4.7). Deposition of sediment and high flows on this alluvial fan has led to a long history of flooding along the railroad tracks. With a 9-square mile drainage area and glacial sources, deposition of gravel on the lower fan causes frequent natural channel migration. Railroad personnel have constructed berms on the alluvial fan to constrain the channel to the west side of the fan, so that it flows along the south side of the tracks and joins Trail River about two miles downstream. These berms are temporary structures that require considerable maintenance as the channel continues to migrate. Potential issues include erosion of the railroad bed or even inundation of the railroad bed during flood events. Left on its own, the channel would likely flow in a more direct, steeper route down the face of the fan, where it would encounter the railroad tracks. Short term solutions include continuing to construct berms to direct flows, raising the tracks, armoring the edge of the railroad bed, and installing flood drainage culverts under the tracks. However, as the fan continues to aggrade, these issues will continue to occur.

In the Hunter area near Mile-40.5 of the Alaska Railroad, the Trail River channel is migrating toward the railroad bed (Figure 4.8). Dikes have been constructed in this area since at least 1961 to direct flows away from the railroad tracks and prevent flows from affecting the railroad. However, because the channel is aggrading at its current location with its abundant sediment deposition, its natural tendency is to migrate to the lower area along the railroad, where the channel was located prior to 1961. Constructing berms in this location is a temporary solution that will likely require considerable future maintenance.

Figure 4.7. Newly constructed berm and rip-rap along the Alaska Railroad, Mile-36.6, August 2003.

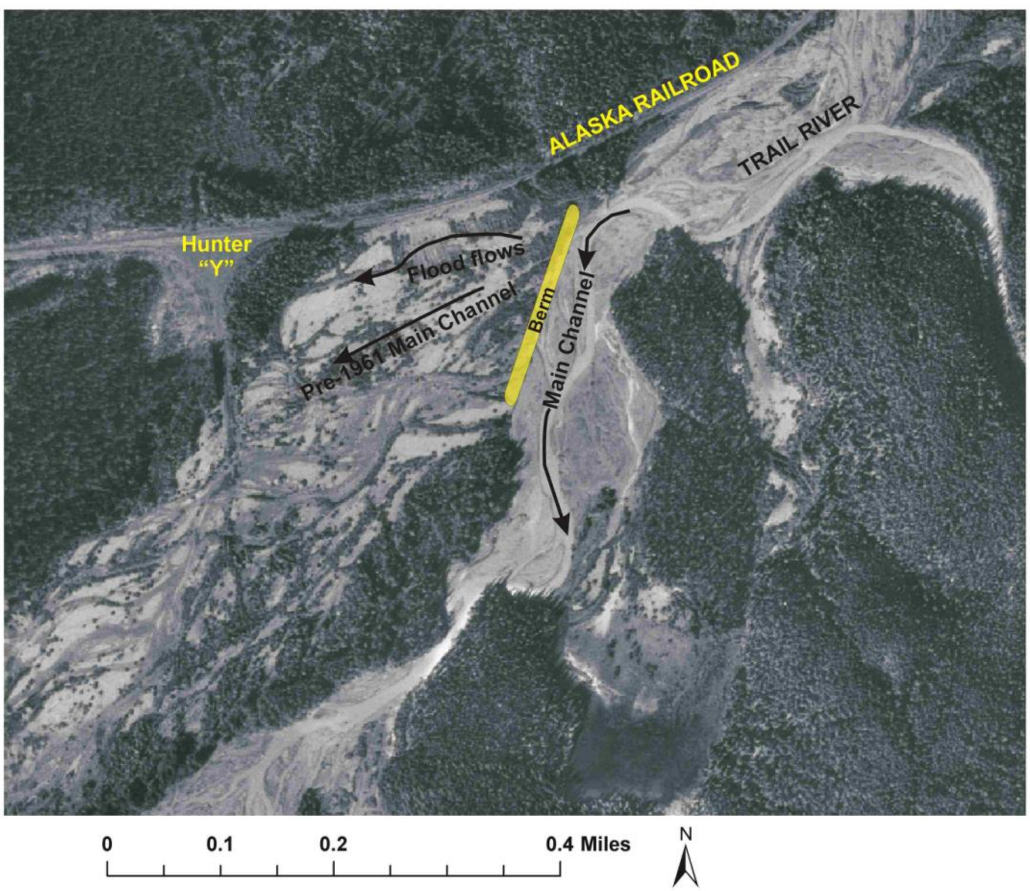

Figure 4.8. Trail River dynamics at the Hunter Wye.

Sediment loads are high in the upper Trail River because of glacial activity as well as erosion within the outwash plain and floodplain of the Trail River. Since about 1974, a small proglacial lake has formed at the terminus of Trail Glacier. Because this lake captures sediment derived from Trail Glacier, sediment loads have decreased since prior to the formation of the lake. However, the river still transports abundant sediment derived from erosion of its bed and banks. A small delta at the head of Upper Trail Lake continues to build as sediment is deposited in the low energy environment of the lake. Downstream of Lower Trail Lake, the Trail River is experiencing little change in channel morphology.

4.3.4 Water Quality

Mining activity currently takes place on portions of Falls Creek, and one miner currently has an approved plan of operations to conduct placer mining in Falls Creek. These small-scale operations generally do not cause large increases in sediment loads and turbidity in Falls Creek. With approved plans of operation in place, these operations will have little effect on water quality in Falls Creek.

However, past mining operations caused alterations of the stream channel, resulting in channelization, loss of riparian vegetation, increased flow velocities, decreased pool habitat, and decreased floodplain availability. Many of these effects persist. Water sampled in 1980 above and below the Lower Falls Creek claim (while no active mining was taking place) showed increases in turbidity and suspended solids downstream of the mining (Blanchet, 1981). However, these increases did not violate the Alaska State water quality standards (Alaska Department of Environmental Conservation, 2003). Increases as well as decreases in heavy metal concentrations were founds upstream and downstream of this site, but no violations of the Alaska State water quality standards were observed.

Abandoned mines in the Trail River Watershed include the Crown Point Mine and the Case Mine. US Forest Service personnel conducted mine cleanups of each of these mines in August and September 2002. At each mine, oil, discarded oil barrels, and trash were removed from the sites. These sites pose a minimal risk to water quality from any remaining hydrocarbons on the sites.

Recreational activities are increasing in the Trail River Watershed. The development of the Iditarod National Historic Trail will provide users access through the watershed along the east side of Trail Lakes. With implementation of Best Management Practices (BMPs), this trail system will have minimal effects on water quality in the watershed. Large numbers of floatplanes utilizing Upper Trail Lake may be affecting water quality in Trail River, with the potential for oil and gasoline spills into the lake. Other motorized uses including snowmachines, boats, vehicles on the Seward Highway and in Moose Pass, and the Alaska Railroad can also potentially cause hydrocarbons to enter Trail River. No water quality data for hydrocarbons exist for the Trail River Watershed.

4.4 Vegetation and Ecology

The assessment area includes several consolidated cover types as defined in the Chugach National Forest GIS database (USDA, 2004). The cover type layer in the GIS database was derived from a more detailed Timber Type layer. Coniferous forests are primarily Lutz spruce, but there may be small acreages with pure white spruce stands, though this is highly unlikely. White spruce is the de facto coniferous designation throughout the GIS Timber Type layer, and this designation will be retained throughout the vegetation and ecology section of this assessment. Sitka spruce has also been included into the white spruce type. Mixed hardwood-softwood types include aspen-white spruce, birch-white spruce, cottonwood-Sitka spruce, cottonwood-white spruce, cottonwood-birch-white spruce, aspen-hemlock, birch-Sitka spruce, and birch-hemlock. The original Timber Type layer was derived from aerial photo interpretation in the late 1960's and early 1970's. Because of the dated nature of the GIS layer, delineations between cover type polygons do not have complete accuracy. Cover type information is summarized in Table 4.1.

Table 4.1. Cover type acreage and percentage, from the Chugach National Forest Data Dictionary (2004).

Forested Cover	Acres	Percent
Hemlock	6,959	5.59
Hemlock-Spruce	7,041	5.65
White Spruce	5,659	4.54
Mixed Hardwood-Soft	2,084	1.67
Birch	1,974	1.58
Cottonwood	1,379	1.10
Aspen	165	0.13
Black Spruce	85	0.06
Total	**25,346**	**20.32**

Non forested Cover	Acres	Percent
Alder	16,684	13.41
Muskeg Meadow	212	0.17
Grass and Alpine	25,945	20.85
Other Brush	6,424	5.16
Other Nonforested	811	0.74
Rock	29,065	23.36
Water	4,576	3.67
Snow and Ice	14,984	12.04
Willow	356	0.28
Total	**99,057**	**79.68**

Grand Total	**124,403**	**100.00**

When considering the landscape as a whole, broad categories of cover type can be recognized in terms of differentiating forested cover from non-forested cover. Much of the landscape falls into the non-forested vegetation category, including grasslands, alpine meadows, and shrub-lands. Table 4.1 shows that almost 80 % of this landscape is non-forested. Much of the acreage is in rock or snow and ice (35 %), as this landscape has many steep slopes angling down to broad river valleys, and many upper elevation valleys.

The assessment area shows the common effect that elevation gradients have on the distribution and type of vegetation in Alaska. Vegetation above 1500 feet elevation is generally shrub and alder dominated communities, including areas of dwarf and ericaceous shrubs. Forested areas are generally confined to below 1500 feet. In forested areas, the system of streams flowing into the larger lakes in the assessment area, create unique riparian habitats that may contain hot spots of plant diversity.

Forested types make up the remaining 20 % of the assessment area. The dominant vegetation includes Lutz spruce and mountain hemlock, and mixed hemlock-Lutz spruce, with hardwood forest making up a much smaller percentage of forested vegetation communities. The GIS layer does not differentiate between white spruce and Lutz spruce, so white spruce can be considered Lutz spruce in this area.

4.4.1 Natural Disturbance

Windthrow

The assessment area is subject to wind throw. Any management activities that take place in the area should consider this. There are also several areas with steep slopes that could be prone to avalanches. Most of these areas are covered in alder and willow shrubs. Avalanches constitute a powerful force for successional change in the assessment area, albeit at a small scale.

Insects as Agents of Disturbance

Arctic and boreal insects are opportunistic in their behavior, responding quickly to changes in climate and the availability of food and breeding material (USDA Forest Service 2006). In Alaska, increasing tourism and international trade elevates risk to forested ecosystems from exotic insect introductions. The recent introduction of the amber-marked birch leaf miner has served to highlight the increasing risk to Alaskan forests and emphasize the need to further develop an early warning system with a wider scope for detecting introductions. Currently annual gypsy moth (*Lymantria dispar* (L.)) trapping and Early Detection/Rapid Response (EDRR) monitoring sites are maintained to detect potentially invasive exotic bark and wood boring insects. (USDA Forest Service 2006)

Defoliators
Defoliating insects eat the leaves or needles of trees and can have a significant effect on both coniferous and deciduous trees. They can cause tree mortality with several seasons of defoliation. If complete defoliation of a conifer occurs before midsummer, the trees will not have formed buds for the following year and the tree could be killed (USDA Forest Service 2006).

Defoliator outbreaks tend to be cyclic and closely tied to climatic conditions. The synchronization of larval emergence and tree bud break is closely related to population increases; the better the synchronization is, the more likely that an epidemic will occur. Higher temperature during pupation and egg depostion of the western black-headed budworm improves adult emergence and survival, increasing the number larvae that develop - the most damaging insect stage (USDA Forest Service 2006).

In a defoliator outbreak, nearly every tree can be affected to varying degrees. The defoliation can result in a variety of biological, ecological, and socioeconomic impacts. Some of those impacts described by USDA Forest Service (2006) include:

- Impacts on wildlife habitat: Defoliator outbreaks may positively or negatively affect wildlife. Larvae are a necessary food source for fledging checks, but bird habitat may be negatively affected by the decrease in cover. Conversely, predatory birds may benefit from the cover change. The added light to the forest floor may result in increased ground cover of herbaceous plants, benefiting browse animals.
- Impacts on aquatic systems: Effects can be positive or negative. Nutrient cycling as accelerated as foliage and insect waste enters the aquatic system. Larvae may drop into streams and serve as a food source for fish. In addition, the loss of overstory cover can increase sunlight exposure to the stream, affecting the aquatic environment.
- Aesthetics and recreation: The visual impact of an outbreak can be quite alarming. Large numbers of larvae can be a nuisance in picnic grounds and campgrounds. Dead tops and dead trees pose a hazard in recreation areas. However the effect is often short term and the scenic quality usually returns to normal the following year.

Defoliating species that may occur in the analysis area

Birch Leaf Miner ((*Profenusa thonsoni* (Konow)) – The amber-marked birch leaf miner is becoming widespread pest of birch in Alaska. It is one of the three species of birch leaf miners introduced to North America in the last century that has made their way to Alaska (USDA Forest Service 2006). USDA Forest Service (2006) states approximately 140,000 acres of infested birch are present in Alaska. Aerial and ground surveys indicated populations occur along the Seward Hwy and populations are known as far south as Soldotna on the Kenai Peninsula (Refer to map 4 on page 23 of Forest Health Conditions in Alaska – 2005). Until the population of an introduced parasitic wasp, *lathrolestes luteolater*, increases to a level where it becomes an efficient biological control agent, birch leaf miner populations are expected to spread unchecked throughout many of south-central Alaska's birch forests (USDA Forest Service 2006). USDA Forest Service (2006) states that evidence from Eilson AFB in 2004 suggests that it can also complete development within the much smaller leaves of dwarf birch (*Betula glandulosa*).

Birch Leaf Roller ((*Epinotia solandriana*(L.)) – This insect has not been observed in this analysis area, but small isolated areas of activity were mapped on the Kenai National Wildlife Refuge in 2005 (USDA Forest Service 2006), so could be present at undetectable levels in the area.

Western Black-Headed Budworm ((*Acleris gloverana* (Walsingham)) – Budworm populations have been cyclic in Alaska, appearing and affecting extensive areas, and then decreasing just as dramatically in a few years. Consecutive years of budworm defoliation may cause growth loss and top-kill. In severe outbreaks, substantial lateral branch dieback can lead to the mortality of large numbers of trees (USDA Forest Service 2006). Generally, heavily defoliated trees may be weakened and predisposed to secondary mortality agents (USDA Forest Service 2006). As a major forest defoliator, the black-headed budworm can significantly influence both stand composition and structure (USDA Forest Service 2006). Defoliation can favor understory shrubs and shade intolerant plants, favoring small mammals, and some insectivorous birds (USDA Forest Service 2006).

Wooly Alder Sawfly ((*Eriocampa ovata* (L.)) – Defoliation by wooly alder sawfly, a European species well established in northern U.S. and Canada, remained moderate to heavy on thin-leaf alder (*Alnus tenuifolia)* in many areas of south-central Alaska from Palmer to Seward. Riparian areas along the Seward Highway sustained the most severe damage. Sitka Alder was seldom defoliated. Continued defoliation may result in reduced growth, branch dieback, and may be a key stress factor for subsequent attack by the alder canker. (USDA Forest Service 2006)

Striped Alder Sawfly (*Hemichroa crocea)* – Alder defoliation can also be caused by the native striped alder sawfly. Although not considered an economically important species, thin-leaf alder is a critical shrub species in riparian areas. It acts as a major nitrogen fixer and nurse species for other plants and is an important pioneer species stabilizing soil on eroded slopes and other disturbed sites. (USDA Forest Service 2006)

Bark Beetles

Spruce beetles ((*Dendroctonus rufipennis* (Kirby)) – Spruce beetles are one of the most important disturbance agents on mature Lutz and white spruce stands in south-central Alaska. Due to large-scale beetle activity in the past and resulting changes in stand structure and composition, beetle populations have declined to endemic levels on the Kenai Peninsula. Beetle activity is occurring in isolated areas throughout the Peninsula. Active beetle infestation was observed in upper Trail Creek in 2005. In general, spruce beetle is moving into some of the less susceptible areas (spruce-hardwood mixed stands) where ample large diameter spruce host material still exists. (USDA Forest Service 2006)

Some of the impacts associated with spruce beetle infestations outlined in USDA Forest Service (2006) include:

- Long term stand conversion: On some sites in south-central Alaska, blue-joint grass and other competing vegetation quickly invade stands where spruce beetles have “opened up” the canopy, delaying reestablishment of tree species.
- Impacts on wildlife habitat: Wildlife species dependent on live, mature spruce stands may decline, including red squirrels, spruce grouse, Townsend warblers, ruby crowned kinglets, and marbled murrelet populations. Species that benefit from early successional vegetation such as willow and aspen such as moose and small mammals and their predators may increase as stand composition changes.
- Impacts on scenic quality: Public perceptions of scenic quality declines significantly where spruce beetle impacted stands adjoin corridors such as

National Scenic Byways (i.e. Seward Hwy). However in the backcountry, surveys have shown that the public is evenly divided as to whether spruce beetle outbreaks damage scenic quality.
- Fire hazard: Fire danger increases in many spruce beetle impacted stands. After a spruce beetle outbreak, grasses and other highly flammable species increase. As dead trees break or blowdown, large woody debris begins to accumulate on the forest floor. A dangerous fire behavior situation results from the combination of fine flashy fuels and abundant large woody debris, as the rate of fire spread as well as the burn intensity increase. Beetle killed trees decompose as a slow rate; therefore likely to influence fire behavior and present a hazard for over 75 years (USDA Forest Service 2006).
- Impact on fisheries: Large woody debris is a necessary component in spawning streams. If all large diameter spruce trees are killed along these streams, the future availability of large woody debris in the streams becomes a concern. Stream temperatures may also increase as a result of loss of shade.
- Impact on watersheds: Intense bark beetle outbreaks kill large amounts of conifers. This “removal” of significant portions of the forest will to some degree impact the dynamics of stream flow, timing of peak flow, etc. Hydrologic studies conducted outside Alaska on impacts associated with spruce beetle outbreaks indicate significant effects. Alaska is currently finishing a two year study of ecosystem functions on a watershed scale including regeneration and stream flow following large scale mortality due to spruce beetle.

Engraver Beetle ((*Ips perturbatus* (Eichoff)) – Infestations of engraver beetles have declined since 2004. *Ips* infestations occur mainly along river flood plains and areas disturbed by erosion, spruce top breakage, harvest, fire or wind. Increased tree mortality in Alaska caused by *Ips* species has stimulate research on new management tactics using pheromones and tree bark volatiles to minimize damage. Initial results from studies conducted on the Kenai in 2004 to determine if the application of verbenone and conophthorin would protect single trees from successful attacks are promising. These chemicals interrupt aggregation of the beetle. In the study, the beetles avoided 100% of the treated trees and successfully attacked all baited control trees (USDA Forest Service 2006).

Fire

The upper portion of the Trail River Watershed is fairly isolated with occasional summer use by airplanes and hikers due to established trails. The lower portion of the watershed has the highest concentrations of users due to the proximity of the Seward Highway, railroad, Trail River Campground, trailheads and lakes. Currently the watershed is within the natural range of fire occurrence (Figure 4.9).

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, sub-alpine and alpine plant communities. About 60 % (74,967 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.

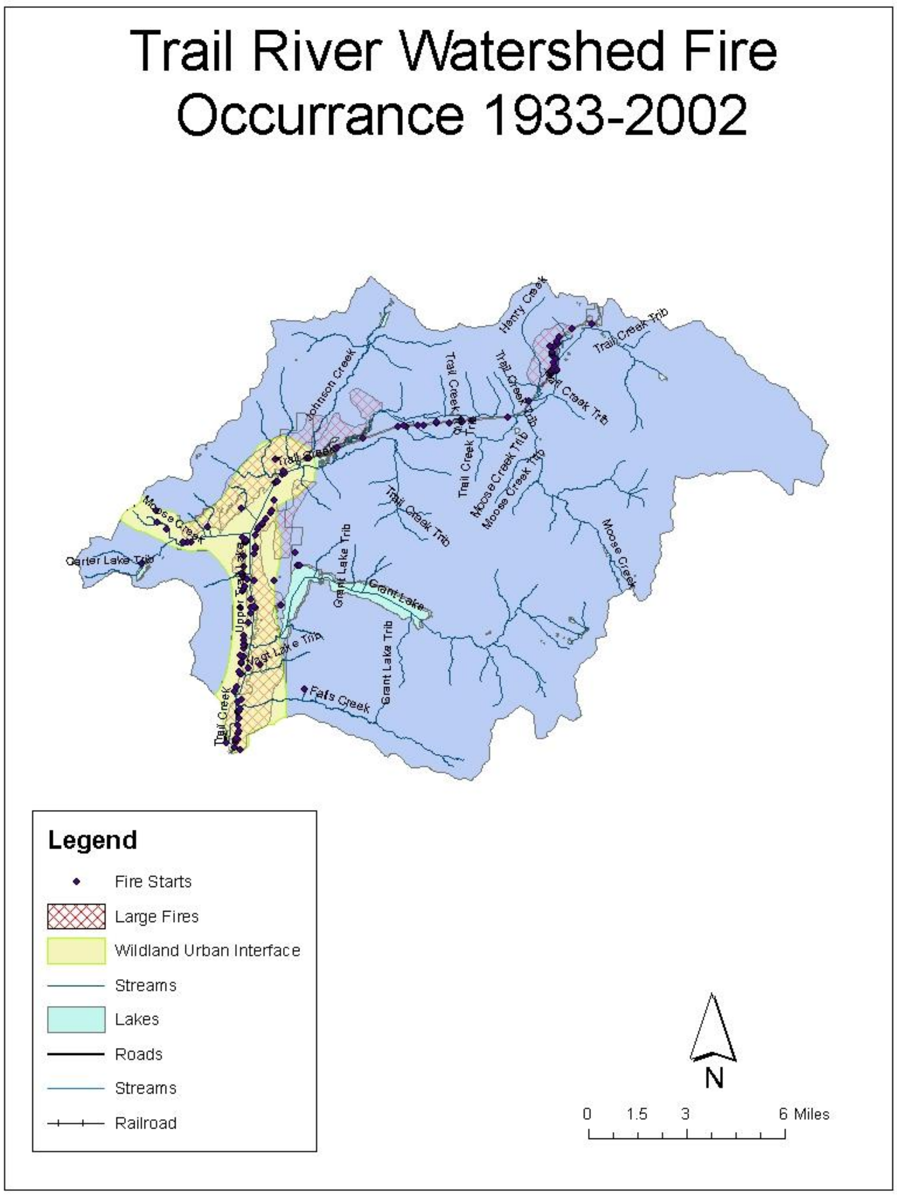

Figure 4.9. Trail River Landscape Assessment Fire Occurrence Map

4.4.2 Human Disturbance

Human disturbance in the assessment area is extensive. The area includes the community of Moose Pass with all of the associated disturbances of human settlements including roads, trails, and associated infrastructure. Summer and winter recreational activities including, hiking, snowmachining, skiing, fishing, camping, and hunting, take people into more remote sites in the assessment area.

Effects on the vegetation are minimal in the winter months. Disturbance to vegetation communities in the summer is small relative to the size of the assessment area as a whole.

4.4.3 Sensitive Plants

Gravel areas along the shores of Upper and Lower Trail Lakes and Grant Lake provide habitat for the pale poppy (*Papaver alboroseum*), although the closest documented populations near the assessment area for this species are located at the mouth of Victor Creek.

Habitat for other sensitive plants on the Regional Forester's list include subalpine and alpine meadows, riparian zones, bogs, rock outcrops, and freshwater pools. There are 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 are a subset of non-native species characterized by rapid spread and take over of native habitats. The possibility of establishment and spread of these species is very real in the assessment area due to the plethora of human disturbances, such as roads and trails. Several aggressive species have been found in previous plant surveys in the assessment area, including white sweet clover (*Melilotus alba*), butter and eggs (*Linaria vulgaris*), and narrowleaf hawksbeard (*Crepis tectorum*).

Non-native species are also located along roads and trails and within residential sites within the assessment area. A variety of non-native plant species have been documented in the area of interest, including common dandelion (*Taraxacum officinale*), pineapple weed (*Matricaria discoidea*), several species of clover (*Trifolium spp.*), and over two dozen other species.

Any increases in recreational use, development of hiking trails, campgrounds, and backcountry cabins will lead to an increase in both non-native and invasive species within the assessment area. Disturbances to topsoil and intact forest canopies should be minimized. Once established, these species can prove difficult and expensive to control or eradicate.

4.4.5 Spruce Bark Beetle Effects

Spruce bark beetle damage is extensive, affecting almost all areas along the Seward Highway, Upper and Lower Trail Lakes, and Grant Lake, as well as several areas along Johnson Pass trail.

The pervasive influence of the spruce bark beetle not only presents a fire hazard, but will also lead to an opening of the forest canopy, which could lead to the establishment of non-native and invasive plant species, particularly as human activities increase. Effects on the plant community composition, structure and function will also be extensive across the landscape over the long term.

4.5 Fire

The Kenai Peninsula is a transitional zone between boreal forests and coastal rain forests. Sitka spruce thrives near the coast where climatic conditions limit the frequency and intensity of naturally occurring fires. Mountain hemlock occurs 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 species in Alaska (Lutz, 1953).

On the Kenai Peninsula, the spruce bark beetle may well play a natural complementary role with fire in spruce succession (Uchytil 1991).

Human impact on the forest has varied and those which came later have masked early impacts. Thirty-one large fires have burned within the watershed totaling 9530 acres with 168 fires; all were human caused. Fire occurrence data from 1933 to 2002 (69 years) shows a 199 fires recorded, totaling 9600 acres burned within the watershed with an average of 139 acres burned per year over time. The majority of fire starts are small fires under .1 acre in size along the travel corridors.

The increased use of travel corridors by visiting forest users may cause an increased risk of fire starts. Within the corridor, wind driven fires could spread to the Moose Pass community and other wildland urban interface communities. For the most part the corridor is private; state controlled or Alaska Railroad lands. As for backcountry recreation, there is supporting data that clearly shows some fires caused by humans but not to the extent of the main travel corridors. The risk is present within the dead spruce, heavy down fuel accumulation and grass micro-sites.

4.6 Aquatic Species and Habitats

Trail River is predominately a pristine watershed where natural processes dominate the landscape. Stream fishing is rare in this watershed with lake fishing the main attraction for anglers. No sport fishery issues are present due to regulatory prohibitions on salmon fishing in the area. Since salmon fishing has been prohibited in the waters above the Lake outlet to Kenai Lake, anglers have not degraded the riparian area by trampling at access points or along stream banks. Since no established trails exist to the upper reaches of Trail Creek, it is inaccessible to anglers. The turbid glacier waters and dense valley-bottom vegetation make sport fishing very difficult for resident fish, which is allowed in the upper Kenai Drainage.

4.6.1 Streams in Trail River Watershed

Trail River is two miles long and located between Lower Trail Lake and Kenai Lake. This reach has some in-channel spawning habitat but is predominately a travel corridor for fish to the upper Trail Creek Drainage.

Trail Creek is in the northern portion of the watershed. It has turbid glacial water with many braided channels, sloughs, and side channels that provide ample fish habitat for all species of Salmon except chum. The clear-water side channels that flow from the steep hillsides at the lower reaches of Trail Creek, namely Johnson Creek and other unnamed tributaries, provide most of the spawning habitat in the drainage. . On the floodplain, the channels are very dynamic and locations suitable for spawning change from year to year. Salmon have been documented up to the Hunter Wye.

Moose Creek flows into the western corner of Upper Trail Lake. This stream is approximately 3 miles long and provides ample spawning habitat for sockeye salmon. A primitive fish-viewing platform is on the stream and is accessed by a trail at the pullout along the Seward Highway near the Trail Lake Hatchery. The outlet stream from Carter Lake flows into Moose Creek.

Johnson Creek is five miles long and flows from Johnson Lake into Upper Trail Lake. The lower two miles are sockeye spawning and coho rearing habitat. Two other unnamed streams with similar salmon habitat are within two miles of Johnson Creek. Both of these streams flow into the northern end of Upper Trail Lake and are only used by salmon in the lower half mile of stream, before the gradient picks up and limits fish access to the upper reaches of these channels.

Grant Creek is the outlet stream of Grant Lake. King, sockeye and coho are known to use this stream for rearing up to the barrier falls below the Grant Lake outlet in a very deep confined gorge.

Falls Creek has rearing habitat for king salmon the lower mile of steam before flowing into Trail River.

Carter Creek is the outlet stream for Carter Lake. Sockeye use this stream for spawning in a very short section before the stream climbs up almost 1000 feet in one half mile to Carter Lake.

4.6.2 Lakes in Trail Creek Watershed

The following lakes area described by the Alaska Department of Fish and Game stocked lake website, (ADFG 2005a).

Carter Lake

Description

Carter Lake is a 47.9 acre lake and sits at 1486 feet elevation. The lake is flanked between mountains on its north and south sides and drains roughly 1438 acres. The maximum depth of the lake is 60 feet, has a shore length of 2,625 yards, and a shoreline development of 1.4 (USDA 1987). Vegetation surrounding the lake is sub-alpine. The outlet of the lake has a moderate gradient for the initial 1312 feet. then begins a steep descent. Approximately 492 feet down stream of the lake is a pool with limited spawning potential due too high turbidity (USDA 1987). Carter Lake has a number of small outlets and two small streams on the northwest and northeast sides of the lake respectively (USDA 1987).
Carter Lake is accessible via a 3.5 miles trail from the Carter Lake trailhead at mile 34 of the Seward Hwy.

Fish Species

Rainbow trout

Stocking

Carter Lake is currently part of the ADF&G stocking program (2005a). The lake is stocked with rainbow trout on even years. The lake was stocked initially in 1963 with arctic grayling, which were unsuccessful. The lake has been stocked on a regular basis with rainbow trout since 1976.

History/Surveys

Gill net surveys, fyke net, and minnow trap surveys were conducted on Carter Lake in 1975, 1991, and 2003. In 1975, a fish habitat survey was carried out to assess the limnological characteristics and fishery potential in order to determine the management actions that should be taken to increase the recreational fishery. The 1975 minnow trap and gillnet surveys found no presence of grayling from the 1963 stocking. Adequate sized spawning gravel was observed at the outlet stream (USDA 1975). Water quality data and limnological measurements were taken in 1970 and 1975. Bathymetric maps were generated of the lake (appendix a). Benthic samples and plankton tows collected a variety of aquatic invertebrates including caddis fly larvae (average abundance), blackfly larvae (low abundance), mosquito larvae (low abundance), ammarus (abundant), and midge larva (low abundance) (USDA 1975). The 1976 survey concluded that the lake would support a good recreational rainbow trout sport fishery and would be a good ice fishing location for winter users. A trickle dam (21 x 1 x 1 m) retainment structure was built in 1976, 437 yards downstream from the outlet (USFS 1987a). This structure is scheduled to be replaced in 2006, since the trickle dam is not retaining fry in the lake.

ADF&G conducted creel surveys at Carter Lake in 1964 on two separate days and surveyed fourteen anglers who caught 33 arctic grayling. ADF&G State Wide Harvest Survey (SWHS) conducted from 1985-2004 reported 592 responses from anglers fishing Carter Lake. Carter Lake ranked within the top 10 of the most popular lakes for fishing on the Seward Ranger District based on the ADF&G SWHS results. In addition, angler surveys were carried out using voluntary survey questionnaires in 1991. Between 1993 and 2001, an average of 1093 people registered at the Carter Lake trailhead annually, about 40% of the summer use register. Most of the use occurred in the summer. There is some winter use by skiers, snow machine riders, and ice fishers.

Several skiers signed the registration; however, no snow machine users registered. In 1997, 12% of the users were related to fishing recreation. In 1998, 23% declared fishing as the primary recreational activity (O'Leary 2002).

Grant Lake

Description

Grant Lake is a 1606 acre lake which sits at 699 feet above sea level and is part of the Kenai River drainage. The glacial fed lake has an upper and lower basin separated by a narrow isthmus, which contains a small island. The lake drains 43.5 square miles and has a volume of 622,954 acres/yd. The lake reaches maximum depths of 95 feet and averages 43 feet. Grant Creek is the lake outlet (average 190.7 ft^3s) and has a 59 foot falls, which prevents upstream migration of fish to the lake. The glacial influence in the lake reduces light penetration to 2.3 feet. Grant Lake lies in a Fish and Wildlife Recreation Management Area prescription directed by the Chugach National Forest Plan. A portion of the southwestern basin lies on State of Alaska land.

Fish Species

Threespine stickleback, slimy sculpin (*Cottus cognatus*), dolly varden, and rainbow trout are found in Grant Creek. Coho salmon stocked in the 1980's but probably no longer persist in the lake.

Stocking

Coho salmon were introduced from 1983-1986 as an attempt to provide coho salmon for recreational, commercial, and subsistence fisheries in Cook Inlet and Kenai River drainage.

History/Surveys

A number of studies have been conducted on Grant Lake by several agencies dating as far back as 1948. Studies focused on limnology, stream discharges, biological sampling, stocking, and hydropower feasibility. The U.S. Geological Survey (USGS) Surface Waters Branch gauged stream flows from 1948 to 1958 on Grant Creek, water quality analysis in 1950-1956, and suspended sediment analysis in 1967 and 1974 (ADFG 2005). U.S. Fish and Wildlife Service (USFWS) monitored water quality in the lake in 1960 and in cooperation with ADF&G in 1981 (ADFG 2005). The study focus of the 1950's and 1960's was to locate a feasible hydroelectric project on the Kenai Peninsula (Marcuson, 1989). In 1960 a preliminary permit was given to the Chugach Electric Association of Anchorage, Alaska for a proposed power commission project to be located on Ptarmigan and Grant Lakes in July 1960 (Pautzke, 1961). The power commission project was to be located on Ptarmigan and Grant Lakes (Pautzke, 1961). The proposed plan intended to divert water from Ptarmigan and Grant Lakes and Falls Creek to a common power house located on Lower Trail Lake (Pautzke, 1961). The plan included a 98 ft x 984 ft dam at Grant Lake and a dam at Ptarmigan Lake outlet (Pautzke, 1961). Cooper Lake was selected as the location for the hydroelectric project and no action was taken on this permit.

A cooperative coho salmon stocking program managed by USFS, ADF&G and Cook Inlet Aquaculture association (CIAA) was carried out from 1982-1988. The objective of the project was to provide coho salmon for recreational, commercial, and subsistence fisheries in Cook Inlet and the Kenai River drainage (Marcuson, 1989). USFS collected limnology data and enumerated smolt. ADF&G stocked fry and analyzed the limnology data. Cook Inlet Aquaculture Association evaluated the number of returning adult coho salmon (Marcuson, 1989).

An inclined plane trap was operated to enumerate out-migrating smolt at the outlet of Grant Lake in the fall 1983-1984 (Marcuson, 1989). The lower lake basin was the most productive water for coho rearing as a result of high food availability, and less glacial influence. A total of 3750 coho returned to Grant Creek (Marcuson, 1989). Twelve adult coho with coded wire tags returned to Grant Creek of the 798 coho tagged (Marcuson, 1986).

In 1984, the USFS and ADF&G received comments from concerned citizens regarding the stocking of salmon fry in Grant Lake. The public was worried about genetic problems and competition with native species (Rudnick, 1984).

ADF&G collected water quality data from 1992 and 1993. In addition ADF&G surveyed macrozooplankton in 1992 and generated a bathymetric map (ADFG unknown).

In 2004 USFS surveyed the lake and tributaries for fish presence and only found sticklebacks and sculpin. Numerous beaver ponds and dams exist at the inlet.

Johnson Lake

Description

Johnson Lake is 43 acres and sits at 1348 ft above sea level and drains 200-299 acres.
Johnson Lake is part of the Trail Lake watershed and drains into Johnson Creek. The lake lies south of Johnson Pass and is bordered by mountains on the east and west sides. The vegetation surrounding the lake is alpine with spruce, willow, and alder communities (Winter and Williams 1992). There is one inlet on the northwest side of the lake (4.9 - 9.9 ft^3s), one on the southwest side (1.1 - 4.9 ft^3s). Johnson Creek is the only outlet (9.9 - 20.1 ft^3s) and lies on the south end of the lake. A series of impassable falls lies 1.8-3.1 miles downstream of the outlet. Roughly 1.6 miles of good spawning gravel exists in the Johnson Creek between the lake and the falls (USDA 1987). A survey in 1992 reported a beaver dam at the lake outlet, which may prevent rainbow trout from passing into the creek. Johnson Lake lies in a Backcountry Management Area prescription directed by the Chugach National Forest Plan.

Fish Species

Rainbow trout and sculpin inhabit the lake.

Access

The lake is assessable by the Johnson Pass Trail. It is 8 miles to the south Johnson Pass trailhead and 9.9 miles to the north trailhead.

Stocking

Stocked with rainbow trout in 1963 and 1985.

History/Surveys

Gill net surveys were conducted on Johnson Lake in 1970, 1988, 1990, 1992 and minnow trapped in 1992. The 1987 survey report suggested that the rainbow trout population may be experiencing limited growth due to overstocking (USDA 1987). The 1992 survey report concluded that Johnson Lake is a successful fishery and the presence of juvenile rainbow trout in the sample indicates that reproduction is taking place in the lake (Winter and Williams 1992). A bathymetric map was generated of the lake (ADFG unknown). ADF&G surveyed invertebrates in 1970 and reported Planarians, Insects (caddis flies, mayflies, and stoneflies), freshwater shrimp (gammarus), snails, and clams.

ADF&G State Wide Harvest Survey (SWHS) conducted from 1985-2004 received 4882 responses from anglers fishing at Johnson Lake. Johnson Lake is the second most popular lake for fishing on the Seward Ranger District based on the ADF&G SWHS responses.

Trail Lake (Lower)

Description
Upper and Lower Trail lakes are connected by a narrow body of water located at the north end of Lower Trail Lake Lower Trail Lake is 274 acres and sits 1270 ft above sea level. The lake volume is 845 ha/m**.** The maximum depth is 42 ft and averages 25 ft. Upper Trail Lake and Grant Creek flow into the northern tip of the lake. Trail Creek flows out of the south end of the lake. The lake lies on State of Alaska land.

Fish Species
Dolly Varden, lake trout, round white fish, coho salmon, king salmon, and sockeye salmon inhabit the lake.

Access
Upper Trail Lake is accessible by boat and road from the Seward Hwy.

History/Surveys
ADF&G generated a bathymetric map of the lake (appendix A). The ADF&G State Wide Harvest Survey (SWHS) conducted from 1985-2004 received 239 responses from anglers fishing at Lower Trail Lake (table 5). Lower Trail Lake ranked the top 20 most popular lakes for fishing on the Seward Ranger District vicinity based on the ADF&G SWHS responses.

Trail Lake (Upper)

Description
Upper and Lower Trail lakes are connected by a narrow body of water located at the south end of Upper Trail Lake. Upper Trail Lake is 1754 acres and sits at 472 ft above sea level. The maximum depth of the lake is 146 ft, averaging 53.8 ft. The volume of the lake is 11,648 ha/m. Trail Creek, Railroad Creek, and Johnson Creek all flow into the lake at the upper northeast section of the lake. B & W Creek flows into the north side and Moose Creek flows into the west side near the Trail Lakes Hatchery. A permanent outlet structure built in 1982; lies on the southern end of the lake. The northeast tip of Upper Trail Lake lies in a brown Bear Core Area Management Area

directed by the Chugach National Forest Plan. The remaining portions of the lake lie on State of Alaska land.

Fish Species
Dolly Varden, lake trout, round white fish, coho salmon, king salmon, sockeye salmon.

Access
Upper Trail Lake is located on the Seward Hwy. It is also accessible from the Johnson Pass Trail and boat.

History/Surveys
ADF&G collected water quality data 1979, 1980, 1985, and 1986 (ADFG unknown). Chlorophyll a and phaeophytin data was collected in1980 (ADFG unknown). In addition, ADF&G generated a bathymetric map of the lake ((ADFG unknown).

The ADF&G State Wide Harvest Survey (SWHS) conducted from 1985-2004 received 190 responses from anglers fishing at Upper Trail Lake. Anglers reported good fishing within the narrow water body, which adjoins the two lakes.

Vagt Lake

Description
Vagt Lake is located east of Lower Trail Lake and sits 482 ft above sea level. The outlet stream on the southwest side flows into Lower Trail Lake. A trickle dam is located approximately 50 ft downstream of the outlet in a gorge. An inlet enters the lake on the southeast side. The lake is located on State of Alaska land.

Fish Species
Rainbow trout inhabit the lake.

Access
The lake is accessible by trail.

Stocking
Vagt Lake is part of the current ADFG stocking program and is stocked with rainbow trout annually. The lake was stocked with arctic grayling in 1963 and stocked regularly with rainbow trout since 1974.

History/Surveys
Vagt Lake was within a USFS land selection that was transferred to the state in 1980’s. In 1973, a rotenone treatment was carried out to remove the native Dolly Varden species from the lake. Rainbow trout and shrimp were stocked following the treatment.

The ADF&G State Wide Harvest Survey (SWHS) conducted from 1985-2004 received 1070 responses from anglers fishing at Vagt Lake. Vagt Lake ranked as the fifth most popular lake for fishing in the Seward Ranger District vicinity based on the ADF&G SWHS responses.

4.7 Terrestrial Species and Habitats

4.7.1 Terrestrial species

The diverse mosaic of habitat types within the Trail River Watershed supports an array of large game and other non-game animals. Table 4.2 lists the existing and potential habitat for important species within the watershed. Potential habitat provides suitable habitat characteristics, although it is currently not known to be occupied by the species.

Table 4.2. Threatened and Endangered Species (TES), Management Indicator Species (MIS), and Species of Special Interest (SSI) habitat of the Trail River Watershed.

SPECIES	MIS	TES	SSI	EXISTING HABITAT	POTENTIAL HABITAT
Osprey (Sensitive)		X		No	Yes
Trumpeter Swan (Sensitive)		X		Yes	Yes
Brown Bear	X			Yes	Yes
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	Yes	Yes
Wolverine			X	Unknown	Yes
Bald Eagle			X	Yes	Yes
Northern Goshawk			X	Yes	Yes

Sensitive Species

Trumpeter Swans

Potential habitat for trumpeter is displayed in Figure 4.10. Habitat characteristics include smaller lakes and ponds less and PA1 channel type streams. Potential high quality habitat occurs in the Trail River valley upstream of Upper Trail Lake in the main Trail Creek valley bottom.

Potential nesting habitat was surveyed in 2004, 2005 and 2006 at the beginning and end of the breeding season to determine occupancy and reproduction. A single swan was seen during the spring survey in 2004 approximately 3.5 miles upstream of the outlet of Trail Creek into Upper Trail Lake, and a pair was seen during the fall survey 2 miles downstream of the pair seen in the spring. During the 2005 spring survey, one pair was seen in Trail Creek approximately 5.5 miles upstream of Upper Trail Lake. In the fall, a pair was seen within 0.5 miles of the inlet of Upper Trail Lake. In spring of 2006, a single adult was seen within 0.5 miles of Upper Trail Lake inlet near where a swan was observed in the fall of 2005. A pair of adults was seen in the spring approximately 2 miles upstream of the inlet to Upper Trail Lake, and in the fall, a pair of swans was seen approximately 3.3 miles upstream of Upper Trail Lake. No nests or cygnets were observed during surveys.

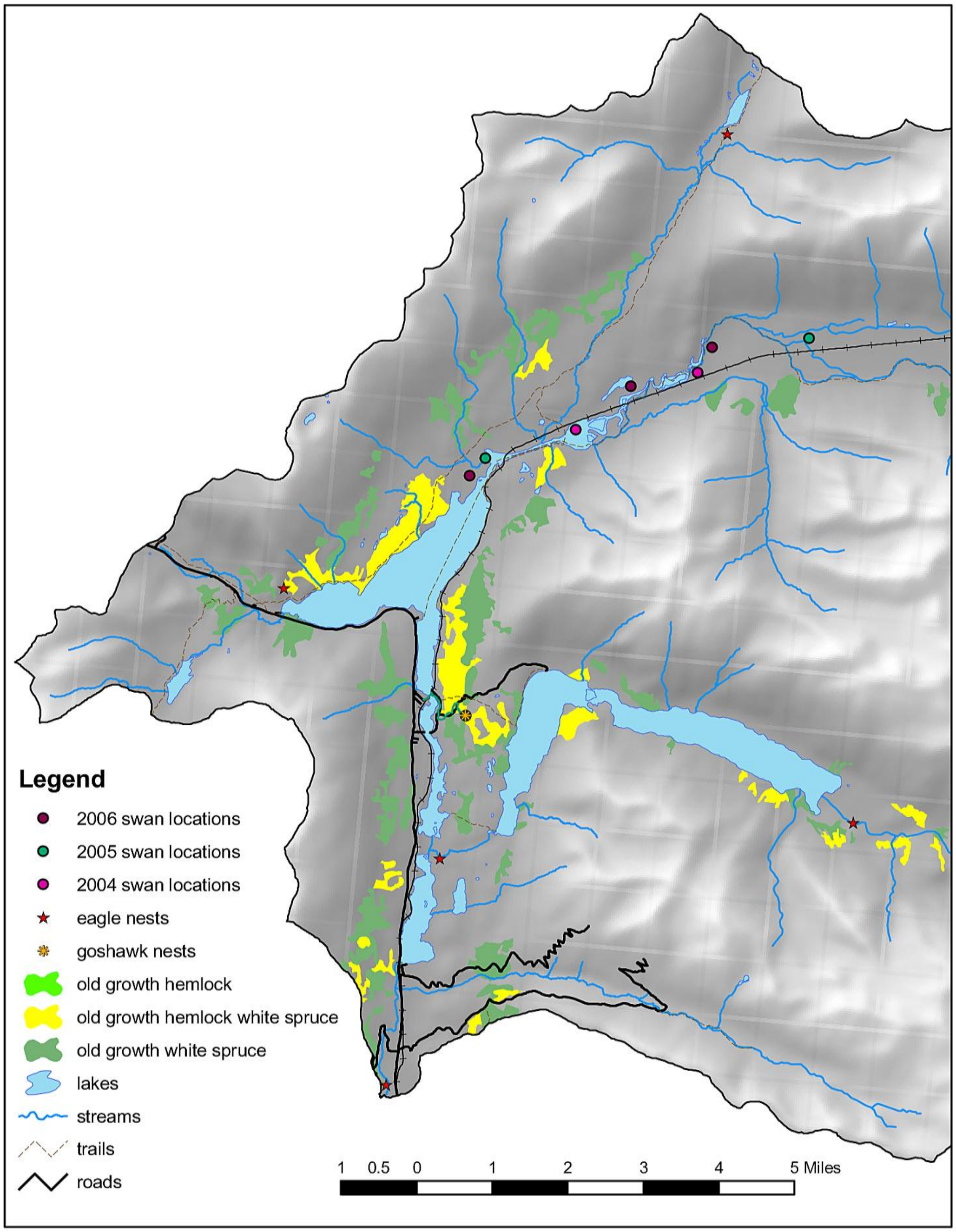

Figure 4.10. Trumpeter Swan, Bald Eagle and Northern Goshawk nests and potential nesting habitat in the Trail River Watershed.

Osprey

The osprey (*Pandion haliaeetus*) is a Region 10 sensitive species. It is uncommon to rare throughout Alaska (Palmer, 1988). The osprey is widely distributed across much of Alaska south of the Brooks Range, but localized near 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 Trail River Watershed, but potential nesting and foraging habitat do occur near Trail Lakes and Trail River. Osprey may travel through the area during spring and fall migrations, but they are not winter residents.

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 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). Moose mortality also occurs due to collisions with trains. 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 comprises 37,479 acres within the watershed. High quality habitat is primarily in riparian areas along the river valleys, but is distributed throughout the watershed on all but the highest elevations. Winter habitat for moose comprises approximately 3789 acres south of Upper Trail Lake along the valley bottom (CNF GIS data). This data will be updated with new data being collected in partnership with ADFG on moose habitat and movements, using GPS collared animals. 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. Moose winter range is displayed in Figure 4.10.

A recent vegetation map developed by the Kenai Peninsula Borough indicates the distribution of hardwoods in the watershed (see section on wildlife habitat). Early seral hardwoods currently exist on 28% of the hardwood acres, which may provide browse for 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 9594 acres within the watershed (See Figure 4.11).

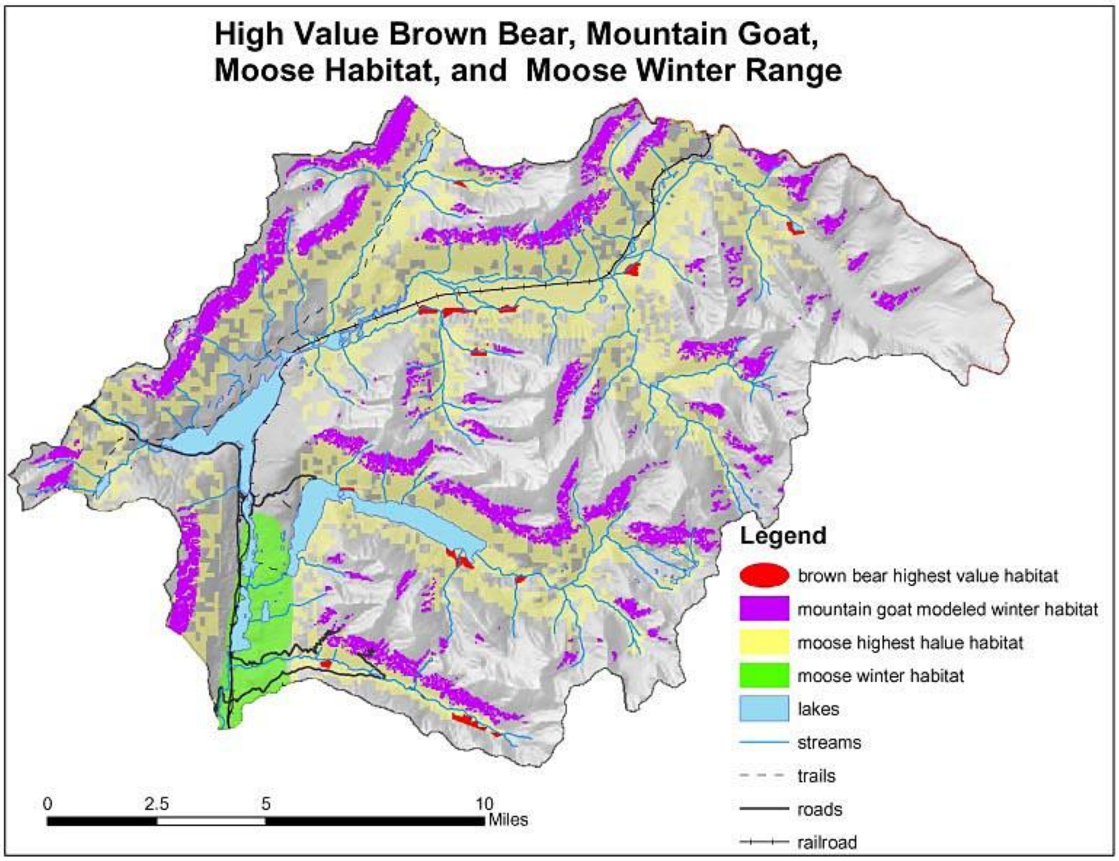

Figure 4.11. High Value Brown Bear, Moose Winter Range, and Mountain Goat Habitat in the Trail River Watershed

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.

Brown bear core exists on 16,143 acres surrounding Trail River and near Carter Lake. The watershed contains 1,540 acres of low value brown bear habitat, 80,939 acres of moderate value habitat and 425 acres of high value habitat (USDA 2001, see Figure 4.11) 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 people. Several encounters have occurred at salmon streams resulting in injury to humans and injury or death to brown bears. Brown bears use areas along Trail Creek above Upper Trail Lake during salmon runs. The best potential denning habitat is identified from a denning habitat model developed by Goldstein et al. (in preparation). This model predicts the probability of denning across the landscape. Habitat with the highest probability of being denning habitat (80 – 100%) occurs in purple in Figure 4.12, on 134,897 acres. Habitat with 60-80% probability is displayed in green. Potential denning habitat is abundant and well distributed on steep slopes. Habitat most likely to be used by females with cubs after den emergence, which are important foraging areas occur on approximately 416 acres primarily within the core area (not displayed).

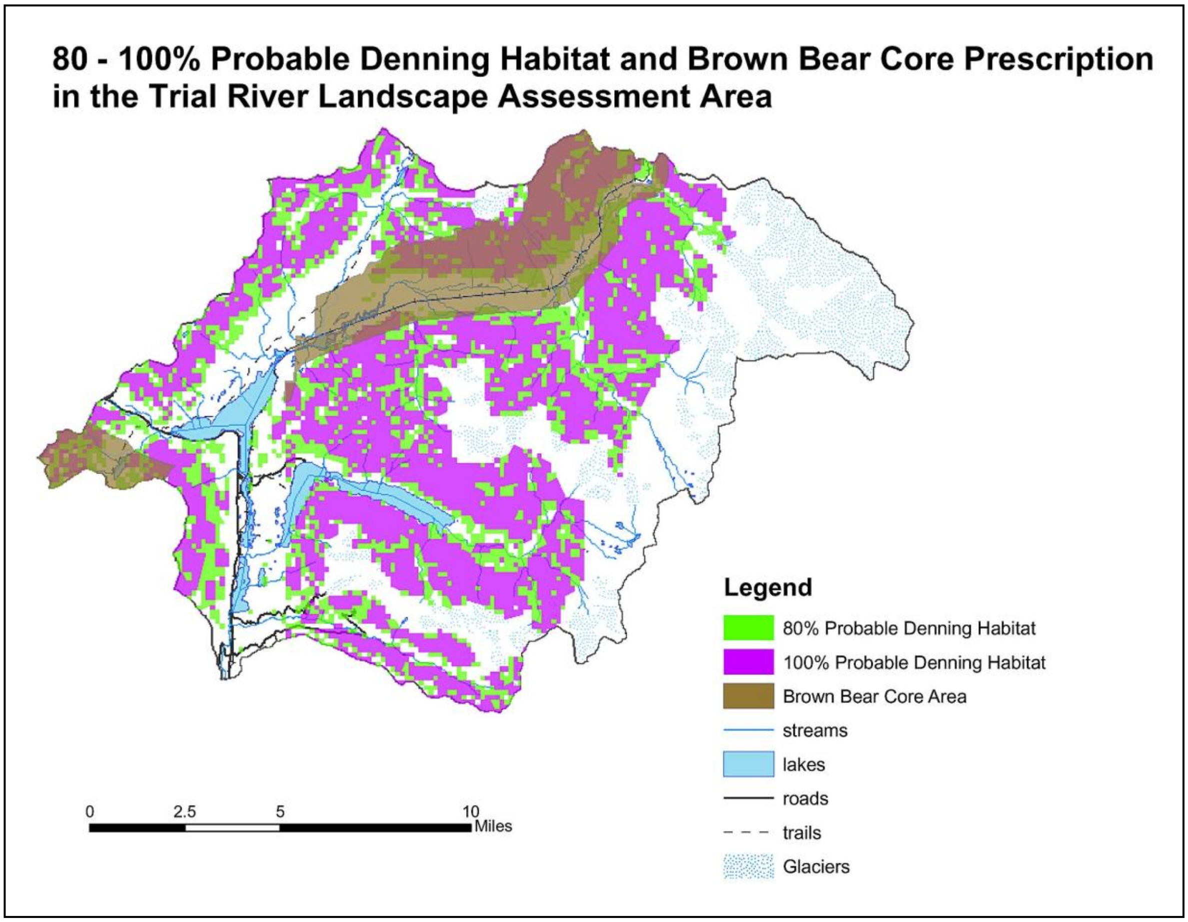

Figure 4.12. Brown Bear Modeled Denning Habitat

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. Approximately 80 % 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 known bald eagle nests in the watershed, one near the outlet of Trail Creek near Kenai Lake, one between Lower and Upper Trail Lake, one at the east end of Grant Lake, and one near the Trail River Hatchery at the northwest end of Trail Lake (Figure 4.9). 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.

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. 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. Aerial track surveys conducted by ADFG in 2004 (Golden 2004) resulted in two track groups identified north of the watershed. Past surveys in 1992 (Golden et al. 1993) noted tracks throughout the watershed. Surveys were not conducted in 2005 or 2006 due to lack of adequate survey conditions, but potential habitat exists in the watershed for foraging and denning.

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 is one known northern goshawk nest located within the Trail River Watershed, but more likely occur. Potential habitat exists in mature hemlock and hemlock-spruce forests with large trees within the watershed (Figure 4.9). No suitable nesting habitat exists along Trail River, as determined by aerial surveys in 2005 for the Whistlestop project. Few surveys have been conducted to determine if goshawks are present and breeding in the remainder of the watershed, except adjacent to Grant Lake Trail. A goshawk was sighted in September 2007 in the Moose Pass 7A project, showing that goshawks use the area for foraging.

The majority of mature hemlock and spruce stands are in the western portion of the watershed along the highway and the river. There are also some stands of old growth spruce in the Johnson Creek drainage, Trail Creek drainage, and a small amount of old growth hemlock and spruce on the east end of Grant Lake (figure 4.6). The spruce bark beetle has affected approximately 95% of large conifer trees. Some of these stands may provide nesting or foraging habitat, but the bark beetle is likely reducing the value of these stands for goshawk nesting habitat as the canopy becomes more open.

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 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 Trail River Watershed are lacking, but local residents report seeing them (personal communication with Mark Kromrey, 2007).

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). Cyclic changes in snowshoe hare and other small mammal populations (Poole, 1994) influence the production and survival of lynx kittens dramatically. 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 Trail 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 have not been conducted in the watershed. Murrelets may mature or old growth conifers for nesting, although many of the large spruce have been affected by the spruce bark beetle. Murrelets potentially nest in the Victor Creek area near the southern boundary of the watershed, so habitat may exist within the watershed. The majority of the watershed is within 30 miles of the coast, a distance which murrelets are known to travel inland for nesting.

Townsend's Warbler

Townsend's warblers are found throughout forested locations on the Seward Ranger District. 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 one point count route within the watershed. Surveys on this route have been conducted since 1994. The route traverses through a hemlock spruce forest along the northwest shore of Upper Trail Lake, but includes small sections of hardwoods. Townsend's warblers have been identified during surveys 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).

Townsend's warbler habitat likely occurs throughout forested sections of this watershed, in mature 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 two 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). One pack of wolves uses the Trail River Watershed (personal communication Ted Spraker, ADFG, 2001, and Grant Harris, USFS, 2007).

4.7.2 Vegetation and Wildlife Habitat

Existing Condition

Data on existing vegetation structure is available from two sources. Chugach National Forest GIS data on cover types and timber types is 30-60 years old (See Figure 4.13). Recent mapping work by the Kenai Peninsula Borough (KPB-2007), using Ikonus imagery provides more up to date information (See Figure 4.14). The KPB cover classes describing small, medium, and large trees are described in Appendix C. To compare that data that lists three structures to the TIMTYPE data, which lists four structures, I combined the TIMTYPE pole timber and young growth saw timber classes together to correspond to the borough's medium or pole timber size. I considered TIMTYPE data that is seedling/sapling to correspond with the borough seedling/sapling size. I considered the TIMTYPE old-growth saw timber to correspond to the borough's large size class.

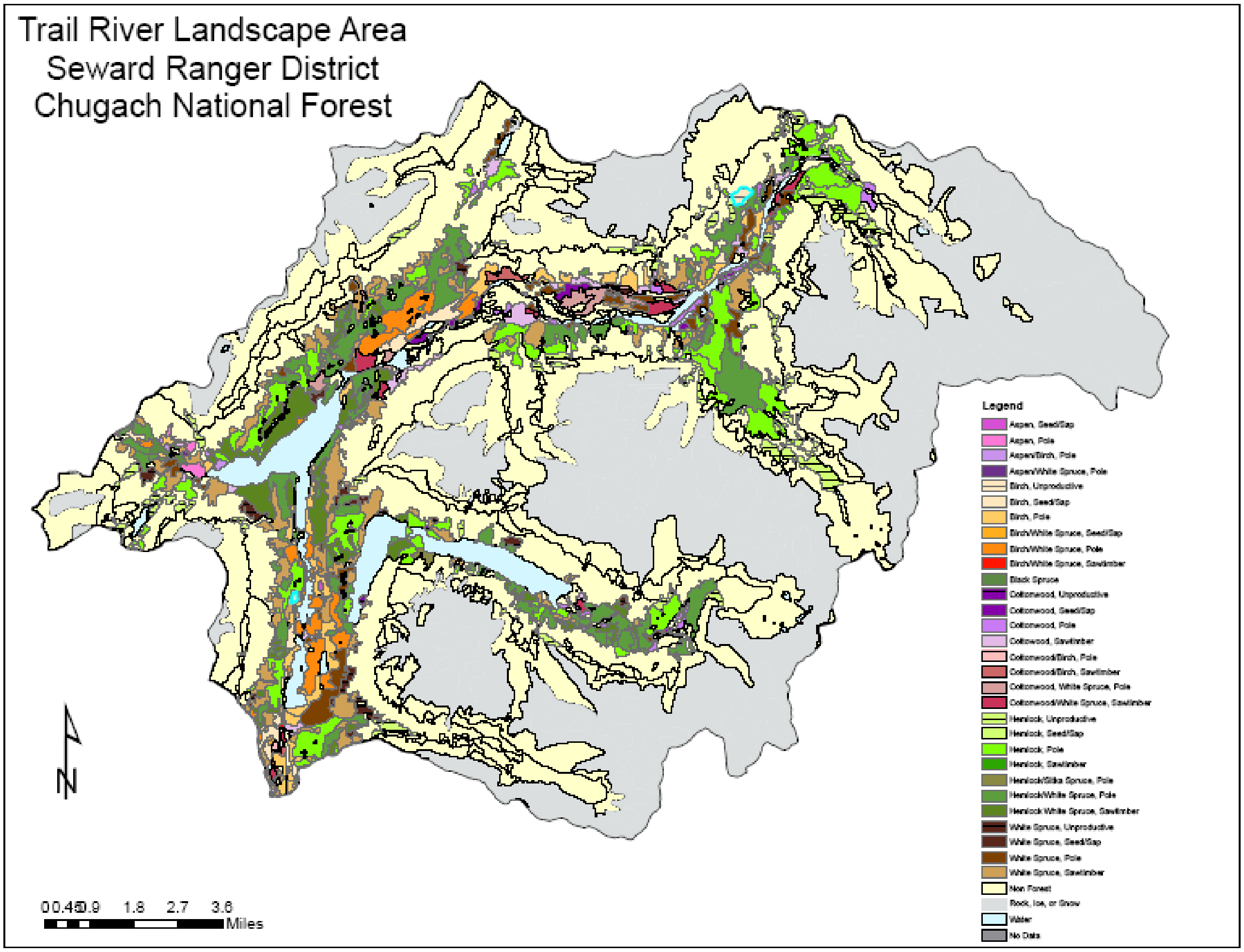

Figure 4.13. Vegetation Composition and Structure from TIMTYPE Data (30-60 years old)

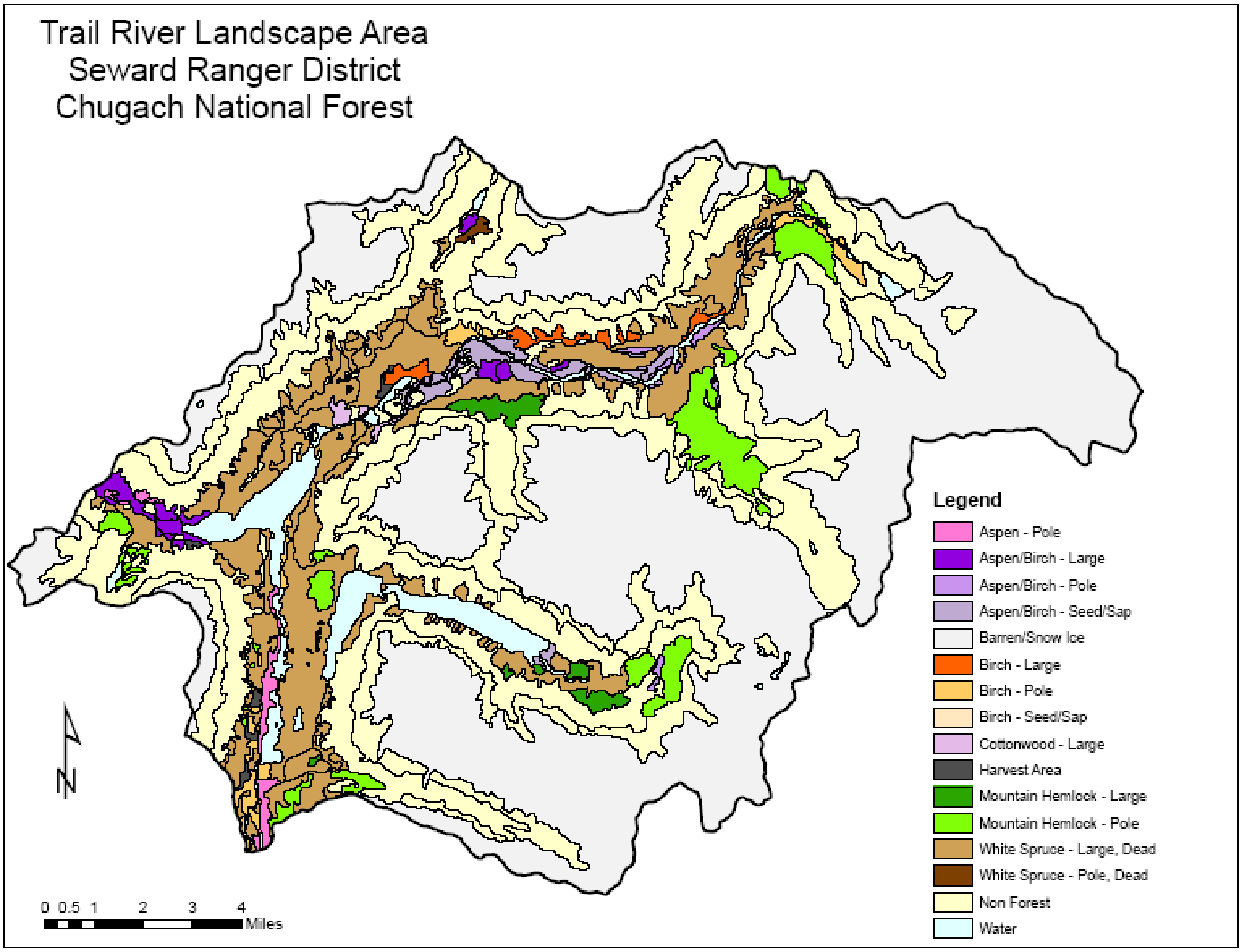

Figure 4.14. Vegetation Composition and Structure from Recent IKONUS Imagery

Table 4.3. Percent of Small, Medium and Large Hardwoods from Two Data Sources.

Hardwoods	Previous Condition (30-60 years ago) from TIMTYPE Data	Existing Condition from Recent Ikonus Imagery
Small (Seedling/Saplings)	1%	28
Medium (Pole Size and young saw timber)	77%	38
Large (mature, old growth)	10%	34

Table 4.4 Percent of Small, Medium and Large Conifers from Two Data Sources.

Conifers	Previous Condition (30-60 years ago) from TIMTYPE Data	Existing Condition from Recent Ikonus Imagery
Small (Seedling/Saplings)	3%	1%
Medium (Pole Size and young saw timber)	73%	19%
Large (mature, old growth)	2%	80%

Obviously, the data shows significant differences in structure, but also paints an interesting picture of changes over time (see Synthesis Section). While some differences are likely due to classification errors and different classification methods, some trends are apparent. Considering the more recent data, the wildlife habitat in hardwoods is a diverse mixture of size classes, with the majority of hardwoods in the mid size class.

Wildlife habitat in conifers is primarily available in the large size classes, mainly in large conifers. Unfortunately, 95% (15218 acres) of these stands are predominantly dead or dying due to the spruce bark beetle. The only stands not affected are large mountain hemlock. Habitat for species that prefer large or old growth conifers or denser canopies is unraveling as large trees die, canopies open, fire risk increases.

4.8 Human Uses

4.8.1 Human Uses: Past

Much of the area of the Trail River Watershed remains un-inventoried for cultural resources. The majority of the area shows 40% slope or higher, it can be deduced that the main loci of unknown archaeological sites would be in the lower valleys. Knowledge of the current range, distribution and condition of cultural resources is dependant 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 the private sector archaeological contracts for various CNF projects.

Presently there are 36 archeological sites listed on the Alaska Heritage Resource Survey database (2004) that lie in the landscape area with a majority of these sites located near major waterways. The known sites in this area are almost entirely from the historic period, and are concentrated where the archeological surveys have occurred. Although these areas have been surveyed, further investigations need to be completed through the remaining corridor, slope permitting. As defined in our PA with the State Historical Preservation Office, high sensitivity zones are defined as the following:

a. River valleys, lake and river systems providing passes or portages across larger land masses
b. Lake and stream systems containing, or known to have contained, anadromous fish runs; including a focus on barrier falls locations in such systems
c. Area of former lode and placer mining activity
d. Elevated/ fossil marine, river or lake terraces
e. Cave and rock shelters
f. Other areas identified through historical, ethnographic or oral history research/sources.

The sites listed in this landscape analysis are those known now. Research and future field investigations could potentially reveal additional cultural resources. Many known and new sites may become eligible for the National Register as they reach the 50-year mark and will require formal evaluation.

Sites of greatest importance to the focus area include the Johnson Pass Military Road (Johnson Pass Trail), numerous sites associated with the development of transportation via the Alaska Railroad, and areas of heavy mining such as Case, Crown Point and Falls Creek Mines (Table 4.5).

Table 4.5 Sites associated with development via the Alaska Railroad and heavy mining areas.

SITE NUMBER	NAME
FS 127	Johnson Lake Mailcamp
FS 111	Old Mail Camp #1
FS 107	Moose Pass Cabin #1
SEW 17	Grandview Roadhouse
SEW 21	Trail Lake R.R. Station
SEW 93	Hunter Roadhouse
SEW 99	Grandview
SEW 140	Crown Point Mine Trail
SEW 141	Falls Creek Mine Trail
SEW 148	Seward-Moose Pass Trail [Inht-Pt]
SEW 155	Brosius Cabin
SEW 156	Sew-00156
SEW 162	Falls Creek Mine
SEW 192	Crown Point Mine
SEW 251	Moose Pass-Portage [Inht-Pt]
SEW 252	Snoring Inn
SEW 285	Solars Sawmill
SEW 290	Sluice
SEW 366	Johnson Pass Military Road [Inht-Ct]
SEW 410	Madson Cabin
SEW 415	Sew-00415
SEW 567	Johnson Trail Cabins
SEW 573	Moose Pass Military Road [Inht-Ct]
SEW 592	Moose Pass Inn
SEW 601	Warburton's Cottage
SEW 659	Case Mine (Grant Lake Placer Mine)
SEW 678	Upper Trail Lake Garage
SEW 679	Crown Point Cache Pit
SEW 775	Hunter Habitation #2
SEW 776	Hunter Habitation #1
SEW 823	North Grant Lake Cabin
SEW 869	Falls Creek Camp
SEW 1006	East Point Mine (Fs#602)
SEW 1047	Mills Creek Trail
SEW 1062	Fall Creek Mining District
SEW 1068	Akrr Telegraph Line

4.8.2 Human Uses: Present

In comparison with other areas on the Seward Ranger District, recreation use is low in the Trail River Assessment Area and dependent on weather conditions. The ruggedness of the watershed and the lack of access to most of the eastern portion of the watershed play a big role in this determination. Recreation in the watershed is concentrated along established routes (the highway, trails, and waterways) during both summer and winter use seasons. These routes lie in valley bottoms and across bodies of water. The exception to this is winter helicopter supported skiing that occurs in the mountainous areas. There are only two developed recreation sites within the watershed – Johnson Pass South Trailhead and Carter Lake Trailhead. The recreation in the area is largely dispersed.

Use figures for two trailheads in the assessment area support the assertion that recreation use is low in the watershed. Carter Lake and Johnson Pass South register counts for the past five years are described in Table 4.6. There are problems with capturing accurate use figures across all user groups as not all users register. Typically, horseback riders, bicyclists and snowmachiners do not register at Forest Service trailheads. However, it can be assumed that the same number and types of users register across the district. Comparing trailhead register figures at Carter Lake and Johnson Pass South with other trailhead figures indicates that Johnson South is among the lowest used trailheads and Carter Lake is moderately used on the Seward Ranger District (Table 4.4). High use areas on the Seward District have over 1500 users registering annually at trailheads. Further, these areas also have developed recreation opportunities such as campgrounds and cabins. A high use area on the Seward Ranger District can be found in the Russian River Watershed.

Table 4.6 Trailhead figures for Johnson Pass and Carter Lake.

	2001	2002	2003	2004	2005
Johnson Pass – South TH	**311**	**258**	**434**	**302**	**360**
Carter Lake	**585**	**879**	**980**	**914**	**714**

4.8.2.1 Trails

Within the Trail River Assessment Area, there are four recognized Forest Service trails or portions of trails, one State managed trail, three mining roads that are used for hiking (of which, two are used for ATV riding), three winter routes and one water route (Table 4.7).

Table 4.7 Trails, Routes and Roads in the Trail River Assessment Area

Recreation Trails	Length in the Trail River Watershed
Johnson Pass Trail	13 miles
Carter Lake Trail	3.1 miles
Grant Lake Portage Trail	1.1 miles
Ptarmigan Creek Cut Off Trail	0.2 miles
Vagt Lake Trail	1.9 miles
Crown Point Mine Road (aka Crown Point ATV Trail)	4.2 miles
Grant Lake Mine Road (aka Grant Lake Trail)	2.6 miles
Falls Creek Mine Road (aka Falls Creek ORV Trail)	5.7 miles
Moose Pass Cooper Landing Winter Route	2.0 miles
Johnson Creek Winter Route	4.2 miles
Trail Glacier Winter Route	11.2 miles
Trail Creek Water Route	8.1 miles

Johnson Pass Trail
The Johnson Pass Trail is a 23-mile point-to-point backcountry opportunity for Chugach National Forest visitors of which 13 miles are located in the Trail River Watershed. The trail is popular with bicyclists as well as hikers. The Johnson Pass South Trailhead is located at Milepost 32.5, near the western point of Upper Trail Lake. The trailhead has a paved parking lot (eight vehicle capacity), bulletin board, trail register and vault toilet. Winter users access the Johnson Pass Trail by parking at the Moose Pass Community Hall, Moose Pass School, and Trail Lake Lodge, by crossing Upper Trail Lake to the Johnson Creek Winter Route. The southern section of the Johnson Pass trail is lightly used in the summer compared to other trails on the Seward Ranger District.

Carter Lake Trail
This moderately popular trail has a three acre site easement at the trailhead. The Carter Lake Trailhead is located at Milepost 34 and sports a paved parking lot (ten vehicle capacity), bulletin board, trail register and vault toilet. The trailhead is plowed during the winter and overflow vehicles sometimes park at the Johnson Pass South Trailhead. The trail is scheduled for reconstruction in 2009. This reconstruction will include installation of simple bridges to replace natural fords but no rerouting of tread.

Ptarmigan Creek Cut Off Trail
Only a short section of this trail lies within the watershed. Ptarmigan Creek Cut-Off Trail connects the Falls Creek ORV Trail to the Ptarmigan Creek Trail. No use figures are available.

Grant Lake Mine Road and Grant Lake Portage Trail
These two routes receive very light summer use and light winter use. There is no developed trailhead or signage. Users need to boat across Lower Trail Lake, though many trespass on the railroad trestle across the outlet of Upper Trail Lake, in order to access the trails during the summer months. Once the lakes freeze, some snowmachine and cross-country ski use occurs. The construction of the Iditarod National Historic Trail will create terrestrial access for these trails and use on them may increase, but it is not expected to be extraordinary.

Crown Point ATV and Falls Creek ORV Trails
These two mining roads/ trails provide opportunity for summer motorized use on the Seward Ranger District. They are lightly used trails by hikers and private ATV riders. There is no development at the Crown Point trailhead and only a gate and two signs at the Falls Creek trailhead. A special use permit holder is authorized for 120 temporary days on each trail and is expected to receive a five-year permit (expiring in 2011) after environmental analysis is complete.

Vagt Lake Trail
Located on State of Alaska lands, the trailhead doubles as an undeveloped boat launch and day use area. A recently installed sign marks the beginning of the trail. No use figures.

Moose Pass Cooper Landing Winter Route
This motorized winter route parallels the Seward Highway starting near the Johnson Pass South Trailhead, connecting to the Old Sterling Highway at the Tern Lake Day Use site. Only two miles of this route are in the Trail River Watershed. No use figures are available.

Johnson Creek Winter Route
Winter motorized users interested in accessing the Johnson Pass area typically cross frozen Upper Trail Lake and travel to the northeast inlet of the lake. The Johnson Creek Winter route starts on the western side of the railroad tracks and is blazed and brushed. No use figures are available.

Trail Glacier Winter Route
Winter use along this route is typically difficult and only occurs when conditions are right. Snowmachines travel this corridor to access Trail Glacier. No use figures are available.

Trail Creek Water Route
Moose hunters access the Trail Creek corridor via boats when water levels allow. No use figures are available.

Public use cabins/ campgrounds

There are no Forest Service public use cabins or campgrounds in the Trail River Watershed. One special use cabin is permitted along Johnson Pass Trail. Free use camping occurs on Borough land along western lakeshore of Upper Trail Lake in the area known as the “Ball Diamond” at mile 30 of the Seward Highway.

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. It is one of 15 roads recognized for outstanding scenic, natural, historic, cultural, archaeological and recreational qualities in the nation. The daily traffic counts for the Seward Highway averaged 1,770 through Moose Pass in 2001.

Special use authorizations

There are approximately 18 Outfitter Guides permitted for a variety of activities in the Trail River Watershed. The primary uses are hiking, mountain biking and fishing; in addition, ATV riding, overnight camping, and helicopter supported skiing are permitted in the area. Activities are largely concentrated along travel corridors and lakes: Johnson Pass, Carter Lake, Crown Point ATV and Falls Creek ORV Trails, Johnson, Bench and Carter Lakes. Helicopter skiing occurs in the Bench Peak area, Grandview and some exploratory use in the East Moose Creek area.

The Forest Plan outlines the capacity allocation for outfitter guides for each management area. The management areas within the watershed typically allow for up to 50% of use to be guided, although the Brown Bear Core Management Area allows for 60%. Final use reports from Outfitter Guides show actual use has been approximately 12% of permitted use in this watershed over the past three years – well below capacity allocation.

Other considerations

An air taxi service and float plane school operates on the Upper Trail Lake from May through October. Various lakes inside and outside the analysis area are used for “touch and go’s.” This activity may be a source of recreation conflict, though the District has not received any complaints to date.

Planned development adjacent to or within the Landscape Assessment Area

Whistle Stop Project

The Record of Decision to implement the Whistle Stop Project was signed in 2006. This project provides access and facilities along the Alaska Railroad corridor from Trail Creek to Spencer Glacier. Within the Trail River Watershed, there are proposed facilities at Grandview and Trail Creek. The facilities are to be phased in depending on use and demand. Facilities at Grandview are part of the second phase of implementation and include construction of a Whistle Stop station, two hardened campsites, one-mile interpretive trail, four-mile trail that leads to the toe of Trail Glacier and connecting trail between the Grandview stop and the Bartlett stop, of which only one-half mile is within the watershed. Trail Creek facilities are part of the last phase of implementation. They include construction of a station, two hardened campsites, and a public use cabin. Planned facility development was reduced from initial project proposal in response to concerns related to possible wildlife impacts.

This project has the potential to greatly expand the existing opportunities along the Alaska Railroad corridor; however, most of this expansion is planned for the area outside the Trail River Watershed. As stated in the Record of Decision, further development rests on assessment of visitor use and demand, confirmation of the Business Plan projections of use and revenue, and recovery of project operation and maintenance costs.

Iditarod National Historic Trail

The Iditarod National Historic Trail (INHT) is a congressionally designated historic trail created under the National Trails System Act that spans from Seward to Nome. A Decision Notice and Finding of No Significant Impact were completed in 2004 for the segment under Forest Service management. Approximately 10 miles will be constructed in the Trail River Watershed. The majority of the route has been flagged and lies east of Lower and Upper Trail Lakes and ultimately ties in with the Johnson Pass Trail. When the portion of the INHT within the Trail River Watershed is completed, this trail will be open to winter motorized uses and may become a popular snowmachine and ski route as well as a hiking and biking trail.

Hut-to-Hut Proposal

The Alaska Mountain and Wilderness Huts Association (AMWHA) has submitted a proposal to develop a system of backcountry huts that would be open to the public and accessed through a trail system that would connect with the Johnson Pass Trail. This project proposal is listed on the Schedule of Proposed Actions (SOPA) and is currently being reviewed through an Environmental Impact Statement (EIS) conducted by the Forest Service. Development of the Huts Project has the potential to increase day hiking opportunities and overnight trips on the Johnson Pass Trail, but would most likely affect the northern section of the trail, which is located outside of the Trail River Assessment Area.

Recreation Capacity

An estimate of the number of people that could occupy a watershed at one time within limits of a recreation setting is the recreation capacity of the watershed (USDA Forest Service 1986). Determining the recreation capacity of an area can be difficult. Opinions on the usefulness of the information are amazingly divergent. Factual information must be tempered with professional observation and judgment.

Calculating capacities of dispersed areas is more difficult than calculating capacities of developed areas. Capacity in dispersed areas is related to recreation setting and user expectations (Revised Forest Plan FEIS, 3-301). The *Revised Land and Resource Management Plan: Chugach National Forest* employs the Recreational Opportunity Spectrum (ROS) to discuss differences in setting across the Forest. These settings have distinct characteristics and are arranged in classes that cover pristine settings to highly developed ones. By utilizing the ROS class of the lands within the assessment area and the model developed during Forest Plan revision for determining potential "preferred" developed recreation sites, carrying capacity can be determined.

The lands within the Trail River Assessment Area are classified as Semi-Primitive Motorized (SPM) and Semi-Primitive Non-Motorized (Winter Motorized Allowed) (SPNM), with two mining claim areas classified as Rural. SPM and SPNM classes describe the landscape as natural in appearance with a low concentration of users. Although there is evidence of use in these areas, such as trails and hardened campsites, the use is not degrading to resources. Within SPNM there is a high probability for experiencing solitude, freedom, and tranquility. Primitive roads or other motorized travel routes are present in SPM and these change the level of probability for experiencing solitude from high to moderate. The lands around Grant Lake, Crown Point, and Falls Creek Mine Roads are SPM. SPNM covers the areas around Upper Trail Lake and Trail Creek.

Not all lands within a watershed are suitable for recreation or the development of recreational opportunities. The presence of steep, north-facing slopes, glaciers, and rock can negate recreation potential. The model developed for Forest Plan revision considers those factors. When the model was applied to all lands within the Trail River Watershed (Forest Service as well as state and private), 81.5% was deemed unsuitable for recreation development (101,350 acres). Of the remaining land, 8.8% is non-Forest Service land that is suitable for development (10,930 acres), 6.7% is Forest Service land (8,320 acres) and 3.0% is fresh water (372 acres).

The model eliminated lakes when determining suitable land for potential recreation for the Forest Plan, however, recreation in the Trail River Landscape Assessment area occurs on lakes. Thus, the lake acreages were included as potential recreation areas.

Recreation capacity is typically expressed as people-at-one-time (PAOT). That is, the number of people who could occupy a developed or dispersed area in a day. Since the area within the Trail River Watershed is largely SPM and SPNM, the capacity coefficient for Semi-Primitive areas should be used (0.008 people per acre). Multiplying the number of acres suitable for recreation in the assessment area (22,970 acres) by this coefficient produces the PAOTs for the area (183.7 people per day) or people who could potentially recreate in the watershed each day and still maintain the ROS class of the lands.

Certainly, there are periods during the year that are more conducive to recreation, thus simply multiplying the PAOTS by 365 is inappropriate. The summer use season for the Trail River Watershed is typically Memorial Day through Labor Day, approximately 110 days. Winter use season begins with opening the trails to motorized use (Dec 1 each year, depending on conditions) and closing on April 30 for 151 days. The total for both seasons is 261 days. Using the number of PAOTs and multiplying that by the number of days in the use season results in the recreational capacity for the watershed of 47,945.7 people per year.

As mentioned above, visitor use information available for this watershed is scant. Final use figures from Outfitter/ Guide permit holders, trailhead registers for Carter Lake and Johnson Pass South, and professional observation and opinion were utilized in the preparation of this assessment. Actual guided use is well below permitted levels and is low. Review of the trailhead register counts also indicates that use within the watershed is low. Data collected from trail counters and compared to trailhead registers indicates that 40% of visitors typically sign in. Use numbers for the past five years show that average use on Carter Lake Trail is 814 people per year and Johnson Pass South is 333 people per year. Adding those two figures together (1147) and accounting for the visitors who do not sign in (60%), yields an estimate of actual visitors for the two trails of 2,867 per year.

This analysis of the recreation capacity of the Trail River Watershed is simplistic. However, it is appropriate for the watershed. Current use is low and potential recreation development and use is limited because of the area's geographic characteristics.

5.0 REFERENCE CONDITIONS

This section documents the knowledge of past conditions in the Trail 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 Trail 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

The reference condition is 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. Around the turn of the century, the first railroad in Alaska was built starting in Seward and heading north through the Trail River Watershed. 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. By the mid-1950s, the highway system was well established. The rail and the highway corridors shaped the settlement patterns in the watershed.

During the last 40-50 years, the driving force in non-Federal land ownership occurred with the passage of Alaska Statehood Act of 1958, the Alaska National Interest Lands Conservation Act of 1980 (ANILCA) and the Alaska Railroad Transfer Act of 1982. These statutes allowed the State of Alaska to select and hold title to Federal lands and shaped the landownership pattern in the watershed.

5.2 Geology, Minerals, and Soils

5.2.1 Geology and Minerals

Mining and Mineral Deposits

The Chugach National Forest lands have had a long history of mineral activity. In 1848, a Russian Surveyor, Peter Doroshin discovered placer gold in the Kenai River system. The Russians near Kenai Lake mined placer gold in the early 1850s. Strong interest in mineral development came after the United States purchased Alaska in 1876. By the late 1800s placer gold miners were active in the Kenai Peninsula. The first notable production came in 1911 from the Falls Creek area.

Lode Gold

The most significant lode gold production form the Chugach National Forest was in the 1930's and 1940's. Little or no production from lode gold deposits has taken plan since 1956. Past producing mines within the TRAIL RIVER LA include the Crown Point, East Point, Falls Creek, Skeen Lechner, and Case Mines (See Figure 5.1).

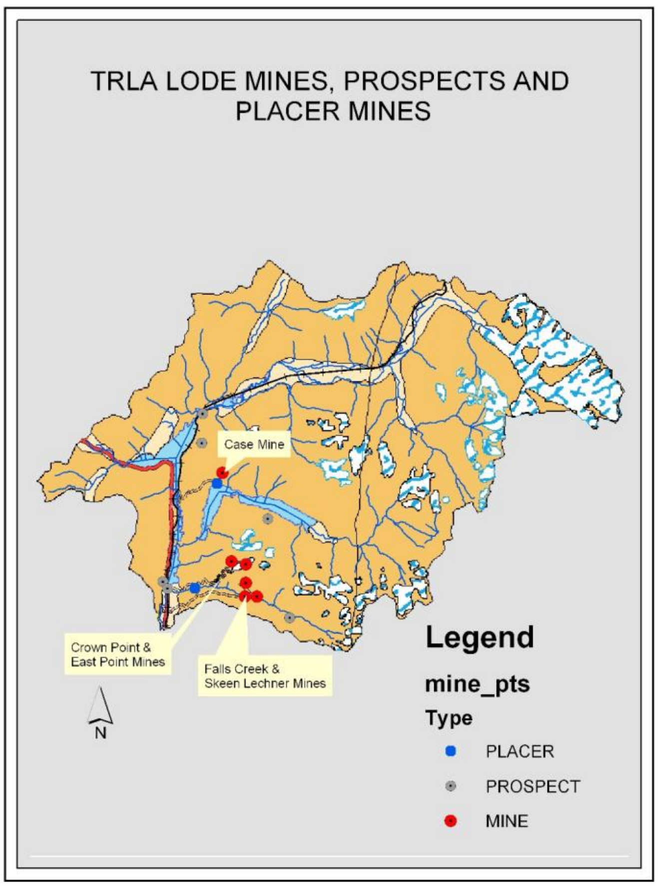

Figure 5.1. TRAIL RIVER LA Lode Mines Prospects and Placer Mines

Crown Point Mine Mineral Deposit
The host rock in the mine area is slate and sandstone of the Valdez Group of Late Cretaceous age (Nelson et al., 1985). The mineral deposit consists of a quartz vein along a shear zone that strikes northeast and dips vertically. The zone formed during or after folding of the surrounding slate and graywacke (Hoekzema and Sherman, 1983). On the surface, the vein has been traced for more than 1,500 feet. The width of the zone is from five to 48 inches wide, the average width is 25 inches (Johnson, 1915). The zone is terminated on the east side of the workings by a northeast-trending fault (Hoekzema and Sherman,1983). The zone consists of crushed and sheared country rock with numerous lenses and stringers of vuggy quartz that contains gold, arsenopyrite, galena, sphalerite, and calcite (Johnson, 1915). The mine produced 1,273 ounces of gold and 206 ounces of silver from 1935 to 1941 (Hoekzema and Sherman, 1983). Grab and chip samples collected from the workings and surface exposures contained from trace to 65 ppm gold and from 1.6 to 19.5 ppm silver (Hoekzema and Sherman, 1983).

The workings on the property are on four levels: 4,170, 4,320, 4,450, and 4,550 feet elevation. Extensive stoping has occurred on the upper three levels, and the lowest level was used mainly for haulage (Hoekzema and Sherman, 1983). The deposit was discovered in 190, and development started in 1910-11 with the installation a 5-stamp mill and a 630-foot aerial tram. The mine, owned by Kenai Alaska Gold Company since
1910, produced 1,852 ounces of gold and 428 ounces of silver from 1911 to 1916 (Hoekzema and Sherman, 1983). The mine was reopened in 1935 by the Crown Point Mining Company and produced 1,273 ounces of gold and 206 ounces of silver from 1935 to 1941 (Hoekzema and Sherman, 1983). Grab and chip samples collected from the workings and surface exposures contained from trace to 65 ppm gold and from 1.6 to 19.5 ppm silver (Hoekzema and Sherman, 1983).

The deposit was discovered in 1906, and development started in 1910-11 with the installation a 5-stamp mill and a 630-foot aerial tram. The mine, owned by Kenai Alaska Gold Company since 1910, produced 1,852 ounces of gold and 428 ounces of silver from 1911 to 1916 (Hoekzema and Sherman, 1983). The mine was reopened in 1935 by the Crown Point Mining Company and produced 1,273 ounces of gold and 206 ounces of silver from 1935 to 1941 (Hoekzema and Sherman, 1983). Production totaled 3,145 ounces of gold and 634 ounces of silver (Hoekzema and Sherman, 1983).

The U.S. Bureau of Mines estimated a resource of 30,000 tons containing 0.363 ounce of gold per ton and 0.1 ounce of silver per ton (Hoekzema and Sherman, 1983).

East Point Mine Mineral Deposit
The mine has produced from a single quartz-pyrite-arsenopyrite vein that strikes N55E and dips 45-60SE (O'Neill, 1960). Bedrock in the area consists of slate and graywacke of the Valdez Group of Late Cretaceous age (Cobb and Tysdal, 1980). Where the vein was worked, it was 6 feet thick, although it pinched out at both ends. The workings consist of 100 feet of drift and a 70-foot winze and stoping (Hoekzema and Sherman, 1983). Data from smelter returns and sampling complied by O'Neill (1960) for the mined section of the vein indicated a head grade of 4.92 ounces of gold per ton and 1.37 ounces of silver per ton.

The workings consist of 100 feet of drift and a 70-foot winze and stoping (Hoekzema and Sherman, 1983). Data from smelter returns and sampling complied by O'Neill (1960) of the mined section of the vein indicated a head grade of 4.92 ounces of gold per ton and 1.37 ounces of silver per ton. Total production was estimated to be 1,725 ounces of gold and 479 ounces of silver (Hoekzema and Sherman, 1983).

The mine has a reserve of 3,700 tons of ore containing 2.35 ounces of gold per ton and 0.5 ounce of silver per ton (O'Neill, 1960).

Falls Creek Mine Mineral Deposit
The mine worked a quartz-calcite vein in a shear zone that also contains gouge. The vein is between 8 inches and 4 feet wide within a 5-foot-wide shear zone that strikes N50E and dips northeast. The host rock consists of tightly folded slate and graywacke that strike north to northeast and dip 75 to 90E (Brooks, 1911 [B 480-B, p. 32]). Nelson et al. (1985) mapped this area as shale and graywacke of the Valdez Group of Late Cretaceous age. The vein is composed of massive white quartz with a minor amount of calcite. Arsenopyrite is the principal sulfide in the wall rock and in the vein. Other sulfides include chalcopyrite, galena, pyrrhotite, pyrite, and sphalerite. Brooks (1911 [B 480-B]) noted that gold appeared to be concentrated in a bluish quartz. Recorded production totaled 65 ounces of gold and 13 ounces of silver (Hoekzema and Sherman, 1983).

Workings total about 860 feet of adit, drift, and winze. Hoekzema and Sherman (1983) reported that the workings were inaccessible; however, the current mining claimants opened the portal below the falls in the early 1990. It is only a few feet above the creek level. Improvements consisted of two 2-stamp mills, a Chilean mill, and a crusher powered by a Pelton water wheel operating under 80-foot head of water from Falls Creek (Brooks, 1911 [B 480-B, p. 32]). The remains of a ball mill can be seen several hundred feet upstream from the stamp mills. The 3.5-mile-long mine road was usable by all-terrain vehicles (ATVs) in 2000; the road begins at Crown Point, across the highway from the Trail River campground road. The gold was reported to be free milling and averaged between $30 and $40 to the ton in gold (gold at $20.67 per ounce) (Brooks, 1911 [B 480-B]). A 6-foot chip sample collected by the U.S. Bureau of Mines from the vein exposed on the surface assayed 0.09 ounce of gold per ton and 0.07 ounce of silver per ton (Jansons et al., 1984).

Total recorded production is 65 ounces of gold and 13 ounces of silver (Hoekzema and Sherman, 1983). Some of this may have come from the Skeen Lechner mine because both were operated by the same company.

Skeen Lechner Mine Mineral Deposit
The deposit at the mine consists of two quartz veins that have been developed by three levels of workings at elevations of 2,140, 3,210, and 3,260 feet. The upper vein occupies a fracture in massive graywacke mapped as part of the Valdez Group of Late Cretaceous age (Nelson et al., 1985); it strikes N15W and dips 45E. The upper vein is 20 to 45 inches wide and is surrounded by 1 to 4 inches of fault gouge (Martin et al., 1915). The lower vein lies about 90 feet southwest of the upper vein and strikes N45W and dips 65NE. It measures 46 inches in width at the upper tunnel and varies from one to 4 feet in the lower adit.

Both veins are offset by a series of N55E-trending shear zones that dip vertically. The movement of the faults is right lateral, and the throw is about 30 feet (Hoekzema and Sherman, 1983). Both veins are composed of shattered white quartz with faint indications of secondary banding. A small amount of calcite occurs with the quartz. Sulfide minerals are of arsenopyrite, pyrite, and galena. Sulfides are also found disseminated in the wall rock and tend to be concentrated on vein margins (Martin et al., 1915). Native gold is associated with arsenopyrite and galena.

Workings total about 2,000 feet (Jansons et al., 1984). Most of the production came from the lower vein. Total production was 1,786 ounces of gold and 502 ounces of silver (Hoekzema and Sherman, 1983). Samples collected from the workings and surface exposures contained from trace to 360 ppm gold, and trace to 30 ppm silver (Hoekzema and Sherman, 1983).

The property was discovered in 1907, and development started on the 3,210 level in 1910 (Jasper, 1958). By 1912, when the property was abandoned, about 1,000 feet of workings were completed. In 1938, the Falls Creek Mining Company (owner of the Falls Creek mine and mill) acquired the property, and intermittent development occurred through 1950 (Jasper, 1958). The workings include 1,259 feet of drifts and stopes on the lower vein and 741 feet of drifts and stopes on the upper vein (Hoekzema and Sherman, 1983). Samples collected from the workings and surface exposures contained from trace to 360 ppm gold and from trace to 30 ppm silver (Hoekzema and Sherman, 1983).

Production totaled 1,786 ounces of gold and 502 ounces of silver (Jansons et al., 1984). Some of this may have come from the Falls Creek mine.

The U.S. Bureau of Mines estimated a resource of 10,000 tons containing 0.82 ounce of gold per ton and 0.3 ounce of silver per ton (Hoekzema and Sherman, 1983).

Case Mine Mineral Deposit

The mine is located in the NE1/4 section 29, T. 5 N., R. 1 E., of the Seward Meridian, on the north side of Grant Lake; the workings extend into the south half of section 20, T. 5 N., R 1 E., in the C-7 quadrangle. The workings are accessible from Moose Pass by the Grant Lake trail that begins at either the railroad bridge on the west shore of Upper Trail Lake or half a mile south of the railroad bridge on the west shore of Upper Trail Lake. (The public is not allowed to walk across to the trail (northern entrance) on the railroad bridge. The southern entrance to the trail is accessed by boat.) The mine camp is at an elevation of 700 feet. The mine workings are about half a mile north-northeast of the camp between elevations of 1,500 and 1,600 feet.

The deposit at this mine consists of quartz veins in interbedded slate and graywacke of the Valdez Group of Late Cretaceous age (Cobb and Tysdal, 1980). The veins occur in three orientations. One set generally parallels the north-northwest strike of the country rock and dips about 70 west. This set of veins contains pods and lenses within a shear zone that follows bedding. The hanging wall of the veins is slate, and the foot wall is graywacke. The veins range from 12 to 36 inches wide and average about 16 inches. The strike length varies, but in the adit at 1,540 feet elevation, this vein was more than 100 feet long. Ore minerals include arsenopyrite, chalcopyrite, galena, and pyrite; gold is also present.

The second set of veins strikes roughly east-west and dips 80S. These veins range in width from less than a foot to more than 5 feet. A majority of the material mined came from these veins. They are hosted in graywacke and are truncated on both ends by left lateral faults (Hoekzema and Sherman, 1983). Samples collected by the U.S. Bureau of Mines in 1980 assayed as much as 1.11 ounces of gold per ton (Hoekzema and Sherman, 1983).

The third set of veins strikes northwest and dips 65 NE. These veins appear to be discontinuous and barren (Hoekzema and Sherman, 1983).

The mine workings consist of three adits, at elevations of 1,500,1,540, and 1,600 feet. The 1,500-level adit is 12 feet long and follows a quartz vein that pinches out at the face. The 1,540-level adit is the main working. It is 170 feet long and has two 30- to 40-foot-long crosscuts that follow the east-west-trending veins. The western crosscut is stoped to the surface (Hoekzema and Sherman, 1983). The 1,600-foot adit is about 40 feet long and follows the northwest-trending vein (Hoekzema and Sherman, 1983). Samples collected by the U.S. Bureau of Mines in 1980, assayed as much as 1.11 ounces of gold per ton (Hoekzema and Sherman, 1983). Sampling by the U.S. Forest Service as part of a patent examination showed sporadic gold grade as much as 2.10 ounces per ton, interspersed with barren samples.

Production is estimated at 972 ounces of gold and 123 ounces of silver (Jansons et al., 1984).

The proven reserves at this mine are reported to be 270 tons of ore having a grade of 0.78 ounce of gold per ton and 0.2 ounce of silver per ton (Hoekzema and Sherman, 1983). The U.S. Bureau of Mines suggested that this deposit has a moderate potential for development as a small mine. The mine was examined both by a private consulting geologist and by a government mineral examiner as part of the patent process. U.S. Government mineral examiners concluded in 1993 that mineralization exposed to that date would not support a small-scale mining operation. The private consulting geologist suggested that further work could define a down-dip extension of the known deposit.

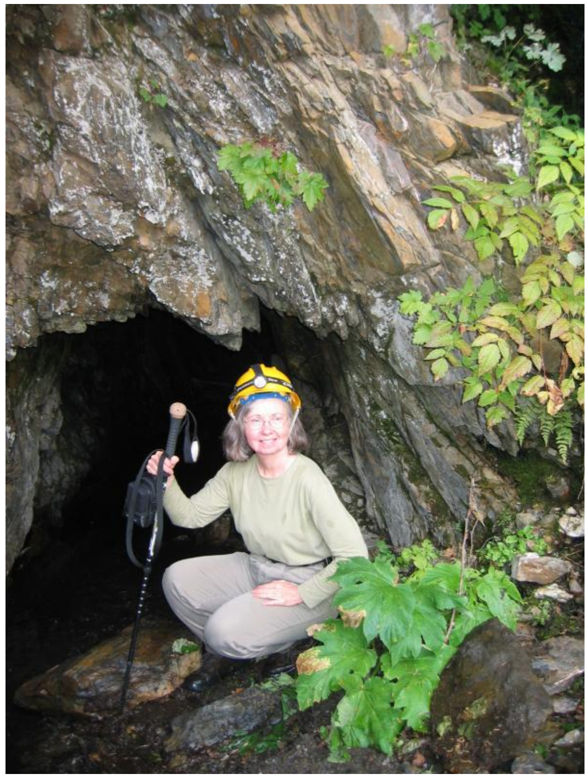

Figure 5.2. Carol Huber, Forest Geologist, at Case Mine portal near Grant Lake

Placer Gold

Falls Creek Placer Deposit

This placer is located in T. 4 N., R. 1 E., sections 16, 17, and 18 and S1/2 section 13, T. 4 N., R. 1 W. of the Seward Meridian. From its headwaters, this creek flows westwardly into Trail Creek. The lower 2 miles of the creek has produced placer gold; upstream, in another 2-mile section of the creek, the stream gravels contain small amounts of gold. The map location (Figure 4.1) is in the center of the lower canyon, in SE1/4 section 18.

Bedrock in the drainage is slate and sandstone of the Upper Cretaceous Valdez Group (Nelson et al., 1985). Most of the Falls Creek valley is narrow and steep sided. From its headwaters, Falls Creek descends in a series of steps. The uppermost section descends rapidly along a bedrock canyon below which is a relatively gentle portion with a narrow flood plain. Another canyon area begins just below the Falls Creek mine (lode) and continues to within a mile of its junction with Trail Creek. Below the second canyon a broad alluvial fan has developed. Small amounts of gold have been found in the silty gravels a half mile above the Falls Creek mine and in the alluvial fan gravels below the lower canyon (Jansons et al., 1984). Suction dredges in the lower canyon have recovered coarse gold.

Martin et al. (1915) reported that all gold recovered had been taken from low benches in the canyon in the lower part of the creek and at the mouth of the canyon; they reported that the amount of gold in the canyon small, not sufficient to pay wages on pick and shovel work. In 1911, the gravel in the flats along Falls Creek between Kenai and Lower Trail Lakes was prospected by drilling. Twenty holes were drilled; depth to bedrock ranged from 10 to 23 feet. No definite pay streak was located (Martin et al., 1915). Drilling and prospect pits were dug in the 1950's on the alluvial fan below the lower canyon (Jansons et al., 1984). A small, mechanized operation worked alluvial gravel near the mouth of the lower canyon in 1980 without significant success. Suction dredging has occurred in the lower canyon area during each year since at least 1977 (Jansons et al., 1984).

In 1995, a mining claimant unsuccessfully attempted to patent the BBK #2, a 9-acre placer mining claim in the lower canyon. This small suction dredge operation recovered coarse nuggets.

The U.S. Bureau of Mines collected two 0.1-cubic-yard samples that yielded 0.0022 and 0.0077 ounce of gold per cubic yard. A dredge sample near the Falls Creek mine yielded only traces of mercury coated gold (Jansons et al., 1984). Two suction dredge samples collected by the mining claimant for the patent examination at the BBK #2 yielded .075 and .028 ounces of gold per hour. An estimated 400,000 cubic yards or better of auriferous gravels are present in the alluvial deposits below the lower canyon (Jansons et al., 1984).

The U.S. Bureau of Mines has estimated total production to be between 200 and 300 ounces (Jansons et al., 1984).

5.3 Hydrology

5.3.1 Glaciers

Episodes of extensive glaciation and recession have occurred in South-central Alaska in the past two 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 Trail River Valley. The glacier that occupied the Trail River Watershed fed into a larger complex of glaciers that occupied what is presently Kenai Lake to the southwest. In addition to flowing south along the lower Trail River valley, the Trail River glacier also flowed southwest into Kenai Lake through the low pass separating Upper Trail Lake and Quartz Creek. 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 smaller side valleys of Johnson Creek, Grant Creek, and Falls Creek were left as hanging valleys to the main valley of the Trail River. Because of glacial melting, fluvial erosion helped shape the present form of the Trail River Watershed.

The last glacial advance of the Trail Glacier probably occurred at some point during the Little Ice Age prior to about 1900. Since this time, the glacier has steadily retreated. During the reference period, the valley and cirque glaciers in the Grant Creek, Falls Creek, and Johnson Creek valleys, as well as other small valleys draining into the Trail River, contained considerably larger glaciers than presently exist. During the reference period, glacial processes had a larger influence on streams, water quantity, and water quality.

5.3.2 Streamflows

During the glacial recession that occurred during much of the 20th Century, streamflows in the Trail River may have been larger than those of the present conditions because of larger glaciers, a greater extent of glaciation, and melting glacial ice. Glacial outburst floods may have occurred during this time, but their occurrence is unknown.

5.3.3 Stream channel

During the reference period prior to 1890, The Trail River was more influenced by glacial processes than it is today. Upstream of Upper Trail Lake, the Trail River likely exhibited highly braided characteristics because of very high glacial sediment loads. The outwash plains were mostly unvegetated. The river contained multiple channels that exhibited high rates of channel migration. The outwash plains were confined in places by bedrock outcrops. Downstream of Lower Trail Lake, the Trail River likely had similar characteristics as the present, as the lakes captured the glacial sediment.

5.3.4 Water Quality

Prior to about 1890, sediment loads were likely higher in the Trail River than at the present because of more extensive glaciation and periods of glacial advance. Because Upper and Lower Trail Lakes capture bedload sediment from the upper watershed, sediment loads in the lower Trail River were probably similar to those of today. Prior to 1890, human-related water quality impairment was non-existent because of the lack of development, transportation corridors, and use in the watershed.

5.4 Vegetation and Ecology

This landscape has undergone site-specific human modifications in the recent historical past. Since that time, human disturbances have increased and will most likely continue to do so in the near future. Although reference conditions can be decided upon at any point in the past, the best case is to consider conditions prior to the end of the 19th century and beginning of the 20th century. This time period saw the first use of the Iditarod Trail and construction of the Alaska Railroad. Although no data exists with which to reference the existing vegetation communities during this time period, the composition of plant communities was probably similar to what exists today with the exception of the extensive bark beetle infestation of spruce forests and the presence of non-native/exotic plant species. Bark beetle infestations have occurred at their current levels only over the course of the last 20 to 30 years. Exotic plant species are closely related to human disturbance and therefore, it is unlikely that these species existed in this area prior to human alterations of the landscape.

5.5 Fire

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.

5.5.1 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 (USDA 2002). Langille (1904) and Holbrook (1924) cite historical evidence supporting a climax forest. 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.

The forests in the watershed 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.

5.5.2 Settlement

Beginning in the late 19th century and continuing through the early 20th 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).

Commentaries from the forester's diaries early in this century, describe extensive fires on the Forest from1913-1915. The basic cause for these fires was attributed to railroad activity igniting 95 fires between 1932 and 1953. (Chugach fire history data) The drought conditions following the 1912 Katmai Volcano eruption also contributed to the fire behavior creating favorable weather for burning. Holbrook also reports "the region has been visited by numerous fires and most of the better grade of timber has been burned" (1924). 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.

5.6 Aquatic Species and Habitats

Little is documented about the state of the fishery in the upper Kenai drainage pre-settlement. Without a mature commercial fishery, we can assume higher levels of salmon spawning in most available habitats with population sizes perhaps limited by the amount of available spawning habitat in the upper Kenai Drainage. Current studies are underway to determine the extent of aquatic biomass returning to the Kenai watershed using cores of lake bottoms. These data suggest wide fluctuations in size of runs returning to spawn-perhaps linked to global climate conditions as expressed through lake productivity, (Mann and Finney, 2006)

5.7 Terrestrial Species and Habitats

Past populations of wildlife in the Trail River Watershed are unknown, except that moose are now present, and historically they were not here prior to about 1850 (personal communication with Tony Largaespada, district archaeologist, 2004. The presence of moose is likely due to extensive expansion of hardwoods from 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.

Historic data on vegetation composition and structure is not available from the reference period. Changes in vegetation over the last 30-60 years can be inferred from reviewing differences in vegetation data from GIS maps at different time periods. Previous vegetation data collected 30-60 years ago shows predominantly pole sized conifer and hardwood forests. This suggests that around the reference period, much of the forest may have been in early seral stages, possibly due to human caused fires and timber cutting (See reference conditions under Fire).

5.7.1 Sensitive Species

Trumpeter Swans
Little to no data exists on reference conditions for swans. It is likely that if natural conditions for swan nesting habitat have remained stable, human disturbance, especially from floatplanes, 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 exists 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 Trail 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 an abundant ungulate species on the peninsula. It is unknown if caribou once existed in the watershed, but they are not present now.

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. Warming conditions however are likely increasing the extent of forested habitat up mountain slopes, which ultimately will decrease available alpine habitat for mountain goats over time.

Brown Bear
Data on reference conditions of brown bear is very limited to nonexistent. We assume that historic populations of brown bear were higher, and that European contact decreased brown bear populations through habitat loss, hunting and defense of life and property (DLP's), although potential increases in fisheries, moose populations could have increased bear numbers. The more recent increase in fishing and recreation in the watershed has resulted in some habitat encroachment and increased DLP mortalities.

5.7.3 Species of Special Interest

Wolverine
Little to no data exists on reference conditions for wolverine. As with all fur-bearers, populations may have decreased after European contact due to the increase in hunting and trapping, and habitat encroachment by humans.

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 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 Trail 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 probably 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 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 have also reduced available habitat over time.

Gray Wolf
No data exists 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.

5.8 Human Uses

5.8.1 Human Uses: Past

The reference condition has been defined as the late 1800's to mid 1900's. Prehistoric use in the watershed has been documented; human use and occupation of this landscape began thousands of years ago and continues to this day.

The main impetus that brought humans to the Trail River Watershed was primarily industrial uses, in particular mining. Prehistorically, this area was used for subsistence transportation and trade routes. The town of Moose Pass was established in association with the railroad construction of 1904 and a roadhouse at milepost 29 in 1909. The first business to open in Moose Pass after the roadhouse was a water powered sawmill on Grant Lake, constructed by Al Solars.
Additional resources of the area were exploited through time including fishing and hunting wildlife, and trapping from prehistoric times to today. This naissance further facilitated human interest, access, and exploitation of the watershed.

In terms of transportation, the Johnson Pass Trail is a portion of the well-known Iditarod National Historic Trail (INHT). This trail was originally a travel and trade route for native peoples, adopted by Russian explorers and early 20th century gold seekers. The trail became a road and was used as an alternate route to the Sunrise mining area. In 1920 the operation of this mining road went to the Bureau of Public Roads, and it was eventually turned over to the Forest Service, where it has returned to the function of a trail.

Intense mining in the area began in 1909, when there were three active mining claims on Falls Creek; Skeen and Lechner Mines, California Alaska Mine, and the Stevenson Mine (Crown Point). Additional operations on Grant Lake commenced during this time as well. Frank Case owned and operated the Case Mine, which is still functioning today. Further advancements at Falls Creek, in 1912, diverted the headwaters so the ground on the lower portion of the creek could be mined (Barry, 1997, 1993). These mines began the trend of mineral extraction in this area of the landscape.

5.8.2 Human Uses: Present

The reference time period is 1895. At that time 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 the Great Depression and World War II. Generally, nationwide and to some extent within the watershed analysis area, the thought of camping, hiking and fishing for fun, instead of for subsistence, became more and more popular at this time.

During the 1960's and 1970's, outdoor recreation expanded exponentially nationwide. South-central Alaska's population rose from 50,000 in 1950 to 110,000 is 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 1960's and 1970's in response to the increased public demand.

Various human developments in the area have increased the number of people utilizing the Trail River Watershed. These developments include the founding of Moose Pass (1912), and Alaska Railroad and Seward Highway construction.

6.0 SYNTHESIS AND INTERPRETATION

Chapters 4 and 5 address the issues and key questions presented in Chapter 3. This chapter briefly summarizes the differences between reference and current conditions and considers the key questions, especially those that can be influenced by management activities. It considers desired future conditions and Forest Plan direction.

6.1 Lands

The land adjacent to the Seward Highway in the watershed is almost entirely state or private lands. The land adjacent to Upper and Lower Trail Lakes is also non-National Forest System land. These lands are not subject to Forest Service management. Municipal entitlements will transfer most of the state lands to the Kenai Peninsula Borough. Subsequent land sales will transfer some land to private ownership. Exactly how much land, and when, is not known. Although there are no pending land sales at this time, transfer of public lands to private ownership is a foreseeable action. Further development of private lands is likely.

The state and private land parcels are generally contiguous. The reasonable use and enjoyment of these lands is not dependent on use of the National Forest. There does not appear to be a need for special use authorizations for access roads, waterlines, or other private amenities on the National Forest.

Additional public access needs have not been identified. The road and trail easements listed above provide access to National Forest System lands and appear to be sufficient for current and future use of the National Forest.

The special use authorizations listed above will continue for the near future. No changes are proposed for the current permits.

The Alaska Railroad property located on the active creek bed of Trail Creek is expected to be routinely impacted by flood events. Flooding periodically threatens the integrity of the railbed. Options to relocate the rail corridor out of the floodplain are very limited. Regular maintenance of the mainline within the rail corridor does not involve the Forest Service. However, outside the rail corridor, the Alaska Railroad must obtain special use authorizations for work on the National Forest. The Alaska Railroad currently has one Forest Service permit for flood control dikes near rail Mile 36. Additional flood control work near rail Mile 40 is expected.

6.2 Geology, Minerals, and Soils

6.2.1 Geology and Minerals

Mineral deposits, current and future mineral activity

Known mineral deposits exist in the TRAIL RIVER LA and minerals have been produced from the TRAIL RIVER LA. Gold has been and continues to be the mineral of most interest. Mining claims are an indicator of this interest. Many years have passed since any significant lode gold has been produced and the climate for mineral development has changed in the intervening years. The high cost of development and mining today as well as the environmental obligations of a mining company have taken its toll on small mining operations, making them generally unfeasible. Even though the known deposits contain "reserves[2]", all of the historic gold mines are considered small by today's standards. Even with high gold prices, mines of this type and size are unlikely to be developed and produced again.

The placer deposit is another story; again, the presence of mining claims is an indicator of interest in developing and mining the placer gold deposit. Placer gold has been produced from Falls Creek and may be present in other drainages. Historically placer gold has been mined first by hand mining methods and later mined inexpensively by hydraulic methods. Currently suction dredge mining is a simple, low-cost method to produce placer gold from gold-bearing gravels. Suction dredging may be feasible at today's high gold prices. The primary limitation is the amount of gravel that can be processed. This style of mining is suitable for "mom and pop" scale operations.

Managing past mining and current mining

Because the lands are open to mineral entry and historic mining has occurred, the lands of the TRAIL RIVER LA will continue to be of interest for producing lode and placer gold, but primarily placer gold. The small-scale placer mining is generally not particularly destructive to the environment but must be managed to mitigate that impacts that do occur. Several small-scale operations in the same drainage can cumulatively cause significant environmental damage. This can be managed and mitigated to acceptable levels, however.

Managing past mining consists of identifying and mitigating impacts cause by abandoned operations. Hazardous mine openings that are accessible to the public should be closed. Cabins and other structures remain from abandoned operations. These are an attractive nuisance, which may invite habitation on National Forest lands. The Forest has long been aware of the problem and has made some progress in eliminating these.

[2] Reserves are known deposits that have not been mined.

6.2.2 Soils

Reference conditions compare favorably to the current conditions in regards to mass-wasting. Although the extent of natural slope failures is unknown, there are no management caused failures with the exception of the Trail River/Alaska Railroad that is noted and discussed in Section 2. Non-glacial erosion processes other than mass-wasting are not known to be accelerated on FS lands within the analysis area.

Glacial recession is having the most effect on the geomorphic surface and on soil development on FS lands in the assessment area. This is expected to continue at an increasing rate in the future. Depending on how long formerly ice-covered ground has been exposed, after as little as 10 years to more than a century, soil changes will include lower bulk density, lower pH, changing soil chemistry, and other alterations due to chemical and biological weathering, precipitation of soil minerals and colonization by bryophytes and ruderal vascular species. Some of these recently exposed sites will eventually become prime colonization sites for weedy invasive species. If other disturbance, for example, erosion were to continue, then weed species will continue to occupy these sites and prevent or slow natives from establishing.

The same drivers of glacial recession may cause the fire incidence rate to increase, which would increase the background soil erosion rate on most soil types and land types. If fire incidence accelerates greatly, soils that are currently carbon-sinks would become carbon sources.

In the 210 acres that have had vegetation management, these are expected to continue to revert towards the reference condition, and be non-detectable from soil examination within 20 to 50 years. The gravel pit that is part of this managed acreage would naturally restore itself somewhat but would still be identifiable 20 to 50 years out. Even with maintenance, some trail erosion.
would be identifiable.

6.3 Hydrology

Climate change has caused gradual changes in the hydrologic regime of the Trail River Watershed.
Changes in climate have had and will continue to have an effect on hydrologic processes in the Trail River Watershed. Most notably, the trend of warming temperatures has caused the Trail Glacier to thin and retreat during the last century, and smaller glaciers in the side valleys have diminished greatly in size. Because glaciers presently cover only 12% of the watershed, hydrologic processes are different from those of the reference conditions, with lower streamflows, lower sediment loads, increased channel stability, and increased floodplain vegetation. As this trend continues in the future, the extent of glaciation in the watershed will continue to decrease. The upper Trail River will be the most affected by these changes, as the river continues to adjust to different flow regimes and sediment loads in the long term.

Human uses in the Trail River Watershed have a variety of effects on water resources.

Human uses in the Trail River Watershed are concentrated along the Highway and Railroad corridors. The effects of the transportation corridor, recreational uses, and the community of Moose Pass have some discernable effects on water resources. These effects include the constriction of the upper Trail River floodplain by the Alaska Railroad, possible and potential effects of motorized use on water quality, the effects of recreational uses on water quality, and the effects of past and present mining on water quality and channel morphology. The large degree of planned recreational development in the watershed, including the Whistlestop and Iditarod Trail projects, have the potential to increase recreational use and the potential for water quality degradation in the most heavily used areas. Little data currently exist with which to analyze these existing and potential effects on water resources.

6.4 Vegetation and Ecology

6.4.1 Natural disturbances and climate change

Stand structure in this watershed is similar to many other large watersheds on the Kenai Peninsula. The majority (80%) of the watershed is non-forested with large areas of rock, snow and ice, and grass and alpine communities. The forested areas currently consist of the historical mosaic of tree species. The major exception to this historical pattern is the extensive amount of dead and dying spruce trees because of a severe and ongoing bark beetle infestation. This infestation has led to an increase in standing and on the ground woody debris with areas of large gaps in the forest canopy leading to an increase in early seral plant species. This change in vegetation composition will continue as the effects of the bark beetle infestation play out. Another consequence is an increase in incoming solar radiation coupled with increased soil disturbance, which creates conditions optimum for the invasion of non-native plant species, especially when coupled with historical and ongoing human disturbances in these areas.

Changes in climate may also have a profound effect on this assessment area. Warming temperatures can change hydrological conditions and increase the effects of flooding regimes, further affecting plant successional patterns at the landscape scale. The ultimate consequences of these changes in climate cannot be accurately predicted at this time, but should be taken into account when planning future management activities.

6.4.2 Human development and recreation

As mentioned previously, this landscape has been undergoing significant site-specific human disturbances over the course of the last 100 years. Prior to the beginning of the 20th century, vegetation communities existed in a more or less pristine state, affected only by natural disturbance regimes such as fire, avalanches and seasonal flooding. Human related disturbances include development and maintenance of the Alaska Railroad corridor, new and improved recreational trails, including upgrades to the existing Iditarod Trail, the Seward Highway and associated develop and maintenance, and the powerline corridor. All of these disturbances will have localized effects to the existing vegetation, though these should be minimal when viewed across the landscape as a whole, The biggest concern associated with human activities from an ecological perspective is the introduction and spread of non-native and invasive plant species, and the potential deleterious effects to sensitive plant populations. The spread of non-native and invasive plant species is closely associated with man-made disturbances. Once established in an area, these species can be difficult and expensive to eradicate. More aggressive invasive species can have deleterious effects on existing plant communities ranging from displacement or elimination of native species to large-scale changes in ecosystem structure and function. Since many of the travel corridors go through remote areas, the presence of non-native plant species may not be known until they reach large levels of infestation. Sensitive plant species are also vulnerable to these disturbances as well, and since data regarding their presence or absence in the area is incomplete, it is possible development of recreational corridors could have negative impacts to these populations without resource managers being aware of these effects.

6.5 Fire

6.5.1 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 Moose Pass 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 overwhelming. Fuels treatments for the remote portions of the watershed range between $1000.00 and $3500 per acre and appear to be at this time unattainable due to the lack of funding.

6.5.2 Fire behavior

The spruce bark beetle is part of the cyclic events within the life of the spruce. Under normal weather conditions (low) fire poses little threat outside the Wildland Urban Interface (WUI). Under extreme weather conditions and low relative humidities (90^{th} weather percentile i.e. High) fire behavior in the beetle killed spruce stands (Fire behavior fuel model (FM) 10), and grasses (FM 1,3) change and pose the greatest risk. 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 Behavior Model. (Table 6.1 and 6.2).

Table 6.1. Behavior Model

	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**

Table 6.2. Fire Behavior Prediction by Fuel Type and Weather Conditions

	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

6.6 Aquatic Species and Habitats

Fisheries and Hydrology should together identify impacts from placement of the ARR roadbed to streams and fish habitat. These streams have had ninety-years to adjust to the current configuration but given the dynamic and high-energy channel types in the upper reaches of the Trail Creek further channel changes are expected.

Many of the current channel shifts has negatively affected the roadbed through the channel aggrading and direct erosion.

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, natural disturbance (flooding, avalanches, fire, and the spruce bark beetle), and human use and development.
- The spruce bark beetle has affected 95% of the large spruce, killing the trees. This has created increasing fuel loads, putting habitat at risk for loss due to fire and reducing habitat quality and quantity for and old growth dependant species such as goshawks and marbled murrelets. The loss of live large spruce will affect species for approximately100 years that it will take to replace these large trees.
- Changes over time indicate an increase in early seral and large hardwoods (See Tables 6.5 and 6.6). With these changes, habitat has been increasing for migratory birds and cavity nesters that use larger hardwoods, while browse and cover have been increasing for moose and species that prefer early seral hardwoods.
- Human use of the watershed for recreation, hunting, trapping. and travel corridors (trails, highway, railroad).

6.7.1 Climate Change

Warming temperatures may cause increases in forested habitats and reductions in sub-alpine and alpine habitats. If such shifts occur, then habitat reduction may result for species such as mountain goats and Dall sheep.

6.7.2 Natural Disturbance

The Trail River Watershed is a large glacial valley similar to other drainages on the Eastern Kenai Peninsula. As such, it is very dynamic, with regular flood events as well as other disturbance regimes. The primary natural disturbances within the watershed that influence the vegetation communities and wildlife species dependant on them include flooding, fire, climate change, avalanches and the spruce bark beetle.

Trail River is a braided glacial river, and the habitat in and adjacent to the floodplain changes over time due to erosion and deposition. Newly created mixed hardwood stands create browse and food for moose and other early seral species.

Fire is a natural disturbance factor in the watershed; however, the majority of fires within this watershed have been a result of humans. The natural fire regime in this watershed is that of infrequent but severe fires, with at least 200 years between large fires. Most of the human caused fires have been along the railroad and have been small. This may change, however, as fuel loads in the watershed increase because of the spruce bark beetle, and climate change results in warmer and drier summers. In addition, the increase in recreation in the watershed may also result in an increase in human caused fires, especially along recreation corridors and at dispersed recreation sites. The result of an increased risk of fire in the watershed, while unknown, will most likely result in an increase in early seral plant communities, which for a time will favor species dependant on those communities. Habitat will likely decrease for other species that prefer late seral habitat where the spruce bark beetle has been active., such as goshawks, Townsend’s warblers, and marbled murrelets.

Avalanches occur on steep slopes throughout the watershed, and have played a role in shaping vegetation communities. Alder fields and other disturbance tolerant species generally characterize avalanche slopes. In the late spring, bears feed in these areas, and carcasses from animals caught in avalanches provide food for scavengers such as wolverines. It is unknown what effect climate change will have on winter precipitation and associated avalanches.

Historic data on vegetation composition and structure is not available from the reference period. Changes in vegetation over the last 30-60 years can be inferred from reviewing differences in vegetation data from GIS maps at different time. Some of the following changes seem evident.

6.7.3 Vegetation Composition

Changes in vegetation composition and structure over the last 30-60 years were noted by comparing Chugach National Forest GIS data on cover types and timber types which are 30-60 years old (See Figure 4.13) with recent mapping work by the Kenai Peninsula Borough (KPB-2007), which uses Ikonus imagery (See Figure 4.14).

There has been a potential increase in hemlock and hemlock-spruce types (+2% each type), while mixed hardwood/softwoods may have declined by 4%. Perhaps this is an indication of succession and hardwoods dropping out of some of the stands or being overtopped by conifers. Birch and cottonwood have increased 2% (1% each) while aspen has decreased 2%. Lack of fire in areas where aspen grows may have contributed to this. Data indicates a slight loss of forested habitat (691 acres) or change to non-forested habitat over the last 50 years or so. This may be a result of harvest, development, vegetation typing errors, or other factors.

In non-forested habitat there has been an apparent decrease in grass/alpine and other brush (4%, 5%), and an apparent increase in alder (3%) and snow/ice/rock/non-forested areas (7%). This is interesting, as it potentially shows reduction of alpine areas and increase in sub-alpine (alder). You would expect with increasing temperatures that this might happen, but would also expect a decrease in snow and ice. Because of the way the data was classified, it is impossible to tease apart the snow/ice from barren and rocky areas.

There have been some shifts in habitat types available, as conifers overtop hardwoods and the forest ages. Habitat for species that use conifers and large trees or more mature forest is increasing slightly, while habitat for species using primarily hardwoods or mixed forests may have decreased. If alpine areas are decreasing, alpine species such as mountain goat and Dall sheep may be losing habitat over time.

6.7.4 Vegetation Structure

The current condition is based on mapping using Ikonus Imagery (Rude 2007) and takes into account management activities that would be visible from the air and were identified in coordination with the Forest Service, such previous timber harvest, fuels treatments and other management actions. It does not include state or private land.

Conifers

Over the last 30-60 years it appears about half (54%) of the pole size conifers have grown into large size classes (See Table 6.3 and Table 6.4). This has created a current condition of predominantly large trees (about 80%). The spruce bark beetle has affected the majority of this size class (95%) and the trees are dead.

Very little early seral conifer habitat has been identified, although seedlings and saplings exist in the understory in many stands identified as pole size or large.

Figures 8.2, 8.3, and 8.4 in the Recommendations Section identify the locations of the size classes noted in Existing Conditions in Table 6.3 and 6.4.

Table 6.3. Percent size class distribution of conifer stands

CONIFERS	Previous Condition (30-60 years ago)	Existing Condition	Desired Condition	Difference between existing and desired	Changes over time
Small (Seedling/Saplings)	3%	1%	20%	19%	-2%
Medium (Pole Size and young saw timber)	73%	19%	20%	1%	-54%
Large (mature, old growth)	24%	80%	60%	-20%	56%

Table 6.4. Size class distribution of conifer stands (acres)

CONIFERS	Previous Condition (30-60 years ago)	Existing Condition	Desired Condition	Difference between existing and desired	Changes over time
Small (Seedling/Saplings)	621	212	4027	3815	-409
Medium (Pole Size and young saw timber)	14389	3874	4027	153	-10515
Large (mature, old growth)	4736	16046	12080	-3966	11310

Hardwoods

Changes over time indicate an increase in early seral and large hardwoods (See Tables 6.5 and 6.6). Increasing early seral stages may be the result of management to promote moose browse as well as hardwood regeneration as the canopy opens as the spruce bark beetle kills large conifers. Large hardwoods have also increased and pole size hardwoods have decreased as they have matured or been converted to early seral stages. Some of this change may be a result of vegetation mapping. As conifers overtop hardwoods, some of the hardwoods may still be present in the stand but photos may show the stand as being dominated by conifers now. With these changes, habitat has been increasing for migratory birds and cavity nesters that use larger hardwoods, while browse and cover have been increasing for moose and species that prefer early seral hardwoods.

Figure 8.1 in the Recommendations Section identify the locations of the size classes noted in Existing Conditions in Table 6.5 and 6.6.

Table 6.5. Percent size class distribution of hardwood stands

HARDWOODS	Previous Condition (30-60 years ago)	Existing Condition	Desired Condition	Difference between existing and desired	Changes over time
Small (Seedling/Saplings)	13%	28%	60%	32%	27%
Medium (Pole Size and young saw timber)	77%	38%	20%	-18%	-39%
Large (mature, old growth)	10%	34%	20%	-14%	24%

Table 6.6. Size Class distribution of hardwood stands (acres)

HARDWOODS	Previous Condition (30-60 years ago)	Existing Condition	Desired Condition	Difference between existing and desired	Changes over time
Small (Seedling/Saplings)	728	1251	2712.6	1461.6	523
Medium (Pole Size and young saw timber)	4304	1705	904.2	-800.8	-2599
Large (mature, old growth)	570	1565	904.2	-660.8	995

6.7.5 Human effects on wildlife

In the Trail River Watershed, humans influence wildlife primarily through recreation, hunting, trapping, development, and travel corridors.

Currently, the majority of the watershed is inaccessible except by boat, trail, or aircraft. There are no developed recreation facilities on Forest Service land in the watershed. The railroad does transport passengers on the trains, but currently does not allow the public access to the surrounding forest from the trains. This is about to change with the development of “Whistle Stops” along the railroad corridor which will be constructed to allow passengers to exit the trail at designated stops and hike along newly constructed trails to dispersed camping areas. Several new trails are to be constructed providing increased access to the forest lands from the railroad corridor.

Human development is also prevalent in the southwestern portion of the watershed. While is does not comprise a large portion of the watershed, the effects from this development are considerable in that they are mostly irreversible alterations to the habitat. A primary transportation corridor runs through this section, and there is a small population center (Moose Pass). Since the reference period, human development has increased, resulting in a net loss of habitat for some species. There is also a mixture of land ownership, which presents a challenge to management on a landscape level.

Aircraft, unregulated by Forest Service permits, provides increased access for recreation, wildlife viewing, flight seeing, and flight instruction. Aircraft use the 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. Floatplanes can affect species such as trumpeter swans, and helicopters and fixed wing aircraft can affect mountain goats, Dall sheep and other wildlife.

As human use increases, the potential for negative bear/ human interactions may increase. Bears occur throughout the watershed, but are seasonally concentrated in upper Trail River when the salmon are spawning. This area of the watershed is in the brown bear core area, and as such, the management focus is to maintain this area as a feeding area and a travel corridor for brown bears.

6.8 Human Uses

6.8.1 Human Uses: Past

Human development in the watershed

Historic documents and known sites show that development of the analysis area was greater in the past than today. The number of roadhouses, habitation structures, trails and mining activities has decreased significantly. Additionally, the access to the backcountry via the railroad has since ceased. Limiting the avenues for development in the area has cause the public to focus on limited historic routes, in particular the Johnson Pass Trail.

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 areas 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

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. This Borough population increase may disproportionately increase the rate of recreation growth on the Chugach National Forest. Currently, well over 90% of Americans participate in at least one outdoor recreation activity (Cordell, 1997). 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).

Following suit with national recreation trends, recreation use in the Trail River Watershed has increased over the past 40 years. Various human developments including the Seward Highway construction has increased the number of people using the Trail River Watershed.

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 45-60 foot motor homes has also surpassed the original concept of front-country recreation that was envisioned for the recreationists of the 1960's and 1970's.

Many of the Forest Service campgrounds, day-use areas, trailheads and hiking trails built in the 1960's and 70's are not adequate for today's recreationists and have been or will eventually need to be upgraded, replaced or rebuilt to conform with 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.

Social perspectives in Moose Pass associated with this increase in recreation were captured in November of 2004 during an interactive community forum. Information gathered during this meeting indicated that community members believe there are abundant and "very accessible" recreational opportunities surrounding Moose Pass (Nielsen, 2005). They typically hold negative attitudes toward summer tourism and expansion of commercial recreation development on the Forest and other lands surrounding the community.

Trail River Area recreation trends

In general, an increase in outdoor recreation participation is assumed simply due to population growth. However, the Trail River Watershed has not experienced the same increase in recreation use as other areas on the Seward Ranger District. Forest Service lands within the watershed are rugged and not easily accessible. Lands that are suitable for the development of recreational opportunities either have been developed as in the case of the Johnson Pass and Carter Lake Trails, or are in the process of being developed as displayed by the Iditarod National Recreation Trail and the Whistle Stop Projects, or are not lands managed by the Forest Service.

Across the nation from 1982 – 2000/01, one of the fastest growing forms of outdoor recreation is participation in Off-Highway Vehicle (OHV) use (Cordell, 2004). It can be expected that summer motorized use on the Crown Point ATV and Falls Creek ORV Trails will increase.

Implementation of the Whistle Stop Decision and construction of the Iditarod National Historic Trail will enhance summer access to the watershed and provide additional opportunities for hiking, biking, and camping. User increases are expected in those projects areas. Impacts to resources and mitigation of these impacts are discussed in the decision documents for each of these projects and are outside the scope of this landscape assessment.

Trail River Area recreation conflicts

Recreation conflicts can occur when users or user groups perceive others as interfering with their attainment of recreational goals. Conflicts may occur within a user group, such as crowding, or between user groups whose activities are viewed as incompatible. Examples of potential recreation conflicts in the Trail River Watershed may include conflicts between: (1) bikers and hikers on the Johnson Pass Trail; (2) motorized and non-motorized users on the Crown Point and Falls Creek Trails; (3) winter motorized and non-motorized use on the Carter Lake Trail.

There has been little report of recreation conflicts specific to the Trail River Watershed. However, an environmental assessment to decide winter motorized and non-motorized access across the Seward Ranger District is on going. The outcome of this analysis is not expected to increase winter-motorized use in the watershed.

7.0 DESIRED CONDITION, OPPORTUNITIES, MANAGEMENT STRATEGIES, DATA GAPS, MONITORING AND RESEARCH NEEDS

This chapter discusses desired future conditions, considering the differences between reference and existing conditions discussed in Chapter 6. Desired future conditions consider what is feasible today and current management direction. Opportunities, management strategies, data gaps, and monitoring and research needs are presented for each desired future condition as means to achieve the desired condition.

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	▪ **As identified in the Revised Land and Resource Management Plan, the Seward Highway and the Alaska Railroad will continue to provide transportation between Anchorage and Seward and will provide access to National Forest resources.** ▪ **As identified in the Revised Land and Resource Management Plan, private land in holdings will have development consistent with their economic potential and minimal impact on the surrounding Forest. Private landowners with in holdings 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.**
Opportunity	▪ None identified.
Data Gap	▪ None identified.
Management Strategies	▪ Remain involved in reconstruction efforts planned for the Seward Highway. ▪ Work with landowners and claimants during application process, conduct site-specific NEPA as needed.
Monitoring and Research Needs	▪ Monitor development on non-National Forest lands for possible encroachment.

7.2 Geology, Minerals, and Soils

7.2.1 Geology and Minerals

Desired Condition:	▪ Keep the lands open to mineral entry. ▪ For resource protection, mined lands/areas will be properly reclaimed and impacts mitigated. ▪ Mining will occur only with approved mining plan of operations, with reclamation plan is included. ▪ Monitoring occurs to assure that mining and reclamation is being conducted according to the approved plan of operations ▪ Mitigation occurs for all old mine working hazards, including sealing or other wise closing old mine adits and shafts such as the Fall Creek Mine adit (see Figure 7.1).
Opportunity:	▪ The numerous old mines in the area provide an opportunity for interpretation of the mining history of the area and an opportunity to warn the public about the hazards of abandoned/inactive mines. ▪ Mining access roads and trails can provide access to the backcountry by the public.
Data Gap	▪ None identified
Management Strategies:	▪ Require mining plans of operations according the regulations found at 36 CFR 228 Subpart A. ▪ Require bonds for all operations that require an approved mining plan.
Monitoring and Research Needs	▪ Monitor known operations regularly as well as monitor areas where mining has occurred in the past.

Figure 7.1. Foam closure of the Crown Point lower adit.

7.2.2 Soils

Desired Condition	▪ Soil resources will be the result of natural processes. Soil resources will provide natural soil ecosystem functions, processes, and services such as soil organism habitat, biogeochemical cycles, watershed stability, water storage and release, and above and below ground biodiversity as compared to a natural reference.
Opportunity	▪ Work with other Forest programs, agencies, and landowners to manage soil resources to maintain or improve soil quality and function. Use models including WEPP, CENTURY, RAVE, SOIL and others to predict, manage and/or mitigate erosion, soil carbon, nutrient cycling, pesticide behavior and fate, movement of water, gases, and solutes associated with projects. Provide interpretations for uses, responses, resiliency and restoration to support project design.
Data Gap	▪ The assessment area lacks soil resource inventory of the FS National Hierarchical Framework of Ecological Units for the land type phase and soil units. Other existing inventory units including land types do not meet TEUI or NCSS standards.
Opportunity	▪ Ensure that trail construction follows Forest BMP's Soil Quality Standards (SQS's) and that the potential for soil erosion is minimized.
Management Strategies	▪ Design projects to meet Soil Quality Standards (SQS), soil and water BMP's, and mitigation prescriptions that are documented in ecological assessments (CE, EA, EIS). Watershed restoration activities will improve the characters and functions of the soil. Restoration activities for other resources will cause no harm or will cause net improvement to soil resources. Conduct land stability analysis as prescribed in appendix A.
Monitoring and Research Needs	▪ Monitoring trail construction for adherence to BMP's and Soil Quality Standards (SQS). Also, monitor future fuel reduction projects for mineral soil exposure and vegetation response on mineral soils. ▪ Inventory, map and monitor mass-wasting areas to get baseline type, extent and rates of movement/change/effects. Monitor soil quality parameters associated with project design and implementation. Monitor vadose zone and wetlands associated with restoration for proper hydric soil classification and function. Model the soil carbon pool as a baseline monitoring reference for climate change. ▪ Set up landslide mass-wasting monitoring if management finds that there is a reason to track any existing or potential slope failure. ▪ Monitor vadose zone and wetlands associated with restoration for proper hydric soil classification and function. ▪ Most of the terrestrial carbon sink is below ground. Model the soil carbon pool as a baseline monitoring reference for climate change.

7.3 Hydrology

Desired Condition	▪ Natural processes are the primary controls on water resources in the Trail River Watershed. Management on the Chugach National Forest has limited influence on processes such as global climate change, glacial recession, and channel changes resulting from high flows. Natural processes that shape the landscape dominate the desired condition for water resources in the Trail River Watershed. Because human uses are concentrated along the transportation corridors, much of the Trail River Watershed is currently in its desired condition. ▪ Maintain acceptable water quality in streams and lakes of the watershed, as defined by the Alaska State water quality standards (Alaska Department of Environmental Conservation, 2003). ▪ Maintain naturally functioning stream channels throughout the watershed, particularly in places where the Alaska Railroad affects channel morphology.
Opportunity	▪ Work with the Alaska Railroad Corporation at Mile-36.6, the Hunter Y, and other places in the watershed to protect the railroad from shifting channels and flooding, while maintaining these channels as healthy, functional streams with natural characteristics and beneficial fish habitat. ▪ Examine the past and present effects of placer mining on Falls Creek and its effects on hydrologic function, channel morphology, water quality, and fish habitat. Explore options and alternatives for restoration of degraded areas. If applicable, develop a watershed restoration plan (WRP) for the Falls Creek watershed.
Data Gap	▪ Collect water quality data in lakes where motorized uses, particularly floatplanes, are concentrated. ▪ Collect channel morphology data on the upper Trail River and its tributaries in order to help design measures to protect the Alaska Railroad bed.
Management Strategies	▪ Ensure that the construction and maintenance of the Iditarod National Historic Trail and development of the Whistlestop Project comply with Best Management Practices (BMPs) as defined in the R10 Soil and Water Conservation Handbook (USDA Forest Service, Alaska Region, 2006) to prevent water quality degradation. BMP Monitoring is a monitoring item in the Forest Plan (USDA Forest Service, Chugach National Forest, 2002a).
Monitoring and Research Needs	▪ Monitor existing roads, trails, and ATV routes for BMP implementation and effectiveness. ▪ Monitor channel changes in the upper Trail River along the Alaska Railroad corridor.

7.4 Vegetation and Ecology

Desired Condition	▪ The vegetation communities in the area will be those that are a result of natural processes. Active management of selected areas will occur in order to restore or enhance conditions for wildlife. Abundance and distribution of sensitive plant species will remain stable and non-native plant populations will be reduced in size.
Opportunity	▪ Work with other landowners in the area, including the Alaska Railroad to minimize the introduction of non-native and invasive plant species.
Data Gap	▪ The Trail River landscape lacks a comprehensive series of data in all resource areas, though general information on forest cover, plant community type, current and historical trails, and sight specific information on the presence of sensitive and non-native plant species does exist. ▪ Identify current vegetation and structure through IKONOS imagery, aerial photos, land sat imagery or other methods.
Management Strategies	▪ The maintenance of existing recreational trails and construction of new trails should be done in a way that minimizes disturbance to topsoil, and removal of canopy vegetation to prevent conditions conducive to non-native plant establishment All construction equipment should be thoroughly washed prior to arrival on-site to minimize transportation of non-native plant propagules.
Monitoring and Research Needs	▪ Monitor for the introduction of non-native plant species. ▪ A full biological evaluation for plants should be conducted in any new areas of development in order to establish baseline conditions for what species are present prior to management activities. Sensitive plant surveys should be conducted before any trail construction begins so that mitigation measures can be enacted if populations of these species are found.

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, 2002a).
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. Fire prevention signs at trailheads and roadside stops could raise awareness of fire danger with the public.
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 could occur on a limited basis each year for fuel reduction, improvement of wildlife habitat and restoration to desired vegetative conditions, provided appropriate funding can be obtained. Catastrophic wildland fires are projected to be infrequent and, when they occur, will most likely be within major travel corridors and other centers of human activity. Smoke levels will be within state standards for particulate material, except when catastrophic fires occur (USDA 2002a).
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 wild land fire use for resource benefit planning. ▪ Accurate weather observations and patterns are needed within the Trail River Watershed to manage fire under appropriate fire suppression strategies.
Monitoring and Research Needs	▪ Monitor future fuel reduction projects for mineral soil exposure and vegetation response on mineral soils.

7.6 Aquatic Species and Habitats

Desired Condition	▪ Retain the natural range of variability that occurs in a pristine setting ▪ Healthy spawning habitat for salmon will be maintained. ▪ The Trail Creek Watershed will remain mostly in a pristine condition. ▪ Fish populations for sport angling will be maintained as a sustainable recreational fishery.
Opportunity	▪ Develop resident fishery opportunities for ice fishing and along the Iditarod Trail. ▪ Interpretive signs can be placed along the Iditarod 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.
Data Gap	▪ Effects of Forest Plan implementation on sport fishing opportunities in the upper Kenai watershed. ▪ High quality spawning habitat areas have not been surveyed in the watershed.
Management Strategies	▪ Partnership with ADFG to identify new habitat for salmon. ▪ 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.
Monitoring and Research Needs	▪ We do not know the extent of Coho spawning and rearing habitats in the upper Kenai watershed. ▪ 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 Trail Creek. ▪ Monitor the stock status of Trail Creek salmon.

7.7 Terrestrial Species and Habitats

<table>
<tr>
<td>Desired Condition</td>
<td>

Bear/ human interactions are minimal, and the potential for wildlife habituation of bears is low
Disturbance to wildlife from aircraft and other recreation activities is minimal or within an acceptable range.
Wildlife populations are healthy and support a variety of uses including subsistence and sport hunting, watching wildlife, conservation and other values.
A diversity of vegetation types and structures exists to provide a wide range of habitats for wildlife.

<table>
<tr><th></th><th>Mature/Old Growth</th><th>Pole and Young Sawtimber</th><th>Seedling/Saplings</th></tr>
<tr><td>Conifers</td><td>60%</td><td>20%</td><td>20%</td></tr>
<tr><td>Hardwoods</td><td>20%</td><td>20%</td><td>60%</td></tr>
</table>

Early seral hardwoods exist away (1/4 mile) from the railroad and highway, preferably within moose winter range.
The risk of loss of habitat due to fire is minimal.

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<tr>
<td>Opportunity</td>
<td>

Manage habitat within the Brown Bear Core Management Area to meet the population objectives for brown bears and reduce dangerous encounters between humans and bears.
Monitor current aircraft use in the watershed, and identify potential disturbance to wildlife.
Develop projects that enhance habitat in a way that decreases or does not increase moose collisions in the railroad corridor.
Enhance current vegetation and structure.

Hardwoods: Increase early seral stages of hardwoods by 32%, decrease mid seral hardwoods on 18% and decrease mature hardwoods on 14% (See Recommendations) .
Conifers: Increase early seral conifers (19%), maintain live pole size conifers, maintain and promote live large and old growth conifers.

Reduce fuels in high-risk areas for wildfire.

</td>
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<tr>
<td>Management Strategies</td>
<td>

Increases bear awareness with interpretation and education. Develop a bear safety guide and information on reducing habituation of bears along the Whistle Stops.
Provide additional bear-proof food lockers in backcountry areas.
Improve visibility along trails near seasonal brown bear concentration areas.

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</tr>
</table>

	▪ Design habitat management projects in the Brown Bear Core to enhance brown bear feeding areas and reduce dangerous encounters between bears and humans. ▪ Increase early seral stages and decrease mid and mature seral hardwoods by implementing patch cuts of varying sizes and shapes in mid seral and late seral stages (See Recommendations and Figure 8.1). Consider converting conifer stands or mixed conifer/hardwood stands to early seral hardwoods. Treat spruce adjacent to hardwood stands to allow hardwoods to regenerate naturally. ▪ Decrease late seral hardwood stages by 661 acres. Treat large blocks of late seral stage hardwoods to create early seral stages (See Recommendations and Figure 8.1). Maintain large cottonwoods near riparian areas for bald eagle nest sites. ▪ Decrease mid seral stages by 801 acres.. Work within mid seral stages to assist in creating early seral stages. ▪ Increase early seral conifers on 3815 acres . ▪ Maintain pole size conifers where they are not impacted by the bark beetle, primarily in mountain hemlock stands (See Recommendations and Figure 8.4).Thin and remove dead spruce in mixed dead/ live pole stands to reduce fire risk, maintain pole stands and help promote large stages. (See Recommendations and Figure 8.4). ▪ Promote live large conifers on 12,000 acres by maintaining live mature trees where they are not affected by the bark beetle. ▪ Reduce fuels near trails and other human use areas to reduce fire risk to surrounding wildlife habitat.
	▪ 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. ▪ Increase awareness of potential impacts to outfitter/ guides and flight instructors, and ask for voluntary compliance with recommendations. ▪ 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 ▪ Look for opportunities to design projects that meet fuels reduction objectives concurrent with moose habitat enhancement. ▪ Identify opportunities for mechanical and prescribed burn treatments to increase early seral habitat for moose and other species.

	▪ Look for opportunities to promote mature and old growth habitats for northern goshawks and other species. ▪ Reduce risk of fire in wildlife habitat by cooperating with hazardous fuel reduction efforts near state and private land.
Data Gaps	▪ Existing populations, trends, and existing and potential habitat data is needed for sensitive species, management indicator species, species of special interest, Dall sheep, and migratory birds. ▪ Brown bear population size and structure, spring foraging habitat for sows with cubs, summer feeding habitat and winter denning habitat need to be identified or verified. ▪ The locations of trumpeter swan nesting and rearing habitat, and the impacts that floatplanes and other activities are having on these habitats are unknown. ▪ The impacts of the spruce bark beetle on habitat and wildlife such as goshawks are not known. ▪ Identify important habitat areas in the watershed in relation to human use and areas of concern where recreation impacts may be occurring
Monitoring and Research Needs	▪ Monitor the effects of recreation activities and aircraft on wildlife in the watershed. ▪ Monitor Trumpeter swan nesting habitat and rearing habitat.

7.8 Human Uses

7.8.1 Human Uses: Past

Desired Condition	▪ Management in accordance with Federal laws and the Chugach National Forest revised forest plan. ▪ A complete 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.
Opportunity	▪ Complete the watershed inventory to assist in the development and testing of a predictive model for cultural resources in the region.
Data Gap	▪ A large portion of the analysis area has not been archeologically inventoried, and the majority of the known cultural resources have not been evaluated for the National Register of Historic Places and may need further documentation.
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.
Monitoring and Research Needs	▪ Monitor all known archeological sites in the assessment area. ▪ Complete the federally mandated cultural inventory surveys for the entire analysis area.

7.8.2 Human Uses: Present

Desired Condition	▪ Non-motorize use will prevail during the summer use season (hiking, biking, camping, fishing, hunting, canoeing, rafting, etc.) with motorized use occurring in designated areas ▪ Improvements that increase the ability of the area to accommodate addition visitors will occur as long as the natural quality of the area is not reduced. ▪ Improvements such as trailheads and parking lots and new cabins may be constructed to permit longer winter recreation trips (USDA 2002a). ▪ The Whistle Stop Project and construction of the Seward to Girdwood Iditarod National Historic Trail will enhance access to and expand the recreational opportunities of the area.
Opportunity	▪ No further development of recreational opportunities on Forest lands within the Trail River Assessment Area.
Data Gap	▪ Accurate and complete current use figures, especially winter use
Management Strategies	▪ No further development of recreational opportunities on Forest lands within the Trail River Assessment Area is advocated.
Monitoring and Research Needs	▪ Monitoring of increased recreation use, as described in the decision documents for the Whistle Stop Project and Seward to Girdwood Iditarod National Historic Trail, is vital to assuring impacts to resources are avoided or mitigated appropriately. ▪ Monitoring trail construction for adherence to BMP's and Soil Quality Standards (SQS).

8.0 RECOMMENDATIONS

8.1 Recommended Actions

These recommendations are specific actions that could be taken to implement the management strategies, take advantage of opportunities, or fill in data gaps as listed in Chapter 7.

8.1.1 Lands

No recommendations.

8.1.2 Geology, Minerals and Soils

Soils

- Invasive weed species are a negative impact to soil quality and function, particularly soil biology and chemistry. The threat of invasives' are growing because of increased population using the assessment area and because of climate change which is generally more favorable to weeds compared to native species. Aggressive preventative and treatment actions are recommended to maintain soil quality and species diversity. Reference the Chugach NF Invasive Plant Management plan which provides appropriate management actions.

- Trails are an important capital investment and recreational resource in the assessment area. To protect the soil and land surface, trails need to be maintained properly. One of the most often overlooked trail maintenance actions is water bars. Historically, once eroded material backs up against or fills in behind the water bar, they have been cleaned. Rather than preventing erosion and stabilizing the tread, cleaning water bars has the opposite effect of continuing erosion and destabilizing the trail surface. The recommendation is that water bars should stay in place and not be "cleaned". When the water bars' capacity is filled, a new water bar should be installed.

  Trail tread width and clearing width should be kept to the lowest minimum standard to serve the intended use. Single-track trails minimize erosion and weed invasion.

  Trail relocation, and trail construction needs to be on the most appropriate land type and the most appropriate position on a given land type relative to location and grade to avoid unnecessary disturbance, erosion and potential for weed spread.

- Vegetation treatment that involves heavy equipment needs to follow the soil quality standards although there are exceptions that can be made by the soil scientist, for example, on particular soils with histic surfaces and certain habitat types.

Vegetation treatment using prescribed fire generally has few harmful effects to soils with the exception of organic soils. Prescribed fires should not consume organics below the litter layer (Oi or Oe).

- Generally, when management actions are expected to disturb the soil, as much topsoil as possible should always be saved for finishing the project after disturbance. If topsoil is available, it should be spread and then covered with appropriate mulch, but generally not seeded or fertilized. There should be plenty of seed bank of native plants in the upper layers of topsoil to preclude the need for seeding. Fertilizing native topsoil can often substantially alter the habitat for native plants, which in turn can alter the composition and frequency of natives. Of course, there will be other occasions and situations where fertilizing will be appropriate and desirable. Topsoil should be handled and stored to maintain most of its original properties, including the soil biology and seed bank. There are specific techniques for example, to limit denitrification, to best store topsoil depending on the kind of soil, season(s) and length of time that it will be stored. Contact the soil scientist when contemplating and designing projects.

- Most of the terrestrial carbon is below-ground. Manage soil and vegetation resources to maintain or increase the below-ground carbon sink and sequester the maximum carbon for long time-frames.

8.1.3 Hydrology

Fisheries and Hydrology should together identify impacts from placement of the ARR roadbed to streams and fish habitat. These streams have had ninety-years to adjust to the current configuration but given the dynamic and high-energy channel types in the upper reaches of the Trail Creek further channel changes are expected. Many of the current channel shifts has negatively affected the roadbed through the channel aggrading and direct erosion.

8.1.4 Vegetation and Ecology

Vegetation

Provide opportunities for fuel/ wood

- Follow Vegetation 10 Year Plan. Projects that can potentially offer products such as firewood or house logs include Avalanche Acres (See Appendix B).

Continue to update information on current vegetation composition and structure, as well as spruce bark beetle impacts over time. As new information becomes available, refine or add management opportunities into the SRD vegetation/habitat management 10 year plan to maintain a diversity of vegetative structures, improve wildlife habitat, and reduce wildfire risk.

Invasive Species (Plants, animals, insects)

In response to the issue of climate change, and the expected potential increasing spread of invasive species, and the desired condition to reduce non-native plant populations, we recommend the following:

- Increase public awareness of invasive species at trailheads
  Public outreach in schools
  Trail signage
  Media

- Establish and continue working relationships/partnerships with DOT, Master Gardner program, and AK Railroad

- Promote Weed free hay/forage with special use outfitters.

- Ensure weed cleaning, machinery cleaning, and use of native seed stock provisions in vegetation/fuels contracts are clear, understood, and enforced.

- The maintenance of existing recreational trails and construction of new trails should be done in a way that minimizes disturbance to topsoil, and removal of canopy vegetation to prevent conditions conducive to non-native plant establishment All construction equipment should be thoroughly washed prior to arrival on-site to minimize transportation of non-native plant propagules.

8.1.5 Fire

In response to the issue of climate change, and the expected increase in fire risk and insects and disease associated with increasing temperature, drought, and lightning, we recommend fuel reduction activities in the high priority areas of the watershed. These treatments will benefits fuel reduction and wildlife habitat.

- Use prescribed fire and mechanical treatments within the WUI (on FS and state land) and other travel corridors (trails, railroad) to reduce fuels, improve wildlife habitat and offer forest products. Partnerships with the state and borough will be important to accomplish this. Follow the Seward District Vegetation 10 Year Plan for projects and time schedules. Projects include;
  Avalanche Acres
  Trail Lake Shaded Fuel Break and Habitat Improvement
  Grant Lake Prescribed Burn
  Grant Lake Trail Shaded Fuelbreak
  Moose Pass 7A
  Trail Creek Prescribed Burns

- Implement a fire use program within the limited suppression boundary outside the WUI.

- Put up Fire prevention signs at trailheads and roadside stops to raise awareness of fire danger with the public.

- Implement fuel reduction along trails, heritage sites, dispersed campsites, important wildlife habitat including:
  - Johnson Pass Trail summer and winter routes
  - Carter Lake Trail
  - Falls Creek Trail
  - Crown Point Mine Road
  - Ptarmigan Creek Cutoff
  - Vagt Lake Trail (state)
  - Dispersed campsites
  - Case Mine cabins
  - Bald eagle, goshawk nests, brown bear core areas.

- Encourage collaboration with DOT, Chugach Electric, and City of Seward to treat fuels within their rights of way on FS lands.

- Encourage collaboration with the railroad to treat fuels on their land adjacent to FS lands.

8.1.6 Aquatic Species and Habitats

No recommendations.

8.1.7 Terrestrial Species and Habitats

In response to the issue of climate change, the expected potential changes in vegetation composition and structure, and the desired condition to restore, maintain, or enhance conditions for wildlife, fish, vegetation, and fuel, we recommend the following actions:

Reduce Bear/Human Interactions.

- Increase bear awareness with interpretation and education. Supply a bear safety guide and information on reducing habituation of bears along the Whistle Stops, in brown bear core areas, and other high use bear areas.

- Provide additional bear-proof food lockers and poles in backcountry areas.

- Improve visibility along trails near seasonal brown bear concentration areas

- Vegetation treatment adjacent to dispersed camping areas and trails to reduce bear/human interactions.
  - In brown bear core area
  - New camping areas in Whistlestop
  - Johnson Pass Trail

- Design habitat management projects in the Brown Bear Core to enhance brown bear feeding areas and reduce dangerous encounters between bears and humans.

2. Move toward the desired percentage of size classes in conifers and hardwoods to provide diverse wildlife habitat, and reduce the risk of fire in wildlife habitat Note that in some cases it is not feasible or economical to completely reach the desired conditions.

Hardwoods:

Based on Existing and desired conditions, Table 8.1 describes the percent change needed in structure for hardwoods, and the change in acres needed to meet desired condition. Figure 8.1 shows some potential areas to consider for treatments**.**

Table 8.1. Size class distribution of Hardwoods-Existing, Desired, and Recommendations

HARDWOODS	Existing Condition	Desired Condition	Percent Change Needed to Meet Desired Condition	Acre Change Needed to Meet Desired Condition
Small (Seedling/Saplings)	28%	60%	+32%	+1461.6
Medium (Pole Size and young saw timber)	38%	20%	-18%	-800.8
Large (mature, old growth)	34%	20%	-14%	-660.8

- Increase early seral stages of hardwoods by 32% or 1462 acres, decrease mid seral hardwoods on 18% or 904 acres and decrease mature hardwoods on 14% or 904 acres.
- Increase early seral stages on 1462 acres by doing patch cuts of varying sizes and shapes in mid seral and late seral stages (See Figure 8.1). Maintain large hardwoods near riparian areas for bald eagle nest sites. *Note: Figure 8.1 identifies approximately 3032 acres of mid to late seral hardwoods are available. Much of this is within ¼ mile of the highway or railroad. Treating these areas to promote early seral hardwoods would attract moose to these areas and contribute to moose mortality. Do not treat areas within ¼ mile of the railroad or highway in order to reduce potential moose mortality. Based on this,* ***only 984 acres or less are appropriate*** *for creating browse.* Potential projects include Moose Pass 7A (hardwood stands currently not identified under contract for treatment), and portions of project areas identified in the Trail River Feasibility study (see Appendix B). These areas will be difficult to access and expensive to treat. Other options may include converting conifer stands or mixed conifer/hardwood stands to early seral hardwoods instead of conifers.

Treating stands with spruce adjacent to hardwood stands would allow them to regenerate to hardwoods naturally. Few of these are available, however, that are not near the highway or railroad. A few stands (237 acres) exist adjacent to the Johnson Pass Trail but they are hard to access.

- Decrease mid seral stages by 18% or 801 acres to total 904 acres. Work within mid seral stages to assist in creating early seral stages as mentioned above. Work within the 984 acres identified in Figure 8.1.
- Decrease large stages by 14% or 661 acres to a total of 904 acres. Work within large late stages to assist in creating early seral stages as mentioned above (See Figure 8.1). Maintain large cottonwoods near riparian areas for bald eagle nest sites.

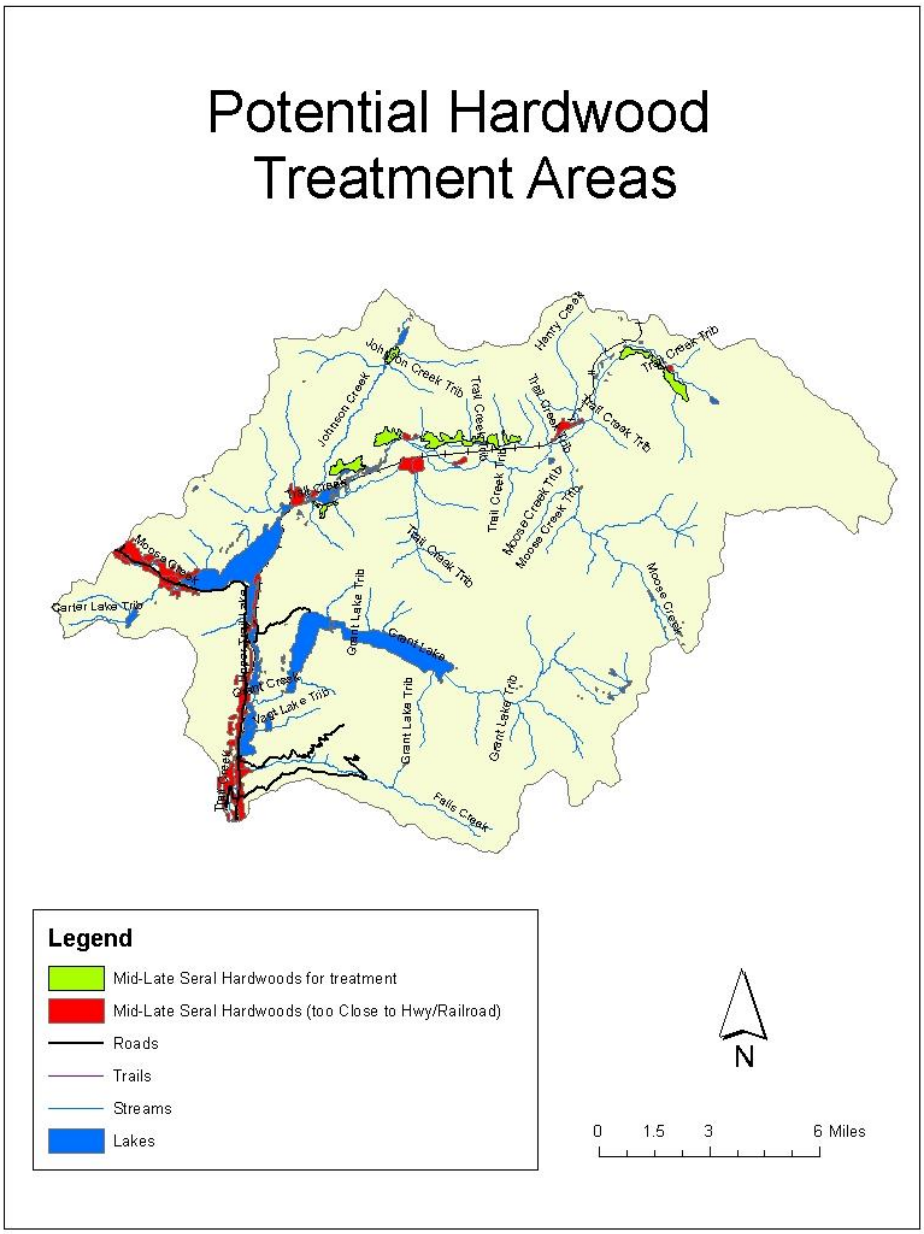

Figure 8.1. Potential Hardwood Treatment Areas

Conifers

Based on Existing and desired conditions, Table 8.2 describes the percent change needed in structure for conifers and the change in acres needed to meet desired condition. Figures 8.2-8.4 show some potential areas to consider for treatments***.***

Table 8.2. Size class distribution of conifer stands-Existing, Desired, and Recommendations

CONIFERS	Existing Condition	Desired Condition	Percent Change Needed to Meet Desired Condition	Acre Change Needed to Meet Desired Condition
Small (Seedling/Saplings)	1%	20%	+19%	+3815
Medium (Pole Size and young saw timber)	19%	20%	+1%	+153
Large (mature, old growth)	80%	60%	-20%	-3966

- Increase early seral conifers on 19% of conifer acres or (3815 acres) to meet a desired condition of 4027 acres. Opportunities exist where spruce bark beetle impacts have occurred. Promote these areas near highways and the railroad to reduce moose mortality and improve visibility. Work cooperatively with the state to improve habitat near the highways where they own the majority of the land. Some of this work could be considered in or adjacent to the Avalanche Acres and Trail River Shaded Fuel Break projects in mixed live and dead spruce stands on **488** acres (See Figure 8.2). Some of this work could be accomplished within stands that are predominantly dead large spruce (**1799** acres, See Figure 8.3).

- Maintain pole size conifers where they exist and are not impacted by the bark beetle. This is primarily mountain hemlock stands (See Figure 8.4). Thinning and removing dead spruce in mixed dead/ live pole stands will reduce fire risk, maintain pole stands and help promote large stages. (See Figure 8.4). These treatment areas occur primarily on state land.

- Promote large conifers on 12,000 acres. Large conifers are those <9"dbh as described in Appendix C (in the Cover classes and information for Kenai Peninsula Borough Vegetation Mapping (Rude 2007). Desired condition shows a reduction of 3966 acres of large trees needed from the current condition, but the majority of trees are dead. So treatments should maintain 12,000 acres of LIVE trees. Treatment ideas to do this are displayed in Figure 8.2. Maintain live large/old growth conifers (spruce and hemlock) not affected by the bark beetle (See Figure 8.2, which displays 5250 acres). Where a mixture dead and live spruce occurs, consider cutting out dead spruce, piling and burning to reduce fuels, and maintaining the large live component if it is not infested. Most areas that contain large dead spruce with large live hemlock are in remote inaccessible areas that are not feasible for hand treatments. Prescribed burns would likely kill the large hemlock component. Some of these areas were considered for burns in the analysis of the Grant Lake project and Trail River Feasibility Study and considered not feasible or desirable for burning. They are listed as no treatment areas on Figure 8.2. Large trees may also be promoted by thinning in pole size classes (See Figure 8.4). Select areas where possible next to live mature or old growth areas.

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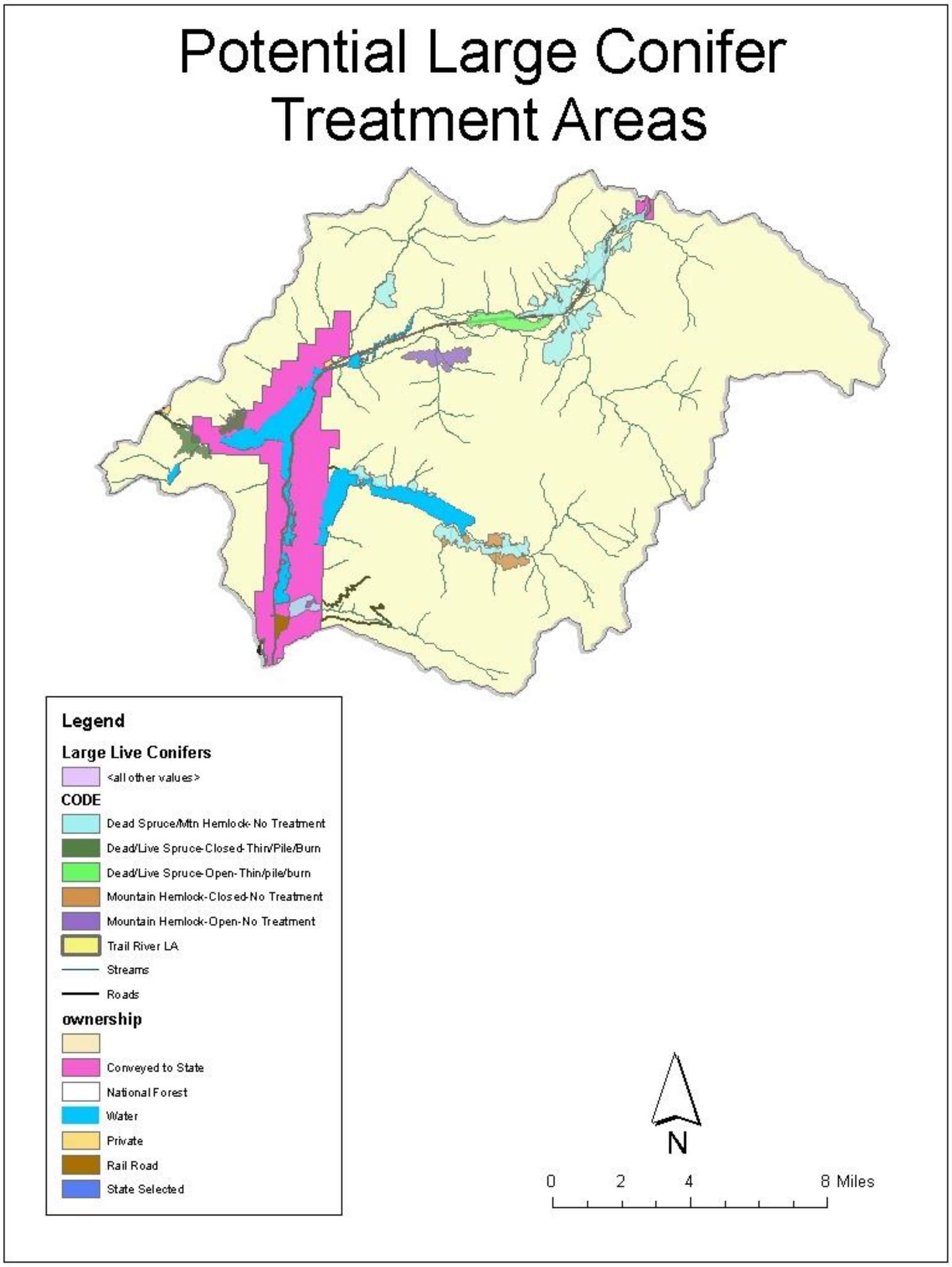

Figure 8.2. Potential Large Conifer Treatment Areas

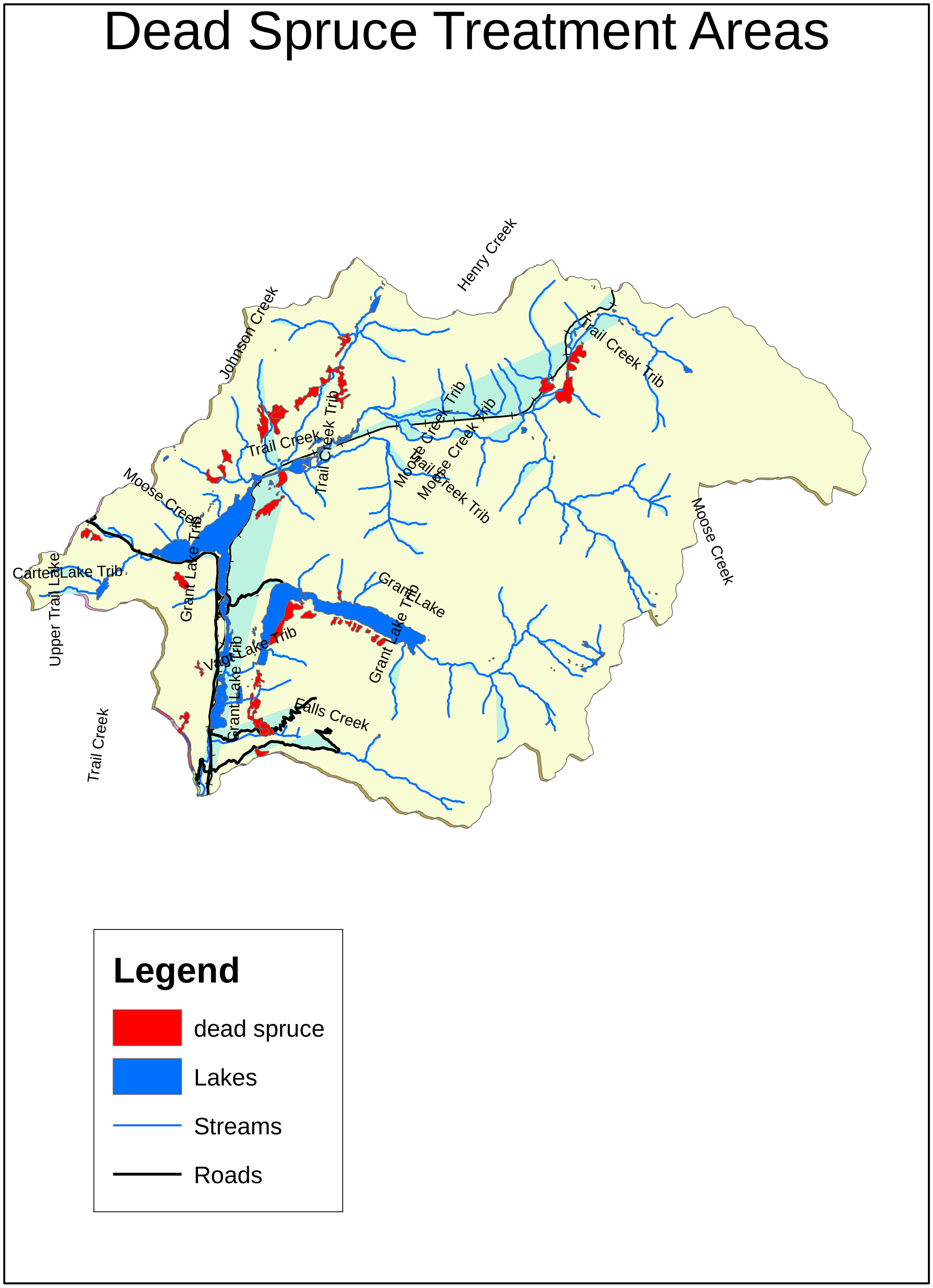

Figure 8.3. Potential Dead Spruce Treatment areas

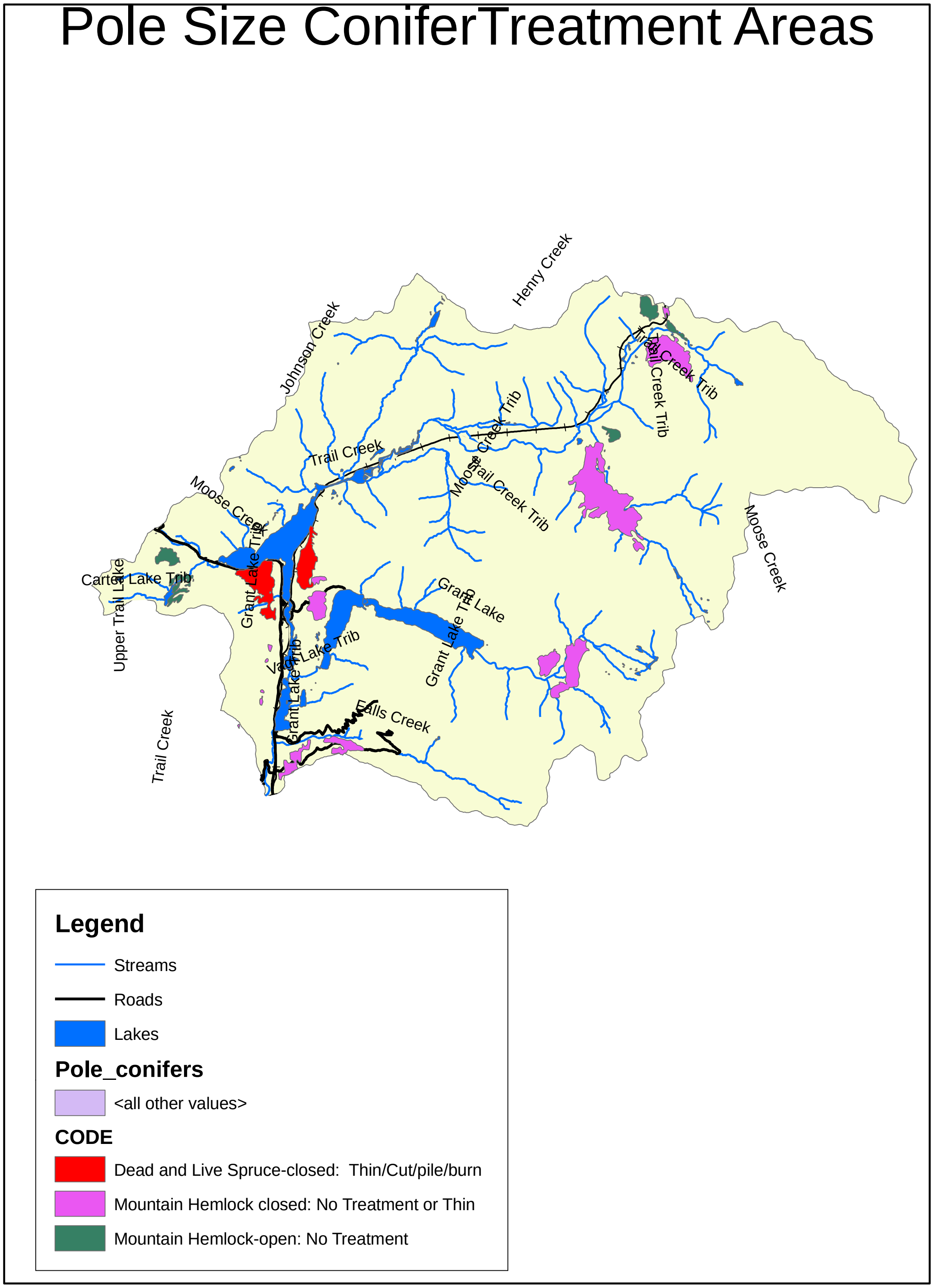

Figure 8.4. Potential Pole Size Conifer Treatment areas.

8.1.8 Human Uses

In response to the issue of potential increasing recreation impacts in the watershed: Monitor human uses in the watershed to maintain acceptable levels as identified in the forest plan.

The Heritage, Wildlife and Ecology Programs will begin to encourage Stewardship Agreements with Outfitter/Guides to:

Interpret historic sites for clients and monitor sites for the Forest.
Gather and interpret wildlife and invasive plant data
Retain the stocking of Vagt and Carter Lakes to provide fishing experiences different from combat fishing on the Russian and Kenai rivers
Develop partnerships to promote fishing on National Forest lands with ADFG, Kenai Sport Fish, and sport fishing associations.

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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%, 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%, and one-tenth acre in size on slopes greater that 72%. 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. Hicks (1982) developed the analysis process used on the Chugach NF. 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 because 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 measures 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 streamflows 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

APPENDIX B: PRELIMINARY TRAIL RIVER LANDSCAPE VEGETATION PROJECTS IDENTIFIED IN THE MOOSE HABITAT/VEGETATION 10 YEAR PLAN.

Trail River Landscape Vegetation Projects

Moose Pass 7A Fuel Reduction and Habitat Improvement: 416 Acres

Wildlife habitat improvement and fuel reduction activities on up to 416 acres of National Forest lands near the southern end of the Johnson Pass Trail near Trail Lake in T5 N., R1 E., Sections 4 and 5 and T6 N., R1 E., Sections 28, 33, 34 near Moose Pass on the Chugach National Forest.

The treatments consist of:

Within 100' of the Johnson Pass/Iditarod Winter Route and Summer Trail:

- Cut/pile/burn all spruce snags except those identified as wildlife trees (see mitigation).
- Hand pile all previously treated materials and natural dead and down material.
- Low to moderate intensity broadcast burning of piles within the fall/winter.
- Providing contractor motorized access to the project area during contract operations by snow machine or ATV.

Within 100-500' of the Johnson Pass/Iditarod Winter Route and Summer Trail:

- Promote willow regeneration for moose: Hinge cut Scouler's willow 7" above ground level.
- Cut/pile/burn 60% of spruce snags except those identified as wildlife trees (see mitigation).
- Hand piling of all treated materials and other dead and down material within 10' of piles. Place piles near Scouler's willow treatments when possible.

Beyond 500' of the Johnson Pass/Iditarod Winter Route and Summer Trail (west side of project area):

- Promote willow regeneration for moose: Hinge cut Scouler's Willow 7" above ground level.
- Hand piling of all treated materials and other dead and down material within 10' of piles. Place piles near Scouler's willow treatments when possible.

Within previous pre-fell units

- Hand piling of ALL treated materials.
- Hand piling of untreated dead and down material within 100' of the trail

Within all units:

- Cover piles with plastic and burn during fall/winter.

Piles will be approximately 10x10x8'

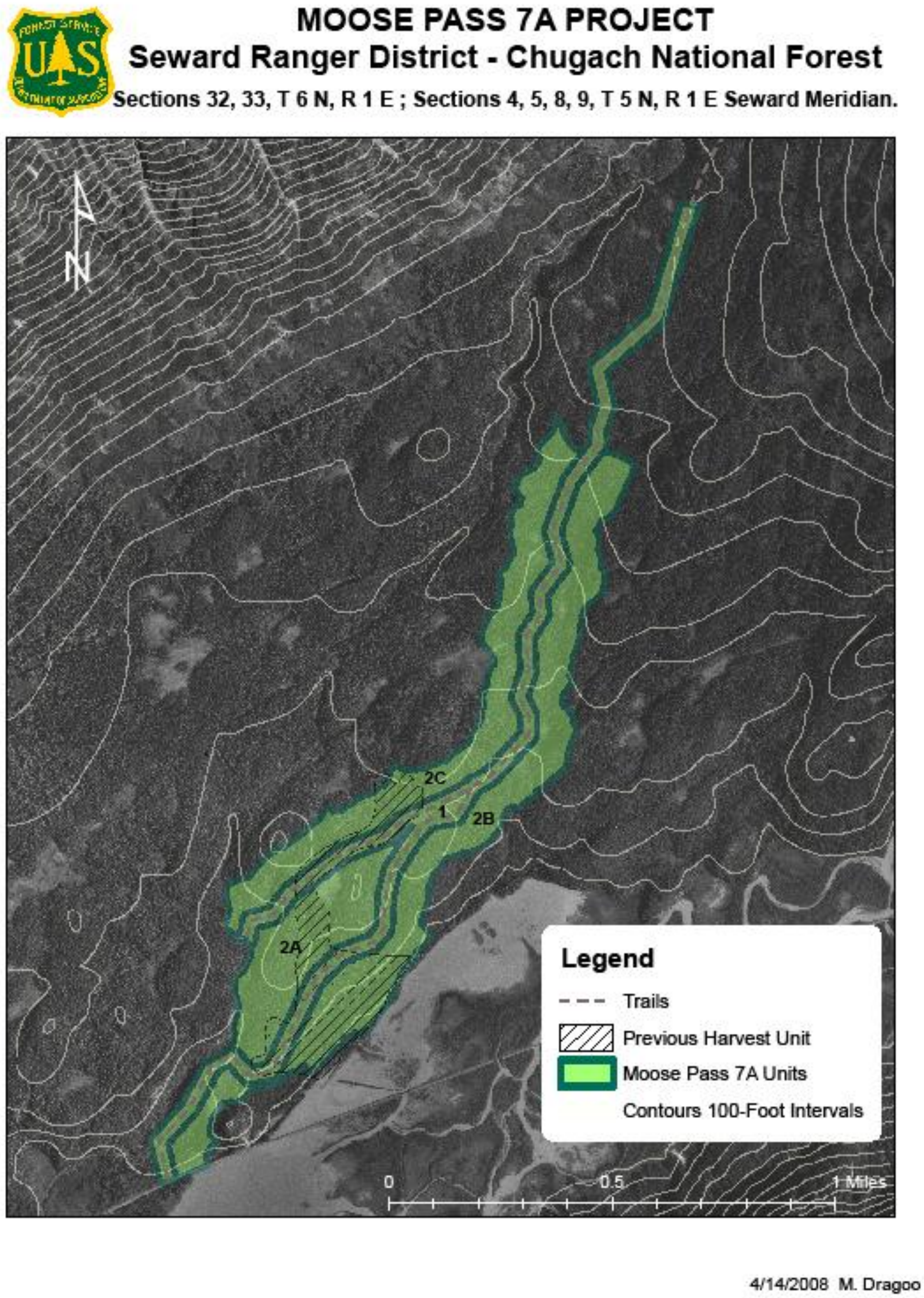

Figure B.1. Moose Pass 7A Habitat Improvement and Fuel Reduction Project (willow treatments not shown).

Avalanche Acres Shaded Fuel Break/Habitat Improvement: 442 Acres

Objectives

- Reduce fuels and fire risk in WUI. Address concerns and actions documented in the Moose Pass CWPP.
- Create fuel break between Moose Pass and Avalanche Acres.
- Enhance growth of large trees and hardwoods for wildlife habitat (migratory birds-near highway). Enhance moose browse in moose winter range away from highway.

Treatments

- Thin from below, remove spruce understory, enhance growth of dominant spruce and hardwoods. Tie treatments into avalanche chutes, prevent fire spread from Moose Pass to Avalanche Acres. Create sheltered hardwood belt.
- Remove dead spruce.
- Cut. Pile, and burn
- Mechanical and hand treatments
- Offer products such as firewood if possible
- Potential stewardship contract

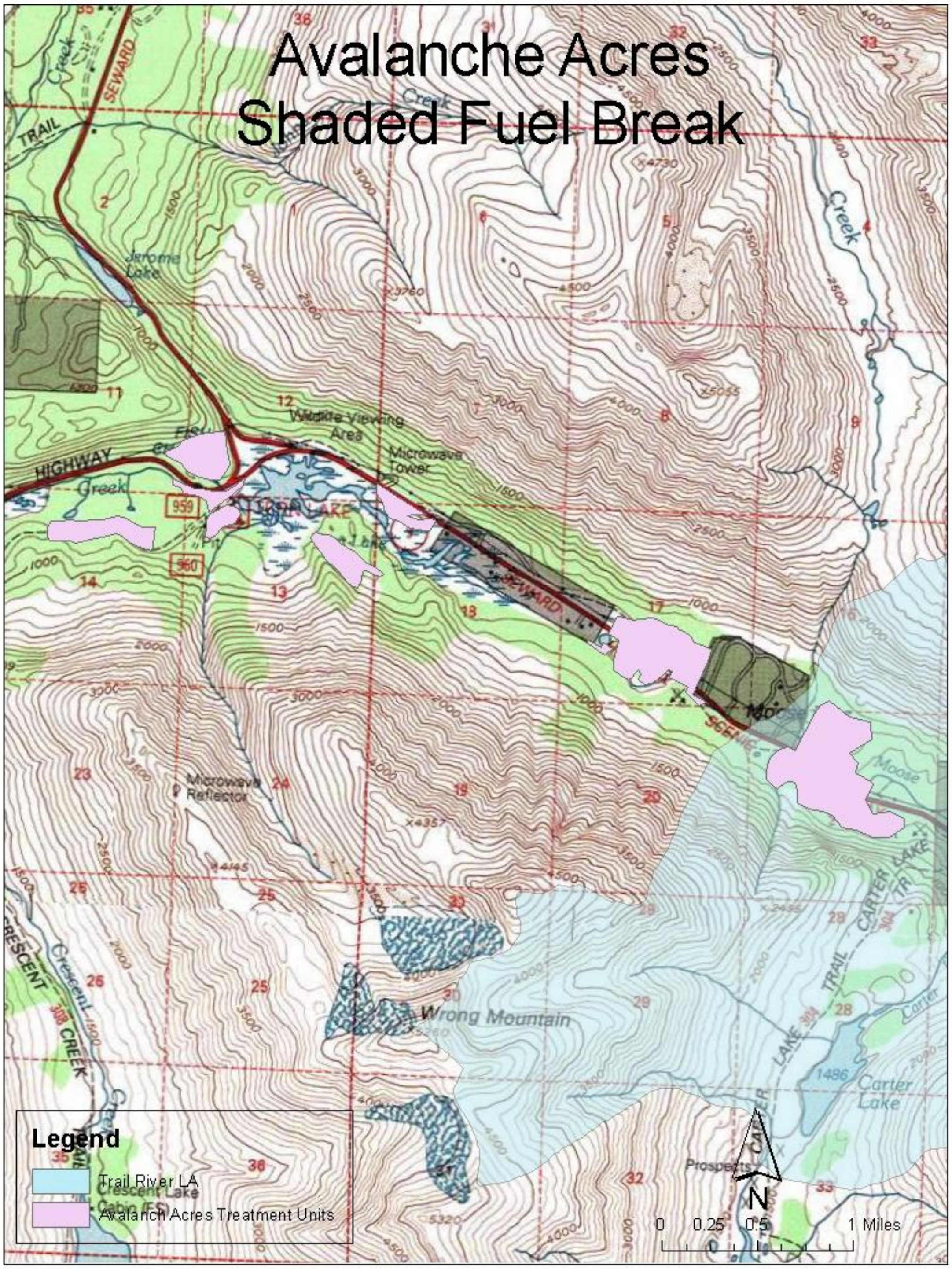

Figure B.2. Avalanche Acres Shaded Fuel Break and Habitat Improvement.

Trail Lake Fuel Reduction and Habitat Improvement

Objectives

- Reduce fuels and fire risk in WUI. Address concerns and actions documented in the Moose Pass CWPP.
- Reduce fuels adjacent to Trail Lake and the Johnson Pass Trail on state land. Create a fuel break near the fish hatchery.
- Enhance growth of large trees and hardwoods for wildlife habitat (migratory birds). Enhance moose browse.
- Tie fuel reduction to Moose Pass 7a unit and Avalanche Acres units.

Treatments

- Remove dead spruce within 500' of the trail, both sides.
- Cut. Pile, and burn
- Hand treatments
- Create fuel break near the fish hatchery which ties into natural boundaries (rock outcrops and avalanche chutes.

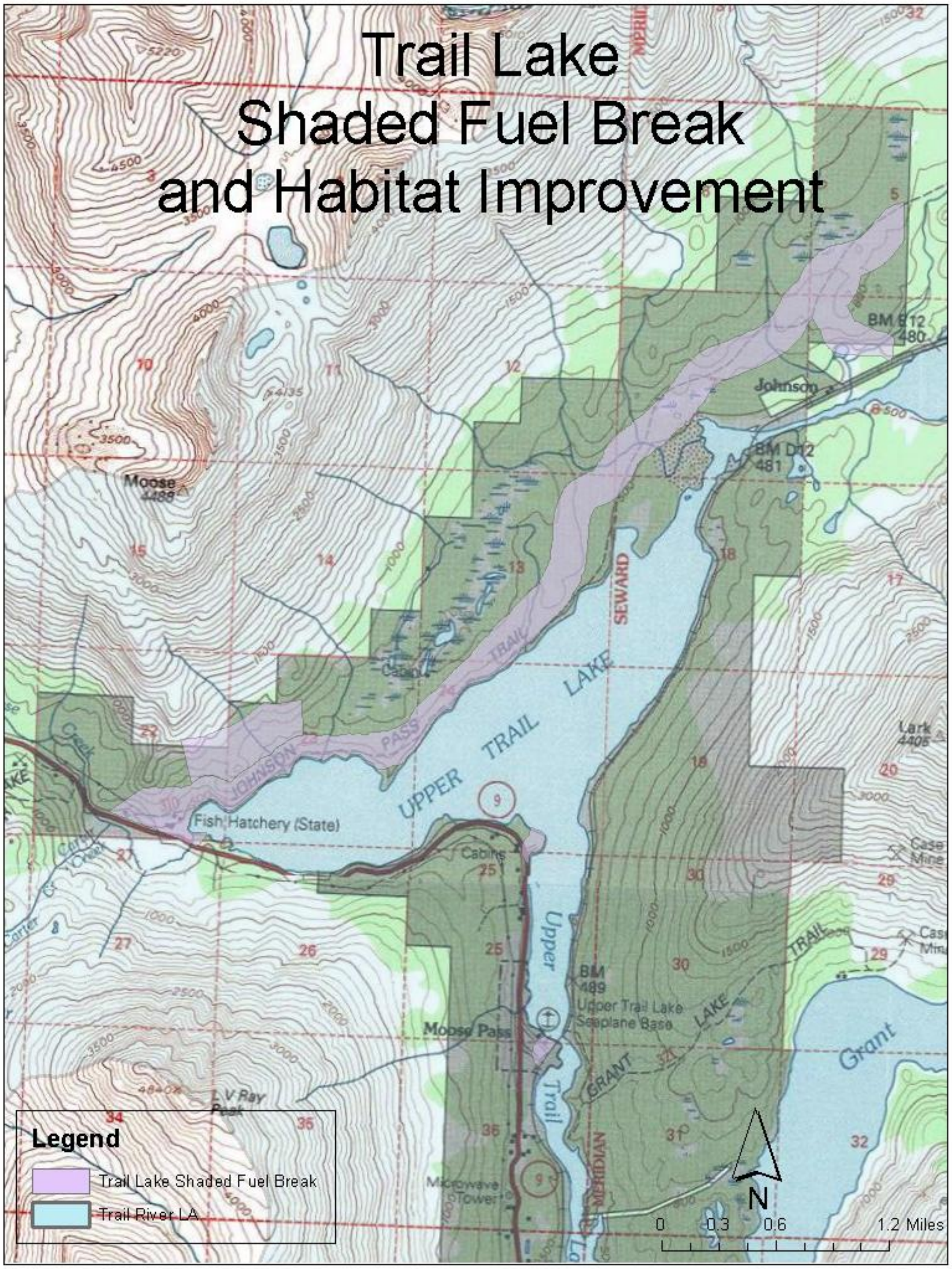

Figure B.3. Trail Lake Shaded Fuel Break and Habitat Improvement

This project includes cutting, piling and burning dead spruce within 500' of the Grant Lake Trail. The project can be a cooperative effort with the State, who owns the land adjacent to the trail on the west end.

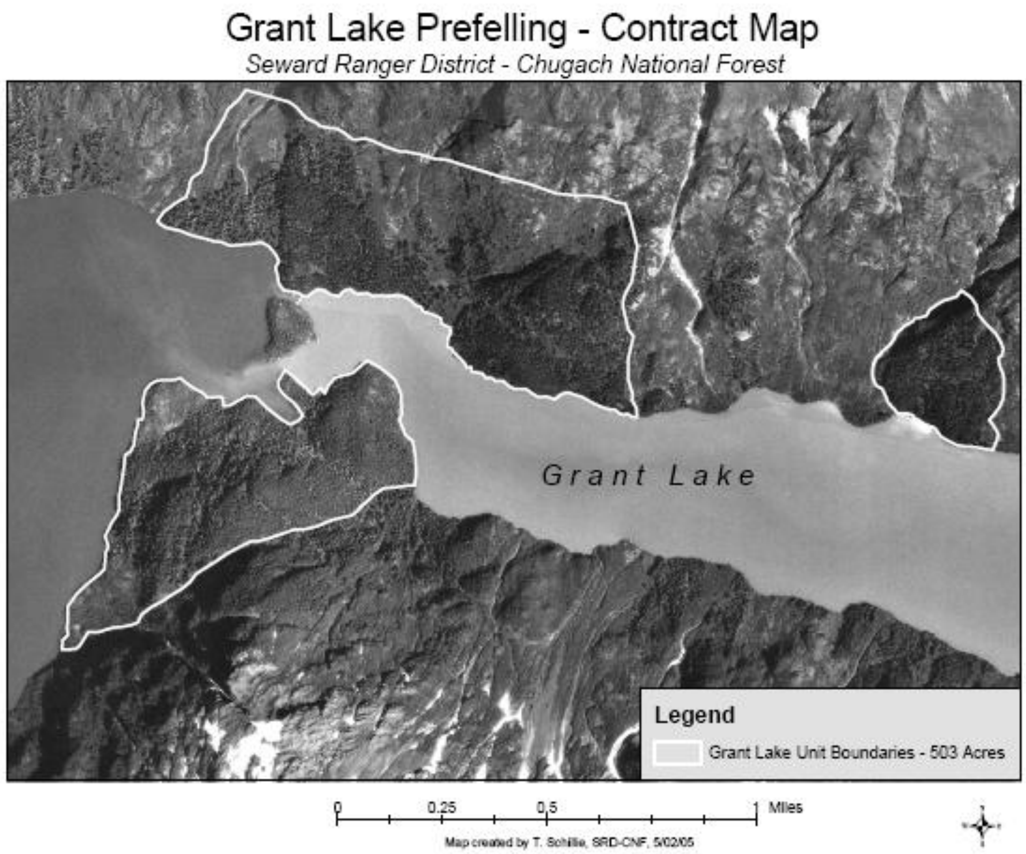

Figure B.4. Grant Lake Prescribed Burn

The purpose of this project is wildlife habitat enhancement for species dependent on early seral hardwoods (moose, etc). In addition to habitat improvement, treatments will accomplish hazardous fuel reduction, and improve forest health in areas adjacent to Grant Lake. Implementation of these treatments would substantially reduce the risk of catastrophic wildfires being started or carried through these portions of the Chugach National Forest.

OBJECTIVES

Pre-felling is necessary to increase the fuel loading to facilitate the Grant Lake prescribed burn, which will:

- Increase early seral hardwoods by prescribed burning.
- Reduce hazardous fuel loads created by the spruce bark beetle mortality.
- Enhance vegetative structural diversity and regeneration.

Trail River Feasability Study and Prescribed Burns

An IDT reviewed the potential to do treatments to reduce fuels and enhance moose habitat along the Trail River corridor in 2005. Some prescribed burn units had been identified based on spruce bark beetle activity and moose habitat (See Figure A.1). The team determined that accessibility was difficult, and treatments would be very expensive and impractical because of accessibility issues. In addition, information came to light that moose mortality was occurring along the railroad corridor. The team determined that any projects identified needed to consider this, and habitat enhancement would need to occur away from the railroad to reduce mortality. Note that Moose Pass 7A is in the process of being implemented as a cut/pile/burn rather than broadcast burn in a smaller area within the core area than shown on this map.

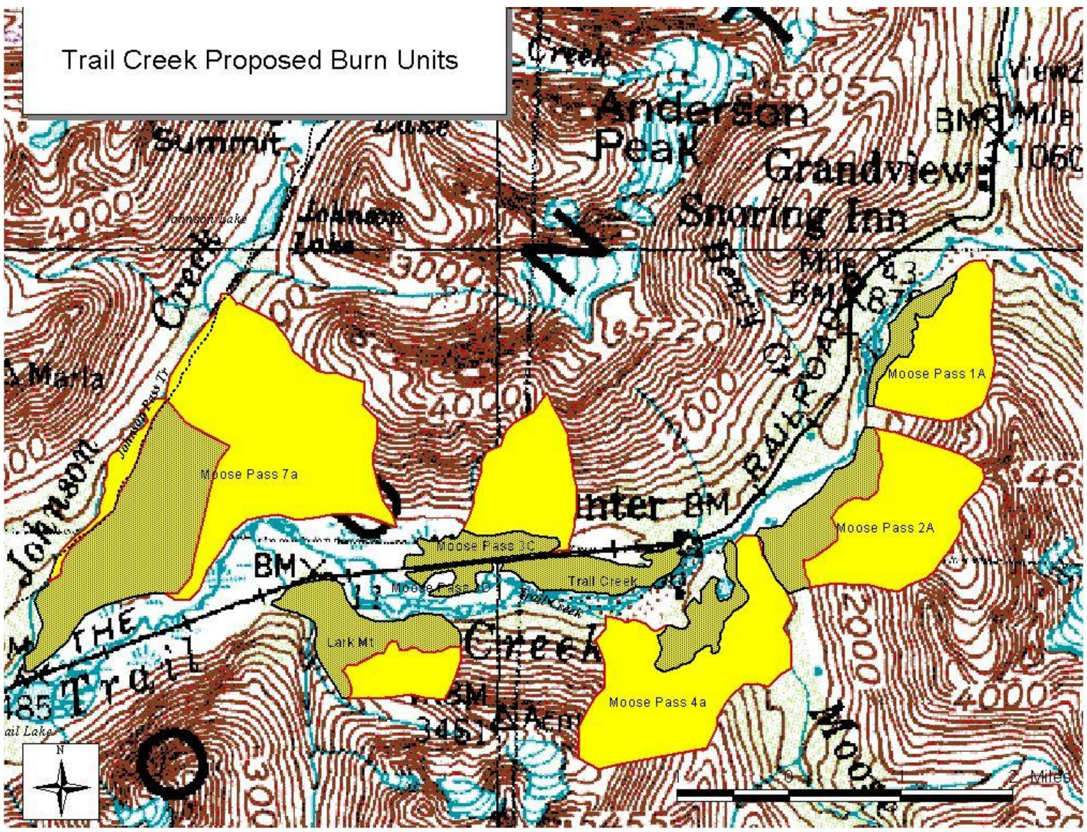

Figure B.5. Potential Prescribed Burn Units along Trail Creek

APPENDIX C: COVER CLASSES AND INFORMATION FOR KENAI PENINSULA BOROUGH VEGETATION MAPPING BY MARVIN RUDE-2007

Earth Cover Classes 1989 Thermatic Mapping Ducks Unlimited/Spatial Solutions, Inc.	Kenai Forest Cover Classes 1997-98 Color Infrared Photos Kenai Peninsula Bark Beetle Project	
Clear Water Turbid Water	Water –	W
Snow and Ice Barren/Sparcely Vegetated	Barren/Snow & Ice –	Bn
Closed Conifer >75% conifer & 60%+ cover	White Spruce -	Ws
Open Conifer >75% conifer & 25%-59% cover	Black Spruce -	Bs
	Sitka Spruce & Hemlock -	SH
	Mountain Hemlock -	Mh
	Dead Species – Precede with D	
Woodland Deciduous 10% - 24% cover	Cottonwood	C
Closed Deciduous >75% decid & 60%+ cover	Aspen	A
Open Deciduous >75% decid & 25% – 59% cover	Birch	B
Closed mixed – Less than 75% dominant, 60%+ cover	Mixed – White Spruce, Hardwood	WsHd
Open mixed – Less than 75% dominant, 25% - 59% cover	Black Spruce, Hardwood	BsHd
	Aspen & Birch	AB
	Hardwood and WSpruce	HdWs
Alder - > 80% alder	Alder	Ald
Alder/Willow Riparian >60% alder or willow	Willow	Wil
Willow > 80% willow	Other Shrubs	OS
Other Shrubs < 80% willow or alder		
Herbaceous/Graminoids - < 40% shrub & < 40% Herb&grass	Grass & Herbs	GH
	Marsh	Mrsh
Clouds Cloud Shadows	Nonforest – gravel pits, beach, agricultural, urban less than 10% stocked	NF
	Harvest Area	Hvst
	Harvest with remaining Hdwd	HvstHd

Size Class:		
seedling and saplings	1-5 in	1
Poles	5-9 in conifer	2
	5-11 in hrdwd	2
Large	9 in + conifer	3
	11 in + hrdwd	3

Stocking Percent:		
Woodland	10% - 24%	W
Open	25% - 59%	O
Closed	60% - 100%	C

Understory: Where significant and can be clearly seen on photos will be designated with a " / "
Example: DWs3O/Ws2 would be a dead overstory of large white spruce in an open stand with live white spruce unerstory.

Classification Key For Kenai Forest Cover Classes

The Alaska Vegetation Classification by L.A. Viereck, C.T. Dyrness, A.R. Batten and K.J. Wenzlick used as a guide.

I. Water--- --------(W)

II. Nonforest (< 10% stocked) ----------------(No Vegetation High Country)------ Barren/Snow/Ice (Bn)
-----------------(No Vegetation Low Country)--------------- Nonforest (NF)

III. Forest (10% or greater stocking with trees)

A. Dead Trees---Species, Size Class, and Stocking preceded with (D)

B. Live Trees— a.Conifer – White Spruce--(Ws) –Size Class Stocking
-- Large (3) - Woodland 10%-24% (W)
-- Pole (2) - Open 25% - 59% (O)
-- Seed/Sapling(1) - Closed 60% - 100% (C)

Black Spruce-- (Bs) –Size Class Stocking
-- Large (3) - Woodland 10%-24% (W)
-- Pole (2) - Open 25% - 59% (O)
-- Seed/Sapling(1) - Closed 60% - 100% (C)

Sitka Spruce/Hemlock-- (SH) –Size Class Stocking
-- Large (3) - Woodland 10%-24% (W)
-- Pole (2) - Open 25% - 59% (O)
-- Seed/Sapling(1) - Closed 60% - 100% (C)

Mountain Hemlock-(Mh) –Size Class Stocking
-- Large (3) - Woodland 10%-24% (W)
-- Pole (2) - Open 25% - 59% (O)
-- Seed/Sapling(1) - Closed 60% - 100% (C)

b. Deciduous - Cottonwood ----(C) –Size Class Stocking
-- Large (3) - Woodland 10%-24% (W)
-- Pole (2) - Open 25% - 59% (O)
-- Seed/Sapling(1) - Closed 60% - 100% (C)

Aspen----- (A) – Size Class Stocking
-- Large (3) - Woodland 10%-24% (W)
-- Pole (2) - Open 25% - 59% (O)
-- Seed/Sapling(1) - Closed 60% - 100% (C)

Birch ------(B) –Size Class Stocking
-- Large (3) - Woodland 10%-24% (W)
-- Pole (2) - Open 25% - 59% (O)
-- Seed/Sapling(1) - Closed 60% - 100% (C)

c. Mixed Stands

White Spruce and Hardwoods - (WsHd)

–Size Class	Stocking		
-- Large (3)	- Woodland	10%-24%	(W)
-- Pole (2)	- Open	25% - 59%	(O)
-- Seed/Sapling(1)	- Closed	60% - 100%	(C)

Black Spruce and Hardwoods - (BsHd)

–Size Class	Stocking		
-- Large (3)	- Woodland	10%-24%	(W)
-- Pole (2)	- Open	25% - 59%	(O)
-- Seed/Sapling(1)	- Closed	60% - 100%	(C)

Aspen and Birch – (AB)

–Size Class	Stocking		
-- Large (3)	- Woodland	10%-24%	(W)
-- Pole (2)	- Open	25% - 59%	(O)
-- Seed/Sapling(1)	- Closed	60% - 100%	(C)

Hardwoods and White Spruce – (HdWs)

–Size Class	Stocking		
-- Large (3)	- Woodland	10%-24%	(W)
-- Pole (2)	- Open	25% - 59%	(O)
-- Seed/Sapling(1)	- Closed	60% - 100%	(C)

e. Harvested Stands------------------(Hvst)

IV. Shrubs

A. Alder---(Ald)
B. Willow---(Wil)
C. Other Shrubs-----------------------------------(OS)

V. Grasses and Herbaceous-DRY------------------------(GH)
VI. Marsh- WET grasses and herbaceous------------(Mrsh)