Resurrection Creek
Landscape Analysis
Hope, Alaska

Prepared for
U.S. Department of Agriculture
Chugach National Forest

January 31, 2002
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Prepared by
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RESURRECTION CREEK LANDSCAPE ANALYSIS

EXECUTIVE SUMMARY

INTRODUCTION

This landscape analysis was initiated as result of human and natural influences which have significantly affected the Resurrection Creek watershed association. The assessment area includes the Resurrection Creek watershed, the Bear Creek watershed, and segments of land along Turnagain Arm to the east and west of the mouth of Resurrection Creek (see Map A). It is within U.S.D.A. Forest Service (USFS) mandates to manage to provide for human use of the land while protecting ecological integrity. The two primary issues which were catalysts for landscape analysis are the effects of placer mining on the aquatic ecosystem, and the effects of extensive infestation of spruce bark beetle.

This landscape analysis used “Ecosystem Analysis at the Watershed Scale: a Federal Guide to Watershed Analysis” (BLM 1995) for developing the report. It is different, however, in two ways. The “watershed association” includes areas not within the Resurrection Creek drainage, but adjacent to it. This landscape analysis also included a public comment program, the results of which are in a separate document, the Comment Analysis Report.

Landscape analyses are commonly described as occurring on two “levels.” Level 1 is a low-intensity assessment, which uses existing documents and assembles them into a coherent analysis of the watershed. Level 2 goes further, collecting original data on streams, habitats, soils, and water quality, among other topics. This document is a Level 1 analysis, as it is based entirely on existing documents. Many of the documents were recently assembled by USFS staff for the respective resource areas.

This document is divided into sections which parallel the suggested structure in the Federal Guide to Watershed Analysis (BLM 1995). These sections are as follows:

- Watershed characterization;
- Key issues and questions;
- Current conditions;
- Reference conditions;
- Synthesis and interpretation; and
- Recommendations.

The following core topics are discussed within each of these sections:

- Erosion processes;
- Hydrology;
- Stream channel;
- Water quality;
- Aquatic species and habitats;
- Vegetation;
- Terrestrial species and habitats; and
- Human uses.

WATERSHED CHARACTERIZATION

The Resurrection Creek watershed association is located in the north-central Kenai Peninsula in south-central Alaska, and contains the community of Hope. Resurrection Creek, Bear Creek, and Porcupine Creek all flow into the Turnagain Arm of Cook Inlet. The watershed association encompasses 111,734 acres (174 mi^2) within the Western Kenai Mountains ecosection, which is a subsection of the Kenai Mountains ecosection. Most of the land within the Resurrection Creek watershed association (98 percent) is National Forest System land. The remaining lands are private, state, state selected, and borough owned. There are 121 active mining claims, comprising an area of 3,367 acres within the watershed association.

The entire watershed is underlain by Cretaceous metasediments of the Valdez Group. Placer gold deposits, first discovered in the late 1800s, are present within the watershed association. Lode gold production has been small. Soils in valley floors are developed mostly on deposits left by departing glaciers, and on alluvium. Soils are typically greater than 40 inches deep.

The climate of the study area is dominated by marine storm systems. Its proximity to the Gulf of Alaska, as well as its high latitude, make the climate cool and generally moist. Hope has a mean annual precipitation of 22.2 inches due to the rain shadow of the Kenai Mountains. Streamflow is dominated by spring snowmelt; hence, peak flow events in the watershed association typically occur in late spring and early summer.

There are approximately 251 miles of streams (1.6 stream miles/mi^2) within the watershed association. Resurrection Creek (24 miles) and Palmer Creek (11 miles) are the longest creeks in the watershed association. The Resurrection Creek watershed contains a variety of stream channel types, which are typical of watersheds in south-central Alaska. Water quality generally remains well within State of Alaska water quality standards, although past mining activities may have contributed contaminants to surface and ground water.

Anadromous species known to use Resurrection Creek include coho, pink, chinook and chum salmon: anecdotal reports suggest that occasional occurrences of sockeye salmon may also occur. Pink salmon are also known to use the lower portion of Bear Creek. Resident fish include Dolly Varden, whitefish, sculpin, stickleback, and possibly rainbow trout. Pinks are by far the most abundant species, having what are considered to be moderate-sized runs. Insects found in Resurrection Creek and other creeks within the watershed are those typically found in cobble-dominated streams. Wood frogs are the only amphibian species in the watershed association.

Vegetation in the watershed association is typical of the transitional zone between boreal forests or northern latitudes and the northernmost coastal temperate forests that are generally found farther to the south. Plant communities range from dwarf-scrub and grasslands typical of alpine areas to a variety of forested uplands and wetlands on the side slopes and alluvial valley bottoms of the different subwatersheds. Interspersed among the forested types, often in riparian areas, on floodplains, alluvial terraces, or in tide flats are various freshwater and estuarine wetlands composed of graminoid herbaceous types, tall and low scrub types, and aquatic herbaceous types.

Terrestrial habitats range from barren snow and ice, steep rocky slopes, and alpine tundra and meadow that provide summer range for mountain goat and other species, to a variety of forested upland habitats and wetlands on the side slopes and alluvial valley bottoms of the different watersheds. These habitats support diverse arrays of large and small mammals, including moose, bear, wolverine, wolves, snowshoe hare, and red-backed voles. Portions of the watershed association function as major migration corridors for moose and caribou as well as the predators they sustain. A variety of migratory and resident birds, including sparrows, thrushes, warblers, goshawks, woodpeckers, and eagles, are also found in the watershed association.

The heritage resources of the watershed include both prehistoric and historic remains, and a variety of historic properties and property types that are either on or are eligible for the National Register of Historic Places (NRHP). The historic mining resources constitute the majority of the known significant heritage resources in the watershed. Only two Alaskan Native related sites are known from within the watershed boundaries. Prehistoric use of the watershed was probably related to the presence of sheep and caribou, and possibly anadromous fish runs. Russian mining exploration on the Kenai Peninsula during the late 18th and early 19th centuries was minimal.

KEY QUESTIONS

During the initial stages of this analysis, a set of "key questions" was developed (by the Analysis Team) from existing basic background information to help frame the issues to guide and define the analysis. This included existing information on watershed conditions, land allocations and current management direction. Many of the questions concern the status of each resource, how this compares with reference conditions, and what processes are at work. Key questions were developed for each key topic.

CURRENT CONDITIONS

Mining and Development

The presence of gold placer and lode deposits has played a critical role in the development of this area over the last century, with lasting effects on the aquatic and terrestrial habitats. It was not until 1974 that USFS Mining Regulations were published and required operators to submit plans in order to mine on USFS-managed lands. The Hope Mining Company (HMC) received its first approved mining plan of operations in 1985. Because of the current low value of gold, and because of the concentrations present in the watershed association, large scale development of these deposits is unlikely. Recent placer mining-related activities in the Resurrection Creek watershed have used various types of equipment, including bulldozers, backhoes, trommels, screening plants, and sluices. Currently, suction dredges are the most common piece of equipment used for placer mining.

HMC currently maintains approximately 60 unpatented federal mining claims that cover approximately 1,000 acres of land, by far the largest groups of claims in the watershed association.

In recent years, recreation and tourism have become an important part of the local economy, with use of the trails and cabins in the backcountry, and campgrounds in the developed areas, becoming increasingly popular.

Erosion Processes

Erosion processes are not well understood in the watershed association, although mass wasting does not appear to be a significant component of sediment delivery to major streams. Snow avalanches occur in most of the tributary watersheds during winter and spring, carrying sediment with them, and often reaching streams. Sediment movement on high elevation, steep valley sideslopes and headwalls is thought to be high.

Soils have only been mapped in the lowest portions of the watershed, along Palmer and Resurrection Creek valleys. Generalized dominant soil types include typic cryorthods and dystric cryocrepts. Typic cryorthods are soils on mountain sideslopes, and footslopes developed on glacial till.

Road density is 0.2 miles/mi^2 within the watershed association; in the most developed areas, it is 0.9 miles/mi^2. This is a relatively low road density and, for the most part, roads are located away from major stream courses. No complete assessment of road surface erosion has been conducted.

A total of 29.5 miles of trail are present. Some localized erosion occurs on the trails, but has not been formally assessed.

Hydrology

Virtually all snow melts from the watershed over the spring and summer. Spring and summer streamflow relate directly to the total amount of snowfall received by the watershed. In addition, the snowpack insulates the ground, allowing greater baseflows in the winter. Snowfall amount affects the water quality of surface runoff as a result of contributed sediment from the channel banks during high snowmelt runoff flows.

During the summer and fall, elevated flows may occur in response to 1- to 3-day rain storms that occur in the region. High flows also occur during snowmelt periods and combination rainfall and snowmelt events. The non-flashy nature of the watershed association, along with its moderate annual precipitation and peak precipitation, keeps high flows relatively low. However, ice jams regularly cause flooding. The frequency and magnitude of this process in the Resurrection Creek watershed is poorly understood.

Channel changes related to mining have likely increased local flooding, as the channels are cutoff from the floodplain and are entrenched. This means a probable increase in flood peak sizes downstream from the mined areas, particularly floods associated with heavy rains. While approximately 50 percent of the forested land within the watershed has been affected by the spruce bark beetle, it is unlikely that this has had a significant effect on hydrology. The percentage of forested land in the watershed association is small, and tends to be in the lower areas which receive less precipitation.

However, localized increases in runoff within beetle-impacted forested areas due to reductions in evapotranspiration are possible.

Approximately 250 miles of mapped perennial stream channel exist in the watershed association; most of these are high-gradient tributary streams. The mainstem of Resurrection Creek is classified mainly as moderate- to low-gradient floodplain channel. A wide variety of placer mining operations from the 1890s up to the present have disturbed these sections of the creek from about river mile (RM) 2.0 to RM 6.5. This disturbance is associated with approximately 4 mi^2 of highly disturbed floodplain/riparian area. Mining has also significantly altered the lower portion of Palmer and middle portions of Bear Creeks.

Stream Channel

Channel disturbance from placer mining has simplified channel structure, reduced large woody debris (LWD), coarsened bed material, cut off the main channel from the floodplain, and eliminated much of the riparian vegetation. Additionally, these conditions have likely led to entrenchment of Resurrection Creek, although there are no data to confirm this. Because of the loss of fines and nutrients in riparian soils, natural revegetation of mined areas is likely to be extremely slow.

Spruce bark beetle infestation will likely lead to a short-term increase in LWD recruitment in those areas where spruce trees are present in the riparian zone. This increase is likely to be followed by a long-term decrease in recruitment, since so many spruce trees will have died. Notably, much of the riparian forest contains a mix of species, and is unlikely to be significantly affected either way. Only in the uppermost reaches, where Lutz spruce is the dominant riparian forest type, might there be significant short- and long-term effects.

Water Quality

Water quality within the landscape analysis area is generally well within Alaska State water quality standards, although past mining operations may have caused some contamination particularly through increased turbidity and sediment loads. Concentrations of heavy and trace metals were measured at several locations upstream, within, and downstream of active mining sites in the watershed and wash water. Concentrations in excess of State water quality levels were measured on five occasions. Manganese concentrations exceeded standards within wash water on Resurrection and Palmer Creeks in 1980. In the same year, lead concentrations surpassed standards within wash water and downstream of mining on Resurrection Creek. Notably, water quality sampling has been extremely limited.

Aquatic Species and Habitat

Anadromous and resident fish are present in the watershed association. Five species of anadromous salmonids are present. Pink salmon are the most numerous species inhabiting Resurrection Creek, and their plentiful numbers have given rise to a yearly fishing derby held in Hope. In even-numbered years, which are the most productive for pink salmon, returns are estimated to be between 20,000 and 35,000. Chum salmon are much less numerous, with about 200 returning yearly. Coho peak counts on Resurrection Creek range from 100 to 500 returning adults per year. Chinook salmon are the largest salmon that spawn and use waters of Resurrection Creek for rearing juveniles. Chinooks range from less than 100 to 500 returning adults per year.

Resident fish include Dolly Varden, whitefish, sculpin, stickleback, and possibly rainbow trout. While Dolly Varden are known to be present, there is no information about their population status in the Resurrection Creek watershed. Rainbow trout may exist above impassible barriers. However, the anadromous form of rainbow trout, steelhead trout, does not occur here. There are no population data on rainbow trout.

Surveys conducted in the summers of 1990 and 1991 observed that chinook and coho salmon fry primarily reared in side channels or protected margin waters of the main channel. Much of this habitat is not available during winter low flows, indicating that winter rearing habitat is likely the primary limiting factor in Resurrection Creek.

Vegetation

Distribution and structure of plant communities have developed in response to existing land uses, climate, wildfire, past and present spruce bark beetle infestations, and other natural processes. Because human land use activities have influenced only about 1 percent of the area within the entire watershed association, the distribution of plant communities has not been adversely influenced by human uses within these watersheds with a few exceptions. Fire, existing and past spruce bark beetle infestations, avalanches, landslides, and other natural processes appear to be the major determinants of the current patterns and distribution of the various cover types. Fire effects in this area are mostly human-caused.

Prior to European settlement, fire frequency was likely lower than it is now, ranging from return intervals of somewhere between 100 to more than 600 years. Large stand-replacing fires occurred at long intervals usually ranging between 250 and 500 years. These occur under extreme events of low fuel moisture, high temperature, low relative humidity, and high winds. It is possible that spruce bark beetle infestations were instrumental in predisposing forest landscapes to large fires. Historically, most ignitions in the region resulted in fires of small area and ecological impact because fuel moisture limited the intensity, size, and severity of burns.

Terrestrial Species and Habitats

Within the watershed association, there are three management indicator species (moose, caribou, and brown bear) and five other species of concern (bald eagle, northern goshawk, wolverine, harlequin duck, and northern red-backed vole) to characterize existing conditions.

Moose are dependent on early seral vegetation types, including young willow, birch, cottonwood, and aspen stands for winter forage; winter range habitat is considered the primary population limiting factor. The continuing spruce bark beetle infestation has altered the habitat structure and function across the watershed association area. Dead or dying spruce forest types are likely to be replaced by early seral phase vegetation communities favorable to moose. Dead and dying spruce have contributed to increased fuel loading that provides opportunities for using prescribed burns to promote early seral vegetation type habitat favored by moose.

The nearness of large nest trees to food sources is the primary limiting factor for the bald eagle population. Eighty-two percent of all bald eagle nests on the Seward Ranger District are in mature cottonwood trees with an average diameter of 31 inches and within one-quarter mile of an anadromous-fish-bearing stream. There is a significant lack of such trees in the watershed association, in part due to past mining activities.

Harlequin ducks nest along the rapids of inland mountain streams, such as those in the watershed association. Nests are located near the waterline adjacent to rapids but near shallow, quiet pools used for rearing. Placer mining has disrupted potential nesting and rearing habitat and reduced food sources. However, there are no existing data on habitat quality or brood production.

Brown bears have large home range requirements and are generally intolerant of human activities and development. According to a habitat model, development in the watershed association has reduced their available spring and summer habitat to 44 and 39 percent of historical habitat, respectively.

After caribou were extirpated from the Kenai Peninsula, they were re-introduced in the 1960s. Habitat within the watershed association, productivity, and age structure of the herd were likely affected by wildfires during the early 1900s. Current habitat use is unknown but will be quantified once a winter range study, already underway, has been completed.

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 in and their use of the watershed association.

An uncommon forest raptor, the northern goshawk feeds in the understory on squirrels, birds, and snowshoe hares. The spruce bark beetle infestation is altering habitat structure in old-growth stands favored by the northern goshawk by accelerating the rate of spruce tree mortality, canopy closure, and understory cover.

The northern red-backed vole is the most abundant and widely distributed microtine in south-central Alaska. Results of recent population studies indicate that vole densities vary in different vegetation types; some beetle-infested areas may need to be maintained to ensure that reservoirs of these small mammals are provided over time.

Human Uses

Current human uses are diverse. Mining, both commercial and recreational, occurs along Resurrection Creek and its tributaries and along Bear Creek. Recreation in the form of camping, hiking, and motorized sports, is concentrated along stream, trail, and road corridors.

Development has focused on the State lands in the lowermost portions of the watershed. Housing and road building have been conducted on a relatively limited scale.

Subsistence uses of the watershed, while not official, include the harvest of special forest products (e.g., mushrooms, berries, moss), hunting of game, fishing, and use of forest for building materials and firewood.

The management of heritage resources by the USFS is legislated by Acts of Congress and Executive Orders, which mandate inventories of heritage resources, and preservation and interpretation of all types of heritage resources for the benefit of the public. Of the 111,734 acres that comprise the total area of the Resurrection Creek watershed association, about 2,372 acres, or about 2 percent of the total area, were surveyed for heritage resources prior to 1992 (CNF GIS data). Archaeological surveys in the past 10 years have added about 3,000 acres to this amount, for a total survey area of approximately 5,400 acres within the watershed, or almost 5 percent of the total area. These surveys have been project-related, for the most part, and so are discontinuous in nature. There are two prehistoric sites and more than 40 known historic sites, including sites associated with Russian settlement in the region.

REFERENCE CONDITIONS

For each of the resource study areas, data on reference conditions is extremely limited. Reference conditions can only be inferred in some cases by knowledge of general effects of human development and natural landscape changes during the last 150 years or so.

Undisturbed or slightly disturbed reaches can indicate reference conditions for streams. These show that channel changes have been significant, leading to significant changes in channel form, complexity, and streamflow. This has in turn led to a decrease in available habitat for fish, aquatic insects, and terrestrial species that use riparian habitat.

Changes in plant communities have been inferred from trends of recent infestations of spruce bark beetle and human development. Much of the forested portion of the watershed has changed significantly since European settlement, although some of this change is within the natural variability of forest conditions.

Due to the relatively recent settlement of the project area, many heritage resources now of concern did not exist 100 years ago. In addition, each year more properties with historic features reach the 50-year mark, and are therefore added to the list of management responsibilities.

SYNTHESIS AND INTERPRETATION

This section combines the information obtained from the various resource areas. The interconnected nature of many watershed functions necessitates collaboration among resource analysts. The following main conclusions were developed in the synthesis process:

- Placer mining has disrupted channel form and function, limited available salmonid habitat, and decreased flood routing times through affected reaches;
- Spruce bark beetle infestation has led to increased risk of fire and a short-term increase in LWD recruitment potential;
- Recreation has had small-scale effects on surface and streambank erosion;
- Mining and road building do not appear to have had an effect on mass wasting;
- Water quality is affected by mining operations on a short-term basis;
- The spruce bark beetle negatively affected habitat for some species, and positively affected habitat for others; and
- The human activity of mining has directly and cumulatively created cultural resources whose eligibility for the NRHP must now be considered.

These conclusions focused the development of recommendations for restoration and management of the watershed association.

RECOMMENDATIONS

Three main restoration and management components were identified: aquatic habitat restoration, vegetation restoration and management, and heritage resources/human uses management. Where appropriate, restoration/-management recommendations included options that varied by level of effort and by tasks. A summary of the recommendations for management and restoration is presented in Table 1.

The aquatic restoration/management recommendations were the most involved. Two options were developed, provided mainly as points for discussion. The options represent points on a continuum of options available; their components are meant to demonstrate potential management tools. A major element common to both options is completion of several surveys deemed necessary to make decisions about restoration alternatives.

These surveys include channel, riparian, and fisheries surveys. Any restoration activity would have to be conducted in accordance with the heritage resource management plan, another component of the recommendations.

The next major area of recommendations concerns fuels management and wildlife habitat. While the USFS is currently conducting activities to reduce fuels loading, additional options are presented here to further reduce the risk of large wildfires. Two options are presented, which vary in level of effort required. The first option focuses on lowering fuels levels and providing fire breaks in the developed areas in the lower watershed (around the community of Hope). The second option includes treatments in the upper watershed as well, around those areas where human activities increase the risk of wildfire. Various types of fuel-reducing activities would occur around cabins and campsites. Treatments would be conducted in a way that minimizes visual and recreational impacts.

Hardwood management, a subset of the vegetation management, was deemed important enough to consider separately. The large birch stands near Hope and upstream represent potential fire hazards and at the same time opportunities for enhancing wildlife habitat. Recommendations involving two levels of intensity are presented. The highest priority is to reduce fire risk in the vicinity of Hope. The second priority would be to increase size class diversity of birch in the large stand created by fires in the 1920s. Third in priority would be to increase diversity of birch size class in the upstream stand, in the vicinity of the Palmer Creek/Resurrection Creek confluence. Aspen, while constituting a tiny fraction of the cover types in the project area, should be expanded due to their value as moose browse. The more intensive management recommendation would include treatment of the upper birch stand and aspen stands, as well as treatment of the Hope area and adjacent birch stand.

The third area of recommendations concerns human uses and heritage resources. Several components of restoration or management were identified. For recreational gold panning, the first option would establish a registration process for miners in which they acknowledge and accept responsibility for acceptable mining practices, and provide signage that instructs miners to avoid the stream bank and warns of safety issues. The second option would include the above, but would ban suction dredging (also part of aquatic restoration recommendations).

A key component in watershed restoration will be the inclusion of a plan to protect heritage resources, including cultural landscapes. A mechanism is needed to preserve historically significant heritage resources while allowing as complete a restoration of the stream channel as desired. The first objective would be to complete an inventory of heritage resources. One way of achieving this would be to partner with interested entities for documentation and interpretation of heritage resources, and rehabilitation of historic buildings. The USFS could develop collaborative stewardship relationships with interested parties for protection and interpretation of heritage resources. In addition to bringing the USFS into closer compliance with NHPA section 110 and Executive Order 11593, completing a heritage resource inventory would also proactively make compliance with section 106 much easier, as resources and their eligibility for the NRHP would already be known for specific project areas. The USFS would establish an interpretative walking tour of heritage resources, and rehabilitate and/or maintain historic cabins in the watershed association. Two options, of lesser and greater intensity, are presented here as well.

Also included in the human uses/heritage resources recommendations are several low-cost options to protect viewsheds, enhance specific recreational opportunities, and to improve accessibility to recreation resources.

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RESURRECTION CREEK LANDSCAPE ANALYSIS, WATERSHED CHARACTERIZATION

1.0 INTRODUCTION

The Resurrection Creek watershed has experienced a wide variety of changes within historical times, due to both natural and anthropogenic causes. It is the U.S. Forest Service's (USFS) mandate to maintain and protect public resources and beneficial uses of National Forest System land. In order to respond to damaged resources and degraded land, and to enable future decision-making regarding the uses of the watershed and its resources, the USFS has initiated a landscape-level assessment. A landscape analysis is broader than a watershed analysis, and includes public involvement. It is an appropriate way to gather existing information and examine the interrelationships between physical, biological, and chemical processes. The present study follows the steps in the federal guide to watershed analysis (BLM 1995). In this document, the following steps will help characterize the watershed, its important issues, and potential solutions. The steps are as follows:

1. Watershed characterization;
2. Key issues and questions;
3. Current conditions;
4. Reference conditions;
5. Synthesis and interpretation; and
6. Recommendations.

This document will follow these steps, and make recommendations for restoration activities and management direction which will provide direction for future management. This document addresses the core topics listed in the guide to watershed analysis (BLM 1995):

- Erosion processes;
- Hydrology;
- Stream channel;
- Water quality;
- Vegetation;
- Species and habitats; and
- Human uses.

This document relies heavily on existing documentation; portions of a watershed analysis already completed by the USFS were used extensively.

Additionally, input was sought from the public on key issues, so that those concerns identified by the public would be included in the analysis as appropriate. Public comments are listed and discussed in a separate document, the Comment Analysis Report, in Appendix A.

2.0 LANDSCAPE CHARACTERIZATION

The Resurrection Creek watershed is located in the north-central Kenai Peninsula in south-central Alaska near the community of Hope (see Appendix A, Map A inset), and encompasses 103,230 acres (161.2 mi^2) within the Western Kenai Mountains ecosection, a subsection of the Kenai Mountains ecosection. Topography consists of rounded, frost-churned mountaintops separated by valleys shaped by alpine glaciers, characteristic of the Western Kenai Mountains ecosection (Davidson 1996). Resurrection Creek flows into Turnagain Arm of Cook Inlet; the watershed comprises 19 delineated subwatersheds (see Map A), with three subwatersheds draining into Turnagain Arm adjacent to the mouth of Resurrection Creek. These are Bear Creek (4,096 acres), Turnagain B (3,351 acres), and Turnagain C (1,057 acres). Although these subwatersheds are not considered to be within the Resurrection Creek watershed, for practical purposes they have been included in this analysis as part of what is referred to as the Resurrection Creek watershed association, which has a total area of 111,734 acres (174.5 mi^2).

The Resurrection Creek watershed is north in aspect, and exhibits a dendritic, but elongated drainage pattern with major streams contained within U-shaped valleys characteristic of a glacially formed landscape.

2.1 Land Ownership

Most of the land within the Resurrection Creek watershed association (98 percent) is National Forest System land. The remaining lands are private, state, state selected, and municipally owned (see Table 2), and occur within the vicinity of the community of Hope. There are 121 recorded mining claims, composing an area of 3,367 acres within the watershed association (Chugach National Forest GIS data). Of these claims, 114 are placer claims, six are lode claims, and one is a mill site claim. These claims are in the vicinity of lower Resurrection Creek, Bear Creek, Palmer Creek, and their tributaries.

2.2 Geology, Minerals, and Soils

2.2.1 Geology

Bedrock geology for the entire watershed is composed of Valdez Group. The Valdez Group is a sequence of sedimentary rocks which underwent alteration during the Upper Cretaceous period, when the Kenai Mountains were uplifted. It is predominantly composed of interbedded greywackes and shales, and slates (Nelson 1985). Infiltration through the bedrock is slow, and generally flows along joints and fractures within the rock. The surficial geology includes extensive quaternary deposits left behind by receding glaciers (glacial outwash) or by rivers and streams (alluvium) within the mainstem valley bottom, and morainal deposits spread throughout the watershed. Numerous alluvial fans have formed where high-gradient tributary streams flow down into the lower gradient Resurrection Creek valley. Infiltration through these alluvial deposits can be rapid.

The distribution of geologic formations by subwatershed is shown in Table 3. Undifferentiated quaternary deposits include floodplains, alluvial fans, landslide debris, and river terraces.

2.2.2 Minerals

Extensive placer gold deposits present in the watershed association were first discovered in the late 1800s, when the U.S. Geological Survey (USGS) first examined the mineral resources of the Hope area in 1895, the year the town was established. Thirty-five subsequent field examinations by the USGS occurred from 1898 through 1941. Claim staking from 1894 to 1896 in Resurrection, Bear, and Palmer creeks launched a rush to the Turnagain Arm field. In 1885, 69 claims were located in the Turnagain Arm mining district in the vicinity of Hope and Sunrise. In 1895, only 108 claims were located in the Sunshine district; by 1896, about 3,000 people had moved into the Turnagain Arm area, and about 2,000 to 2,500 people moved into Sunrise. A second rush of miners into the area took place during 1898.

Following the initial rush around the turn of the 20th century and the initial surge of gold production, mining activity and production decreased quickly. This was due to the fact that the deposits that could be easily worked profitably by hand methods were exhausted. Further, the higher-grade deposits, which were usually confined to the channels of the present day stream courses, were by this time of much smaller size. Substantial quantities of lower-grade stream placer and low-grade glacial deposits remained, but these required the development of hydraulic mining systems and considerable capital investment. In 1908 there were approximately 50 people working on claims in the area. By 1931, only 20 people worked mines in the Moose Pass and Hope mining districts and the adjacent town of Sunrise had dwindled to a population of two people by 1930. During the 1930s, 60 to 70 people lived between Hope and Moose Pass, and in the summer an additional 25 miners came into the area.

In 1896, lode gold claims were located in Bear, Palmer, and Sawmill creeks, and the majority of the lode discoveries in the vicinity were made by the late part of the 19^{th} century. Gold production from lode claims has been small, with only sporadic production over the years from the same properties. The longest somewhat continuous production has come from the Hirshey-Lucky Strike Mine, discovered in 1911, on Palmer Creek, which produced 5,500 ounces. Other gold mines and small producers located in the Palmer Creek drainage are the Teddy Bear, Swetman-New Hope (408 oz), Sunshine Mine, Downing (150 oz), Robin Red Breast, Kenai Star, Robinson & Bowman, and Nearhouse mines (102 oz). In the Bear Creek drainage were the Mighty, Gold Stamp, Coon and Plowman, Taylor, and Lucky Lode mines.

2.2.3 Soils

Soil development in the project area is mainly a product of climate and recent geologic history. Following recession of glaciers, a veneer of glacial deposits was left behind. These deposits, along with material from weathered bedrock, called colluvium, form the substrate on which soils have developed (Davidson 1989). There are also inclusions of shallow soils over bedrock. Soils developed on glacial till are typically medium-textured, with significant inclusions of rocks and gravel, and these soils are usually deeper than 40 inches. In places, a somewhat compacted, water-restricting layer is present. In other areas, soils are fine-textured, and may retain moisture. Other soils are saturated due to excessive amounts of subsurface or surface runoff from upslope. Hydric surface vegetation is often a good indicator of a water-restricting layer or excessive runoff.

Soils in valley floors are developed mostly in deposits of glacial outwash or by alluvium. These soils are also typically deeper than 40 inches, have a matrix of fine to coarse sand, and contain well-sorted gravels and cobbles. Almost all of these soils are well or excessively drained. Fine-textured soils in valley bottoms have developed on deposits in protected areas, pools, and in the floodplains (Davidson 1989). Soil types are discussed in more detail in Section 4.2.

2.3 Hydrology

2.3.1 Climate

Marine storm systems dominate the climate of the study area. The area's proximity to the Gulf of Alaska, as well as its high latitude, make the climate cool and generally moist. However, the watershed association lies in the rain shadow of the Kenai Mountains, making it relatively dry, compared to the Seward area.

Hope has a mean annual precipitation of 22.2 inches (based upon a National Weather Service data from between 1979 and 1995 [Figure 1]). Up to 65 percent of the total precipitation falls as snow at higher elevations. Across the watershed association as a whole, precipitation falls primarily as snow between late October and early April.

Average maximum winter snowpack is about 23 inches at Hope, 25 inches at 1,200 feet elevation (Pass Creek), and 36 inches at 2,250 feet elevation. These maximum snowpacks average around 30 percent water. Average recorded snowpack within the watershed association on April 1 is 32 inches, with a snow water equivalent (SWE) of 9.3 inches, at an elevation of 1,200 feet; 36 inches, with a SWE of 10.0 inches, at an elevation of 1,500 feet; and 40 inches, with a SWE of 12.3 inches, at an elevation of 2,250 feet. The maximum annual snowpack most frequently occurs around the beginning of April.

Thunderstorms and flashy rainfall events are rare. Storms generally last 1 to 3 days; the maximum daily precipitation recorded at Hope (between 1979 and 1995) is 3.2 inches. The largest storms carrying the most precipitation (60 percent of the annual precipitation) occur August through December. April and May are the driest months, with an average monthly precipitation of less than an inch per month.

The mean annual temperature at Hope is 36.7 °F, with a mean daily maximum temperature of 45.1 °F, and a mean daily minimum temperature of 28.4 °F. Temperatures in the watershed association all generally decrease with elevation. Temperature extremes at Hope are –31 °F and 82 °F. Mean annual temperature for the entire watershed association is about 30 °F.

Annual evapotranspiration (loss of water by evaporation from the soil and transpiration from plants) averages around 16 inches per year, less than the average precipitation throughout the watershed association (estimated from Patrick and Black 1968). Few wind data are available. Strongest winds generally occur in the winter, often from the north. Wind velocities of up to 50 miles per hour (mph) are probable at lower timbered parts of the watershed, and velocities in excess of 100 mph are probable on high mountain ridges.

2.3.2 Runoff Patterns

Streamflow is dominated by the patterns of snowmelt. Figure 2 shows how snowpack melt affects the runoff. Bankfull discharge at the USGS gage on Resurrection Creek is approximately 800 cubic feet per second (cfs). Normalized by area, this is 5.4 cfs per square mile. Peak flow events in the watershed association typically occur between May and October. Annual snowmelt peak flows generally last from early June to mid-July. Summer rainstorms can increase snowmelt peaks flows; 1- to 3-day peak flow events also occur in August through October in response to heavy rainfall events. This is usually well after the snowmelt peak.

The record peak instantaneous flow at Resurrection Creek (between 1967 and 1986) was 3,380 cfs (VanMaanen et al. 1988), or 22.7 cfs/mi^2. The minimum daily discharge recorded was 38 cfs, or 0.26 cfs/mi^2. The 10-year flood is approximately 2,400 cfs (16.1 cfs/mi^2).

2.4 Stream Channel Types and Proportions

A total of 25 mapped creeks and associated tributaries account for 251 miles of streams (1.6 stream miles/mi^2) within the watershed association. Resurrection Creek (24 miles) and Palmer Creek (11 miles) are the longest creeks in the watershed association.

A total of 32 lakes throughout the watershed association cover an area of 80.4 acres. Mapped lakes range in size from 0.2 to 20.7 acres. Approximately 50 acres of settling ponds from past mining operations are located in riparian areas along Resurrection Creek. Some of these ponds have been enhanced or altered by beavers. Most of the ponds are not accessible, or have limited access to fish.

The Resurrection Creek watershed contains a variety of stream channel types that are typical of watersheds in south-central Alaska. Stream segments have been assigned stream class values based on fish habitat within the streams. Segments are assigned to one of three classes (USFS, Alaska Region, 2001):

- Class I: Streams with anadromous or adfluvial lake and stream habitat.

- Class II: Streams with resident fish populations. Class II streams are generally steep (often 6 to 15 percent gradient), but can also include streams from 0 to 5 percent gradient without anadromous fish.

- Class III: Streams with no fish populations that have potential water quality influence on downstream aquatic habitats.

Table 4 shows stream segment distribution by stream class value. Nearly all the Class I segments occur within Resurrection (19 miles) and Palmer (5 miles) creeks. The majority of mainstem Resurrection Creek consists of C channel types (Rosgen 1996), with segments of both B and G where gradients are steeper, and/or the channel incises into bedrock and/or course alluvium. Tributaries to Resurrection Creek are almost entirely A channel types, with B channel types occurring where the larger tributaries flow onto the broad valley bottoms of Resurrection Creek.

2.5 Water Quality

Streams in the Resurrection Creek watershed are classified “fishable, swimable, and drinkable” (Class 1A) under the Alaska State Water Quality Standards (18AAC70). Table 5 summarizes the water quality standards. Resurrection and Palmer creeks are also ranked as medium and lower priorities, respectively, in Alaska’s Clean Water Actions Plan (ACWA) (ADEC 2001). The ACWA is a unified state approach to better manage and protect the quantity and quality of Alaska’s water and aquatic habitat. The ACWA Waters List is designed to address the full range of water-related problems in Alaska, not just water pollution; for example, streambank degradation and the threat of excessive water withdrawals from fish spawning areas to be examined, addressed and funded.

Although conventional water quality parameters appear to be within the ranges of state standards, land uses within the watershed, especially those adjacent to streams, have altered some water quality parameters (Tables 6 and 7). Mining activities adjacent to the stream have increased heavy and trace metal concentrations in some areas. Urbanization of Hope has likely resulted in the increase of stormwater runoff and corresponding non-point pollution. Recreational activities such as hiking have likely resulted in increased turbidity levels in areas where trails cross streams.

2.6 Vegetation

Vegetation in the watershed association is typical of the transitional zone between boreal forests or more northerly latitudes and the northernmost coastal temperate forests that are generally found farther to the south. Topography, climate, and glacial deposits found in the Kenai Mountains, left from recent glacial epochs, have created a mosaic of vegetation and plant communities typical of the region. Most of the watershed association is within the western Kenai Mountains subsection with the balance within the Turnagain Arm subsection of the Kenai Mountains ecosection. Climate in the Kenai Mountains is transitional between maritime and continental climate.

In the watershed, the highest elevations on the tops of mountains, which are covered by snow and ice or steep rocky side slopes, support no or very little vegetation. Where soils have developed in glacial deposits and microclimate is more favorable, plant communities range from dwarf-scrub and grasslands typical of alpine areas to a variety of forested uplands and wetlands on the side slopes and alluvial valley bottoms of the different watersheds. On steeper slopes and drainages, avalanches may play an important role in vegetation dynamics and patterns.

A variety of plant community types can be found across the watershed association. These are influenced by human and natural disturbances, such as fire and the current spruce bark beetle (*Dendrocthonus rufipennis*) infestation, and are distributed along topographic, climatic, elevational, and other gradients. DeVelice et al. (1999) have identified 197 plant community types in *Plant Community Types of the Chugach National Forest: South-Central Alaska*, which includes this watershed association. These community types are based on observations from at least three study plots. Their classification follows the nomenclature and protocol in the Alaska vegetation classification developed by Viereck et al. (1992). Each of these community types is described in the document. In addition, information is provided on the number of study plots for each community type as well as species richness, cover, and constancy. Photographs of selected Alaska vegetation classification community types present on the Chugach National Forest also are presented along with keys for identifying the various community types. These community types have not been precisely mapped within the watershed association.

Thirteen consolidated cover types have been mapped using aerial photos. These cover types were consolidated from a larger number of timber types and entered into the forest GIS database. The 13 consolidated cover types are alder, aspen, birch, cottonwood, muskeg meadow, grass and alpine, black spruce, hemlock, hemlock-spruce, mixed hardwood-softwood, sitka spruce, white spruce, and other brush. According to the Resource Information Management Data Dictionary for the Chugach National Forest (August 2001), hemlock-white spruce and hemlock-sitka spruce were combined to form hemlock-spruce. Aspen-white spruce, birch-white spruce, cottonwood-sitka spruce, cottonwood-white spruce, cottonwood-birch-white spruce, aspen-hemlock, birch-sitka spruce, and birch-hemlock were combined and called mixed hardwood-softwood. Cottonwood-balsam poplar and cottonwood-birch were combined to form cottonwood. Aspen-birch and aspen types were combined and called aspen. Natural grassland and alpine high meadow were combined and called grass and alpine. Other brush is not defined in the cover type descriptions but presumably represents various tall and low scrub community types identified by DeVelice et al. (1999), including those dominated by willows, sweet gale, salmonberry, and dwarf birch.

As previously noted, plant community distribution is dependent upon elevational gradients and other factors. This is especially true of high alpine vegetations which are predominantly dwarf scrub and heath types, composed of assorted ericaceous shrubs, dwarf willows, and birches, mostly present at higher elevations above approximately 1,500 feet. Needleleaf evergreen, broadleaf deciduous, and mixed forest communities are confined to lower elevations below about 1,500 feet (DeVelice, R.L., personal communication, 2001). Interspersed among the forested types often in riparian areas, on floodplains, alluvial terraces associated with beaver ponds, or tide flats, are various freshwater and estuarine wetlands composed of graminoid herbaceous types, tall and low scrub types, and aquatic herbaceous types.

2.7 Aquatic Species and Habitats

Anadromous species known to use creeks within the watershed include coho, pink, chinook, and chum salmon. Resident fish include Dolly Varden, whitefish, sculpin, stickleback, and possibly rainbow trout (Seaberg, S. Alaska Department of Fish and Game, personal communication, September 17, 2001). Although there are no existing data for sockeye in Resurrection Creek and angling reports indicate that sockeye salmon were not caught, there are anecdotal reports of sporatic occurrences of adult sockeye salmon migrating into Resurrection Creek (Johansen, E. Seward Ranger District, personal communication, December 2001).

Chinook salmon distribution extends to river mile (RM) 18.0 of Resurrection Creek, with juvenile chinook observed rearing up to the headwaters of Resurrection Creek (Johansen, E. Seward Ranger District, personal communication, December 2001). Chinook are also known the spawn and rear up to RM 0.5 of Palmer Creek (ADFG 1986).

Coho, pink, and chum salmon spawning and rearing distribution has been verified only up to RM 6.0 in Resurrection Creek; however, it is likely that spawning and rearing occurs farther upstream. Anadromous salmon are known to spawn and rear up to RM 0.5 of Palmer Creek, and the lower reaches of Gold Gulch, Bedrock, Wildhorse, Cannonball, Wolf, White, Caribou, and Cripple creeks. Anadromous salmon also are found up to RM 1.0 of Bear Creek and RM 0.5 of Porcupine Creek. Although Bear and Middle creeks do not support coho spawning, they likely provide rearing habitat for juveniles (Wenger et al. 1993).

Resident fish distributions are more extensive, and occur up to RM 19.0 in Resurrection Creek and RM 8.0 in Palmer Creek. Resident Dolly Varden are also found in Hungry, American, Abernathy, Afanasa, Pass, Fox, East, Coeur d'Alene, and two unnamed creeks.

The abundance of the salmon is not well known. Escapement surveys in the 1970s showed a pink run between 20,000 and 50,000 returning pinks. Peak counts of returning chum, coho, and chinook range from less than 100 to 500 each. The abundance of Dolly Varden in Resurrection Creek is unknown (Seward Ranger District, unpublished report).

Habitat and fry surveys conducted in 1991 and 1993 identified side channels as typically having greater channel complexity and higher densities of rearing juvenile salmonids (Wenger, unknown; Wenger et al. 1991). Side channels typically had larger pool/riffle ratios than main-channel reaches regardless of whether they were disturbed by placer mining. Additionally, juvenile salmon appeared to prefer pools with cover whereas resident fish (Dolly Varden) appeared to have no preference for covered pools (Wenger et al. 1991). Although settling ponds are required to construct gravel berms at outlets to prevent access, Dolly Varden and coho were captured in six settling ponds within the Hope Mining Company claims. These fish likely enter the ponds during high flows through either the upstream inlet of the pond or by navigating the outlet channels (Wenger et al. 1991).

As described in previous sections, channelization and the loss of riparian habitat have reduced channel complexity in streams within the watershed. Channel complexity provides the habitat with the diversity necessary for the success of salmonids. The loss of large woody debris (LWD), the primary structuring element for juvenile salmonid summer and winter rearing habitat, has reduced the amount of suitable rearing habitat available. The loss of riparian vegetation reduces the future recruitment of LWD into the stream, maintaining and perpetuating the reduction in suitable rearing habitat. Additionally, the loss of riparian vegetation increases bank erosion, reducing the quality of available spawning gravels. Mining practices may have led to a change in dominant substrate size that has resulted in the reduction of gravel sizes required for successful spawning.

No indigenous amphibians reside within the watershed creeks. However, the wood frog (*Rana sylvatcia*) uses the creek for rehydration, breeding, and egg development. Insects found in Resurrection Creek and other creeks within the watershed are those typically found in cobble-dominated streams (Seaberg, S. Alaska Department of Fish and Game, personal communication, October 1, 2001). These typically include stoneflies (*Plecoptera*), mayflies (*Ephemeroptera*), fly larvae (*Diptera*), and wingless aquatic insects (*Collembola*). Aquatic insects typically associated with pools, ponds, or slow moving water include water striders (*Gerridae*), whirligig beetles (*Gyrinidae*), mosquito larvae (*Culicidae*), and springtails (*Collembola*) (Wallace and Anderson 1996).

2.8 Terrestrial Species and Habitats

Terrestrial habitats in the watershed association are typical of those provided by the plant community types in this transitional zone between boreal forests or more northerly latitudes and the northernmost coastal temperate forests that are generally found farther to the south. The mosaic of wetland and upland habitats provides a diverse array of some of the highest quality habitat on the Seward Ranger District (SRD) for nearly 200 species of wildlife commonly found on the Kenai Peninsula, including several management indicator species.

Habitats range from barren snow and ice, steep rocky slopes, and alpine tundra and meadow that provide summer range for mountain goat and other species, to a variety of forested upland habitats and wetlands on the side slopes and alluvial valley bottoms of the different watersheds. These habitats support the diverse array of animal populations of large and small mammals, migratory and resident birds, small mammals, and other species. Early seral or stand initiation type habitats provide feeding habitat for moose and snowshoe hare, and nesting habitat for neotropical migrants, such as sparrows and warblers (Oliver 1981). Old growth forest habitats provide nesting habitat for goshawks and woodpeckers, thermal and hiding cover for large mammals, and travel corridors for moose, bear, wolverine, and wolves. Broadleaf forest types, such as mature birch in the stem exclusion phase, support populations of other species of migratory songbirds, including several species of thrushes and warblers. Salmon runs in the lower reaches of the watershed association are an important seasonal source of food and support populations of many terrestrial species of wildlife, including brown and black bear and a host of others.

Portions of the watershed association function as major migration corridors for moose and caribou as well as the predators they sustain. Moose move into lower elevation winter range habitats within Resurrection Pass, Palmer Creek, Turnagain Arm, and Six Mile areas. The Kenai Mountain caribou herd migrates seasonally from west to east through the upper watershed.

Wildfire, spruce bark beetle infestations, other natural processes, and human activities affect wildlife habitat. Wildfires and spruce bark beetle infestations appear to have been and continue to be the major factors that influence the structure, distribution, and functions of wildlife habitat throughout the watershed association. Spruce bark beetle have infested 100 percent of the forest types with a spruce component or about 50 percent of all forested stands in the watershed, according to information in the Chugach National Forest GIS database. Red-backed vole populations appear to be increasing in beetle-infested spruce stands as a result of changes in feeding and hiding cover. These changes in red-backed vole populations, which is a keystone prey species for a number of predators, are likely to contribute to increases in the populations of coyote, lynx, hawk, owl, and mustelids that prey on them. Human activities and development, particularly placer mining, have also affected wildlife habitat. Although placer mining has significantly altered habitat in some areas, cumulatively habitat alterations caused by human activities are relatively minor (about 1 percent of the total area within the watershed association), and these are primarily limited to areas in and around Hope.

2.9 Management Indicator Species and Species of Concern

Although there are no federally listed threatened or endangered species or species listed as sensitive by the USFS in this area, there are several management indicator species, state of Alaska species of special concern, and other species of ecological interest and concern within the area. Management indicator species are brown bear, moose, mountain goat, dusky Canada goose, and black oystercatcher. State of Alaska species of special concern include the Kenai brown bear, olive-sided flycatcher, gray-cheeked thrush, Townsend's warbler, and blackpoll warbler. In addition to these management indicator and state species of concern, there are several other species of ecological interest and concern as a result of existing habitat alterations or the vulnerability of these species' habitat to alteration or their sensitivity to human activities. Species of ecological interest and concern are the northern goshawk, bald eagle, harlequin duck, wolverine, pine martin, marbled murrelet, amphibians, and bats.

There are few available data for management indicator and other species of concern in the watershed association. The Alaska Department of Fish and Game (ADFG) conducts annual fall counts for moose and periodic surveys for mountain goats and caribou. Seward Ranger District biologists conduct annual northern goshawk, bald eagle, owl, and neotropical migratory bird surveys. In addition, the USFS conducts periodic surveys of moose winter range conditions, amphibian occurrence, and small mammal relative abundance.

Lacking population data on these various management indicator species and other species of concern, a habitat capability index (HCI) model has been developed to evaluate past, present, and future habitat conditions, trends, and value for these species. The HCI estimates potential habitat value based on the relative value and abundance of a plant community type to provide feeding, cover, and reproduction habitat functions. Index values used to estimate habitat potential range from 1 for optimum to 0 for none. This model has been used to describe habitat conditions at the watershed level, unless noted otherwise, relative to conditions across south-central Alaska for three broad time periods:

- Pre-European settlement;
- Current conditions (1999); and
- Future conditions (2100).

2.10 Human Uses

2.10.1 Heritage

The cultural use of the Resurrection Creek watershed spans a period of about 10,000 years. The cultural resources of the watershed include both prehistoric and historical remains, and a variety of historical properties and property types that are either on or are eligible for the National Register of Historic Places (NRHP). The historical mining resources constitute the majority of the known significant cultural resources in the watershed. Only a small portion of the watershed has been inventoried, although required by the National Historic Preservation Act (NHPA) and Executive Order 11593. Archaeological surveys have until very recently been limited to support for particular projects, as required by Section 106 of the NHPA.

Only two Alaskan Native-related sites are known from within the watershed boundaries. One of the two known sites, SEW-291, is on the Turnagain Arm coast just east of the current town of Hope (AHRS 2001). This site was occupied during the early historical period, and may have been inhabited during late prehistoric times, as well. The other is SEW-762, a prehistoric site in the alpine uplands in the vicinity of Bear Creek in the northern part of the watershed. The latter site has not yet been radiocarbon dated, but observed features and artifacts are diagnostic of prehistoric occupation (Chugach National Forest Heritage Program files, IS&A 01-#, 2001).

Early cultural use of the watershed is also inferred from known sites in nearby ecologically similar areas. The Beluga Point site, on a coastal point opposite SEW-291 on the north side of Turnagain Arm, appears to have been used intermittently as a sheep hunting camp since the early Holocene, (beginning approximately 11,000 years ago) over a period of about 8,000 years (Reger 1998). Several other similar sites have recently been found on other points along the north coast of Turnagain Arm (AHRS 2001). Early Holocene sites are characterized by core and blade technology. An undated site with diagnostically similar microcore and blade technology is known from the Quartz Creek watershed, southeast of the Resurrection Creek watershed, and is believed to have been inhabited about the same time as Beluga Point (Yarborough 1983).

Prehistoric use of the watershed was probably related to the presence of sheep and caribou, and possibly anadromous fish runs. Moose would most likely not have been a subsistence prey for humans, as these ungulates are recent immigrants to the Kenai Peninsula, having begun to move into the area towards the end of the late 19th century, contemporary with the end of the Late Holocene Little Ice Age.

Russian mining exploration on the Kenai Peninsula during the late 18th and early 19th centuries was minimal. Although there have been anecdotal accounts of Russian prospecting and mining tools found in the mountains of the northern Kenai Peninsula, documentation only exists regarding one Russian prospector, Lt. Peter Doroshin, who prospected along the Kenai and Russian Rivers south of the Resurrection Creek watershed (Barry 1997, Johnson 1912). After Alaska's purchase by the United States in 1867, the fur-trade continued to drive the economy until the 1890s. In 1890, Alexander King returned to Kenai with four pokes of gold, the result of two years of prospecting in the Resurrection Creek area (Barry 1997). He returned to the Resurrection Creek to stake a claim in 1893. Other prospectors staked claims that same year and over the next two years, beginning the gold rush to the northern part of the Resurrection Creek watershed. Mining for gold and other related minerals, especially silver, continued until World War II, with prospecting, mining, and population expansion in the mining districts reaching a peak in the first third of the 20th century. Mining came to a halt in the early 1940s with the Preference Rating Order of 1941, and the Limitation Order

L-208 of 1942 (Barry 1997). Although L-208 was revoked July 1, 1945, mining never recovered its pre-war economic importance in the Resurrection Creek watershed area. The early 20th century is considered to be a key period of historical significance for the Resurrection Creek watershed, to which the majority of the historical mining remains are linked.

2.10.2 Contemporary Uses

Forestry has altered the landscape, initially in the form of clearing and logging for mining operations, and later through forest management by the USFS. Natural processes of plant distribution, fire, and disease have been altered, in good ways and bad, by this intervention.

Mining has made dramatic changes to the stream channels and even altered their course (see Sections 4.4 and 5.3). The evolution of mining techniques has included the use of hand tools, petroleum products, and large-scale hydraulic removal of material from the streambed and banks.

Recreational use of the watershed has increased dramatically over the last 20 years. A range of motorized vehicles, pack animals, and people use the trails and roads for a full complement of wilderness activities. Residents of Hope operate businesses that provide everything from lodging to guide services. The USFS maintains roads, trails, campgrounds, and cabins for visitors.

Permanent human residence has made its mark on the watershed as well. Roads allow access to cleared and developed areas, mostly in Hope at the lower end of the drainage. Businesses and homes have been built over the years, and utility corridors provide them with electricity. A primitive airstrip is maintained for small planes.

3.0 KEY QUESTIONS

Landscape analysis 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 to facilitate the implementation of the ecosystem management objectives of the Northwest Forest Plan. Landscape analysis also serves as a basis for developing project-specific recommendations and determining restoration and monitoring needs within the analysis area. During the initial stages of this analysis, the analysis team developed a set of “key questions” from existing basic background information to help frame the issues to guide and define the analysis. This included existing information on watershed conditions, land allocations and current management direction. The key questions developed for this analysis follow.

Erosion Processes

- What are the dominant erosion processes in the watershed and how do they affect aquatic habitat?
- What effects have recreational uses (e.g., camping, gold panning) had on erosion and soil productivity?
- What effects has mining, both commercial and recreational, had on surface erosion and mass wasting?
- Have roads played a significant role in erosion and mass wasting?
- What effects have recent treatments had on erosion and mass wasting?
- What role does windthrow play in erosion, and how is spruce bark beetle infestation affecting it?

Hydrology

- What are the patterns of precipitation and runoff in the watershed association?
- What effects has the spruce bark beetle infestation had on runoff processes?
- Have roads or mining had an effect on runoff processes?
- What is the flood history? How have floods affected habitat and infrastructure?

Stream Channel

- How has placer mining affected channel form and processes?
- What are current placer mining practices like, relative to past operations?
- How has the channel substrate (and bedload) changed over time, and in what reaches?
- What role has large woody debris (LWD) played in channel structure and form?
- What role do ice-jam floods play in the form and processes of Resurrection Creek?
- How has spruce bark beetle infestation affected LWD contribution and runoff? How will it effect LWD recruitment?
- How has recreational use affected bank erosion and sediment deposition?

Water Quality

- Which water bodies are used as a resource, by whom, and for what activities (e.g., fishing, swimming, drinking water, fish use)?
- What are current water quality (WQ) conditions (dissolved oxygen [DO], temperature, total suspended soils [TSS]/turbidity, metals, arsenic)?
- Is water quality degraded, if so, by which parameters and which user groups (e.g., WQ criteria for drinking water vs. fish use vs. swimming)?
- What are the causes (input variables) of WQ degradation (e.g., erosion, gold panning, tailing piles, vegetation removal)?
- What is the vulnerability of water bodies to potential changes in input variables?

Aquatic Species and Habitats

- What is the anadromous and resident fish distribution and relative abundance?
- Where are migration, spawning, and rearing habitats located for each species?
- What are current habitat conditions?
- What were the past fish habitat conditions?
- Where are areas of limiting habitat (e.g., is there a limited area important for a life stage for a specific species)?
- What barriers to migration are present?

Terrestrial Species and Habitats

- What is the distribution and abundance of sensitive plants, plants of conservation concern, plant and animal indicator species, and animal keystone species?
- What are the current habitat conditions for these species? How many acres occur in each habitat type? What percent occurs in each vegetative structural stage within each habitat type, and how is it distributed? What is the distribution and abundance of key habitat components such as old growth, thermal and hiding cover, snags, downed logs, and travel corridors?
- What was the likely historical (pre-European settlement) relative abundance and distribution of these species?
- How has spruce bark beetle infestation affected the abundance and distribution of these species?
- What is the distribution of exotic plants?
- How have exotic plants been imported into the watershed association?

Vegetation

- What is the current structure and distribution of plant communities and how have these been affected by spruce bark beetle infestation?
- How will plant community structure and distribution be affected by the spruce bark beetle infestation?
- What is the role of fire in the ecosystems of the watershed association?
- What are the successional processes in the watershed association and how have these changed since European settlement?
- What was the pre-European settlement plant community structure and distribution?
- How have land management activities and human use influenced the existing plant community structure and distribution?

Human Uses

- What heritage resources are present in the watershed, and where are they?
- How have heritage resources been affected by mining?
- How have past management efforts affected heritage resources?
- What subsistence uses are there in the watershed?
- How have past management efforts affected subsistence use?
- What cultural landscapes are present in the watershed?
- Are there adequate services and infrastructure for recreational users?

4.0 CURRENT CONDITIONS

This portion of the landscape analysis discusses the state of various resources within the watershed association. It is meant as a summary of all that is known to date about the core landscape analysis topics.

4.1 Land Allocation and Mining Claims

Land allocations are set forth in each national forest's management plan. These plans are meant to be updated every 10 to 15 years. The Chugach National Forest has recently finished updating its management plan (USFS 2001). A summary of the land allocations for this watershed are presented in this section.

The presence of gold deposits has played a critical role in the development of the watershed and the effects of development on the aquatic and terrestrial habitats. Robert Mathison and his three sons operated the Mathison Mining Company on Resurrection Creek beginning in 1899, and gradually expanding their operations. They made a profit of $7,000 in 1909, $9,000 in 1910, and $15,000 in 1911. In 1908 only 50 men worked the gravels in the vicinity and 10 claims produced enough gold to be notable. In 1909, Resurrection Creek placers were one of the major producers on the Kenai Peninsula By 1921, the operation at the Mathison Mining Company was idle and operations ceased completely in 1926 or 1927. Carl Clark, Frank Church, and A. Biswagner worked the old Mathison property by 1931 and continued to work the property until approximately 1942 (the advent of World War II). The level of mining that took place after 1942 is not well known since written documentation is lacking, but mining in the 1960s has been mentioned. It was not until 1974 that USFS mining regulations were published and required operators to submit plans in order to mine on USFS-managed lands. Hope Mining Company (HMC) received its first approved mining plan of operations in 1985.

The USGS divided the Chugach National Forest into distinct mineralization "tracts." The Resurrection Creek tract (which includes areas outside of the project area) is defined by the presence of identified gold from placer and "Chugach-type" lode gold deposits, as well as "Cyprus-type" deposits outside the Resurrection Creek watershed (Nelson and Miller 2000). There are seven areas within the tract that are highly favorable for mineral development and production. The remainder of the tract is considered moderately favorable for mineral development and production. In addition to containing many past-producing mines and prospects, geologic data support some potential for the presence of undiscovered resources (Nelson et al. 1994, Bliss 1989). Nelson and Miller (2000) also predict that much of the future gold production on the Chugach National Forest will come partly from the Resurrection Creek tract. They predict that future production will be mostly in areas which have produced gold in the past. Sherman and Jansons (1984) produced an estimate of Chugach-type gold reserves in the Resurrection Creek tract of about 3,100 kg. Development of these deposits is unlikely unless the value of gold increases substantially.

The HMC currently maintains approximately 60 unpatented federal mining claims that cover approximately 1,000 acres of land near and along Resurrection, Palmer, Bear, Bedrock, Cripple, Gold Gulch-Rimrock, Turnagain, Wildhorse, and Willow creeks (USFS GIS Database).

Seasonal mining activities have been conducted on various claims held by HMC. There are several log cabins, a plywood cabin, plywood outhouses, plywood sheds, semi-permanent ATCO buildings, truck body van storage sheds, a plastic tarp building, barrels, fuel tanks, steel, pipe, resident motor homes, and other miscellaneous items in approximately ten camps (Huber and Peterson 2000).

Approximately 13 claims are historically tied to the old placer operations in Resurrection Creek. Hope Mining Company has had a mining plan of operations for conducting exploration and mining on areas of the claims since 1985 (Huber and Peterson 2000). Mining operations are conducted by leasees on HMC claims, rather than by HMC itself. HMC conducts testing and secures permits and plan of operations approval. Since 1985, HMC mining proposals have addressed up to 17 separate mining areas. Most of the mining has been conducted along Resurrection Creek by re-working previously mined areas and mining some areas of virgin gravel.

Mining activities approved through plans of operations in the Resurrection Creek watershed consist of mechanized placer mining using various equipment such as dozers, backhoes, trommels, screening plants, and sluices. These operations apparently have occurred over the past several decades at various scales. In their current approved mining plan of operations, HMC may conduct small scale prospecting and placer mining using suction dredges, hand fed sluices, and pans. There is approval for use of heavy equipment but no mining of this level is presently occurring. Additionally, HMC offers package deals geared to the tourist desiring to stay in a "real placer mine" and pan/sluice for gold. The current low price of gold (under $280/ounce; Goldprices.com) is not encouraging to commercial mining but would probably not deter recreational mining.

Present mining-related activities in the Resurrection Creek Watershed consist of mechanized placer mining using various equipment such as dozers, backhoes, trammels, screening plants, and sluices. These operations apparently have occurred over the past decade at various scales. In their mining plan of operations, HMC also has provided for small-scale prospecting and placer mining using small suction dredges, hand-fed sluices, and pans.

Several lode gold mines are located in Palmer Creek's upper basin, mostly dating back to the early 1900s. Some local milling and cyanide processing were used for these mines. Palmer Creek's most successful lode mine was the Hirshey & Carlson Mine, located near the head of the subwatershed. There are reportedly three adits all in excess of 2,000 feet that produced a total of 5,545 ounces of gold and 4,699 ounces of silver. A 1984 report prepared by the Bureau of Mines (Jansons et al. 1984) estimated total placer gold production within Resurrection and Palmer creeks since 1895 at 30,000 to 40,000 ounces, with 2,000 to 3,000 of those produced since 1980.

4.1.1 Mining Claimants Rights and Obligations

The term "valid claim" often is used in a loose and incorrect sense to indicate only that the ritualistic requirements of posting of notice, monumentation, discovery work, recording, annual assessment work, payment of taxes, etc., have been met. This overlooks the basic requirement that the claimant must discover a valuable mineral deposit. Generally, a valid claim is a claim that may be patented.

4.1.1.1 Mining Claims

A mining claim, however, may lack the elements of validity and in fact be invalid, but it must be recognized as a claim until it has been finally declared invalid by the Department of the Interior or Federal courts. A claim unsupported by a discovery of a valuable mineral deposit is invalid from the time of location, and the only rights the claimant has are those belonging to anyone to enter and prospect on National Forest lands.

4.1.1.2 Rights

By location and entry, in compliance with the 1872 mining law, a claimant acquires certain rights against other citizens and against the United States.

A valid mining claim creates a possessory interest in the land, which may be bartered, sold, mortgaged, or transferred by law, in whole or in part, as any other real property. A locator acquires rights against other possible locators when the locator has complied with the applicable Federal and State laws.

The claimant has the right to dispose of all locatable minerals on which the claimant has a valid claim. Rights to common-variety mineral materials depend upon the status of the claim on July 23, 1955, and on subsequent actions taken under 30 U.S.C. 613. Pre-1955 claims may have "surface rights." This means the claimant would have exclusive possession of the surface the mining claim. There are no mining claims in the Resurrection Creek drainage with surface rights.

The claimant has a number of other rights including:

- Reasonable access to the claim;
- Right to use the surface for prospecting, mining, and processing (but not exclusive possession);
- Right to the use of timber as necessary for the mining operation; and

- Right to clear timber as necessary for mining (claimant cannot sell the timber).

4.1.1.3 Obligations

In order to successfully defend rights to occupy and use a claim for prospecting and mining, a claimant must meet the requirements as specified or implied by the mining laws, in addition to the rules and regulations of the USFS. They require that a claimant:

- Comply with provisions of 36 CFR 28 Subpart A;
- Discover a valuable mineral deposit;
- Pay annual maintenance fees;
- Record location notices and other required filings in the appropriate Bureau of Land Management office;
- Comply with applicable laws and regulations of Federal, State and local governments;
- Maintain claim corners and boundaries;
- Be prepared to show evidence of mineral discovery; and
- Not use the claim for any purposes other than prospecting, mining, or processing operations and uses reasonably incident thereto.

Additionally, claimants can exercise certain rights acquired under the 1872 Mining Law only under an approved plan of operations. On National Forest lands, such plans are approved by the USFS. Any minerals operations that may cause surface disturbance require at the least, a notice of intent. Operations that may cause significant surface disturbance require an approved plan of operations. Requirements for a notice of intent and plan of operations are found in 36 CFR 228 Subpart A, Locatable Minerals regulations.

In addition, a claimant must recognize the lawful rights of other users of the National Forest.

4.1.2 Rights and Obligations of the United States

The United States has, through Congress, the right to control the disposition of resources on the public lands and to develop all necessary rules and regulations. In regard to mining claims on National Forest System lands, the USFS and the Department of the Interior may exercise the rights discussed in FSM 2814.11-16.

The general authority of the Secretary of the Interior with respect to public lands, is described in Cameron vs. United States, 252 U.S. 450 (1920) where the court said:

“By general statutory provisions the execution of the laws regulating the acquisition of rights in the public lands and the general care of these lands is confided to the Land Department, as a special tribunal; and the Secretary of the Interior, as the head of the Department is charged with seeing that this authority is rightly exercised to the end that valid claims may be recognized, invalid ones eliminated, and the rights of the public preserved…. The power of the Department to inquire into the extent and validity of the rights claimed against the Government does not cease until the legal title has passed “

The USFS and the Department of the Interior may exercise rights which include:

- Right to regulate prospecting and mining activities (16 U.S.C. 551, and 36 CFR 228 Subpart A);
- Right to manage and dispose of vegetative surface resources;
- Right to manage and dispose of common varieties of mineral materials; common varieties may be sold and are not locatable;
- Right to enter and cross claims, includes the right of the United States to manage and protect National Forest resources’ and
- Right to authorize uses by third parties, if it will not conflict with prior rights of a claimant.

4.1.2.1 Obligations

- The USFS must respect claims and claimants’ property by using precautions to avoid damage to claim corner markers, excavations, and other mining improvements and equipment.
- The USFS must allow mining claimants to obtain timber.
- Prevention of such violations regarding uses of National Forest System lands and resources includes an obligation to ensure that unauthorized uses of mining claims are eliminated, including unlawful use of buildings and other structures and the taking of common varieties of mineral materials.

USFS officers should provide bona fide prospectors and miners reasonable alternative access routes, exploration methods, special use permits, and operating plan provisions in order that they may carry out necessary mineral-associated activities without violation of laws and regulations.

4.2 Erosion Processes

Erosion processes are not well understood in the watershed association. However, mass wasting does not appear to be a significant component of sediment delivery (Davidson 1989). Landslides may be initiated if two or more slope stability factors are reduced. In addition, recent field investigation revealed that roads and road building appear to cause few if any landslides (Kalli and Blanchet 2001, unpublished report). Very limited evidence of past landslides was observed.

However, in high-latitude watersheds such as the Resurrection Creek watershed, avalanches are a significant source of sediment. Avalanches occur in most of the tributary streams during winter and spring. In higher altitude portions of the watershed, areas of near-surface bedrock appear to be greatly influenced by the rapid mechanical disintegration associated with frost riving and frost shattering, with fragment size related to the bedding and jointing characteristics of the local bedrock (Thorson 1987). Sediment load from high elevation, steep valley sideslopes, and headwalls is expected to be high.

Ample evidence of snow avalanches was observed by previous investigators. Snow avalanches occur regularly in both the mainstem valley and tributary streams during winter and spring. These avalanches may scour below the snow, picking up soil; in addition, rock fragments that have fallen on the snow surface from upslope sources may be incorporated in the avalanche debris. In this way, these avalanches provide a source of colluvial sediment along the streams. Additionally, frost-thaw action also moves sediments downslope into the stream channels. This action occurs as saturated or partially saturated soil freezes, which raises the surface, and lowers in the downslope direction during the thaw cycle. Both mechanisms are perceived to be a significant source of sediment transport within the watershed association (Kalli and Blanchet 2001, unpublished report). However, no quantification of these sources has been completed. The sediment delivered from these processes supplies tributaries of Resurrection Creek with mostly coarse sediment; the processes are not likely to have a significant direct effect on anadromous habitat in the mainstem, because an extensive swath of forest acts as a buffer in these areas.

Other types of mass wasting which may be present include debris flows and debris avalanches. The watershed has a high percentage of steep slopes; almost 50 percent of the watershed is greater than 41 percent slope. This indicates a significant potential for mass wasting. The actual prevalence of mass wasting depends on vegetation, geology, hydrology, and human use of the landscape. Because the watershed contains few signs of these types of mass wasting, it is likely a minor source of sediment.

4.2.1 Soils

Only the soils of the lower portions (below the treeline) of Resurrection Creek and Palmer Creek valley have been mapped (Davidson 1989). Mapped soils total only 12 percent of the watershed association. However, the areas mapped overlap most areas of existing development and use. A list of soils present in the watershed is provided in Table 5.

Generalized dominant soil types include typic cryorthods and dystric cryocrepts, which represent 56 and 40 percent of the mapped area, respectively. Typic cryorthods are soils on mountain sideslopes, and footslopes developed on glacial till. They are deep, well drained, and have moderate to slow permeability. Dystric cryocrepts have moderate depth, are well drained, and have moderately rapid permeability. For both soil types, management considerations include susceptibility to erosion on steep or long yarding paths, skid trails, and off-road vehicles (ORV) roads and trails.

4.2.2 Surface Erosion

Two main types of erosion are possible in primarily undeveloped, well-vegetated watersheds: surface erosion (by overland flow) and streambank erosion. Stream bank erosion and surface erosion are both uncommon within the watershed due to its well-vegetated character. However, no studies which quantify the amount of surface erosion have been conducted.

When vegetation is removed, and the topsoil is removed, surface erosion risk is greatly increased. Thus, the amount of surface erosion occurring in watersheds in south-central Alaska is thought to be correlated with roads and other forms of development.

There are a total of 33.3 miles of roads (0.2 miles/mi^2) within the watershed association. Palmer Creek Road is the longest at 13.2 miles (Table 7). Roads only occur within the lower reaches of the watershed association in the Palmer Creek, Resurrection Creek Flats, Bear Creek, Turnagain B, and Turnagain C subwatersheds. Within this group of subwatersheds the road density is 0.9 miles/mi^2. As a reference, Cedarholm and Reid (1987) reported that when roads approach 2 to 3 miles/mi^2, fine sediment begins to have an effect on salmonids habitat. However, even the portion of the watershed association with the higher road density is not close to this threshold. It is thus unlikely that fine sediments are having detrimental effects on salmonids spawning gravels.

A total of 29.5 miles of trails are present in the watershed association. These are mostly foot and horse trails, which cause a minor amount of erosion. The trails are concentrated in the Palmer Creek and Resurrection Creek Flats subwatersheds. Given the limited extent of trails, and relatively small amount of erosion, trails do not appear to be a significant source of sediment in the watershed association. Notably, local erosion can cause small areas of loss in soil productivity. Additionally, even localized erosion can be a management concern, resulting in increased maintenance costs.

Anecdotal evidence indicates that portions of the Resurrection Creek Pass trail have become severely eroded. Other areas may be subject to erosion. However, no systematic survey of trail condition and surface erosion have been conducted. Surface erosion and loss in soil productivity has been reported in and around the two campgrounds in the watershed association.

The community of Hope lies adjacent to and primarily on the east side of Resurrection Creek. Habitations in the town of Hope are buffered from the creek by more than 500 feet, except on the downtown street at the creek's mouth. However, connectivity between building sites and roads within the town and Resurrection Creek is unknown. Several homes and the Hope school are located within 500 feet of Bear Creek. While buffer zones of 300 feet are generally deemed sufficient to filter out all sediment (Johnson and Ryba 1992), studies conducted thus far have focused on fully-vegetated buffer strips. No measurements have been taken thus far to determine the effects of development on sedimentation within the watershed association. However, given the limited amount of development compared to the size of the watershed, it is unlikely that this development has caused significant sedimentation of either Bear or Resurrection Creek.

Of the prevalent channel types within the watershed association, stream bank sensitivity is listed as high concern for only one, channel type MM2 (see Section 4.4, Stream Channel). High terraces along the mainstem have been undercut in a number of locations and are a source of erosion and sediment to Resurrection Creek (Kalli and Blanchet 2001, unpublished report).

4.2.3 Effects of Spruce Bark Beetle on Erosion Processes

While large swaths of forested land have been affected by the spruce bark beetle, there has been no obvious immediate effect on erosion processes. Theoretically, the loss of root strength associated with dying trees would lead to some instability in steep, spruce-forested terrain. However, based on limited field observations, there has been no increase in mass wasting in the last 30 years. Surface erosion due to wind-thrown trees theoretically could cause sedimentation. However, due to the relatively thick layer of duff in forest soils, and the understory of vegetation, this process is unlikely to cause a significant amount of sedimentation.

4.3 Hydrology

4.3.1 Surface Water

There are a total of 78 acres of lakes and 252 miles of mapped stream in the watershed association. The lakes are mostly in Fox Creek, East Creek, and Palmer Creek subwatersheds. When lakes are large or are in lower elevations of watershed, they can influence the runoff by mitigating flows and sediment transport. However, given that the lakes (all in the Resurrection Creek watershed) are small and widely dispersed, they are not likely to have a significant effect on runoff patterns within the watershed.

4.3.2 Groundwater

Many of the residential buildings within the watershed use shallow wells for their water supply (Blanchet, D., Chugach National Forest, personal communication 2001). The well-sorted, coarse alluvium in the valley floor is the main aquifer for these purposes. Little is known about aspects of groundwater in other portions of the watershed association. The long, avalanche-swept, well-vegetated valley sideslopes convey infiltrated meltwater from the snowpack to forested areas below, as indicated by distinct vegetation cover types.

4.3.3 Wetlands

A total of 2,744 acres, or 2.5 percent of the watershed association, is mapped as wetlands (Table 8). Wetlands within the Resurrection Creek watershed concentrate along stream channels (riverine) and within forested areas generally lower on hillslopes, where springs and groundwater saturation persist. These latter wetlands (palustrine forested) are often small in size and difficult to identify from aerial photography. They are likely underrepresented on National Wetlands Inventory (NWI) maps of the watershed. Estuarine wetlands are prevalent adjacent to the mouths of Resurrection and Bear creeks.

4.3.4 Runoff

Streamflow produced by the watershed association is directly related to the amount of precipitation received by the watershed. Map A (Appendix A) shows the generalized precipitation distribution across the watershed association. While there are no flow records for tributaries to Resurrection Creek, the levels of precipitation can provide some indication of gross runoff. Figure 3 shows the amount of approximate average annual precipitation zones by subwatershed. Runoff responds to rainfall directly. Although the watershed is not flashy in nature, major storms generally last 1 to 3 days, which is sufficient time to concentrate flows within the drainage. Rainfall amount affects water quality of surface runoff as a result of contributed sediment from the channel banks during high flows. Rainfall in the area is chemically neutral and influences the overall pH of the streams within the watershed association.

The duration of rainfall is important because the Resurrection Creek watershed association has time to respond to the large, 1- to 3-day storm events that occur in the area. The watershed can store a considerable amount of water, but after a day of rainfall, many of the thin soils begin to saturate, and the creek begins responding to the storm event with increased runoff and streamflow. Short duration, high intensity storms are relatively rare within the watershed association, and the flow response from such events is limited by high initial infiltration. Smaller rainstorms in June and July can combine with snowmelt peak runoff to create large flood events, particularly following heavy snowfall winters.

Since virtually all snow melts from the watershed over the spring and summer, streamflow is directly related to the total amount of snowfall received by the watershed. The snowpack insulates the ground, contributing to low flows in the winter. This occurs because shallow groundwater remains liquid under the insulation of the snowpack. Runoff does not respond to snowfall directly, but the volume of accumulated snow in the spring has a direct effect on the size of the snowmelt peak, which is usually the peak flow for the year. Snowfall amount affects water quality of surface runoff as a result of contributed sediment from the channel banks during high flows.

Storm frequency and intensity has a limited effect on stream sedimentation, as most sediment is picked up along the stream banks. Sediment supply to the stream tends to increase as flows are rising due to the availability of new sediments along the stream banks. Sediment concentrations drop off sharply as peak flows decline since the availability of stream bank sediments has been greatly reduced during the rising limb (hysteresis effect).

Other aspects of climate may or may not influence streamflows and sedimentation in the watershed association. These factors include maximum and minimum air temperature, evapotranspiration, and wind. Too little is known to speculate about the influence of these factors, although they are worth discussing.

The maximum air temperature in the spring and summer directly affects the snowmelt rate and, therefore, the size of the snowmelt peak. The timing of maximum air temperatures directly affects the timing of the snowmelt peak. Maximum snowmelt peaks are generated by a combination of a large winter snow pack, low maximum temperatures in April and May, and high maximum temperatures in June and July. High maximum temperatures also increase evapotranspiration rates during the late spring and summer, which can reduce the overall runoff, although this influence is moderate. Stream sedimentation increases markedly for higher snowmelt peak years.

Minimum temperatures have limited direct effects upon hydrologic processes. In the spring when temperatures fluctuate above and below freezing, a stronger diurnal flow effect is seen than when the minimum temperature is above freezing. Cold minimum temperatures in the winter decrease flow rates. Minimum temperatures may have an influence on ice-jam floods, however. Ice-jam floods occur during early freeze-up of rivers, and during early thaws. A pattern of low minima followed by a warming trend is necessary for either situation. The timing and location of the minima play a critical role.

Water lost to evapotranspiration influences the amount of surface runoff during warm summer months. Losses are primarily by transpiration from vegetation, and evaporation from vegetation and other surfaces after rainfall. The percent of exposed surface water within the watershed is small, and evaporation from surface water has a limited effect upon streamflows. Evapotransporation losses can have a small effect on water quality later in the summer, causing increases in chemical parameter concentrations if the weather is warm and rainfall and snowmelt runoff (dilution) is low.

Wind does not play a significant role in production, timing, or quality of surface runoff. Wind may produce localized effects upon snowpack distribution and depths; however, these will have little impact upon overall streamflows within the watershed association. Due to the small area of exposed surface waters with the watershed association, the effects of wind upon evaporation are also very limited.

Elevated flows may occur in response to 1- to 3-day storms that occur in the region, and during snowmelt periods and combination rainfall and snowmelt events. The non-flashy nature of the watershed association along with its moderate annual precipitation and peak precipitation keeps high flows relatively low. The 10-year event on Resurrection Creek is 2,400 cfs, or 16.1cfs/mi^2. Due to these moderate peak flows, the effects upon water quality will not be as severe as in other local watersheds with higher precipitation.

Ice jams are another cause of flooding. The frequency and magnitude of this process in the Resurrection Creek watershed is poorly understood. However, extensive research has been conducted in the Midwest and Northeast states. These floods occur as a result of either early freezing or thawing of the river water. Ice on the surface of the water unexpectedly cracks and breaks up; it then clogs the channel, forming a dam. Water levels may rise and flow over the banks at the site of the jam. Additionally, when the ice jam finally breaks, a flood wave may be sent downstream. This flood wave can possess extraordinarily high stream power. Ice within the flow can scour channel beds and banks, and batter riparian vegetation. Ice jams form at constrictions, confluences, sharp bends, and where there is a substantial decrease in channel slope. While anecdotal evidence indicates these floods occur a few times a year, it is difficult to know how important these floods as channel-forming events, without further study. Because streambanks are frozen when these events occur, their effect on bank erosion appears to be quite limited. These events very likely hasten the downstream movement of large organic debris.

Physical changes to Resurrection Creek's channel allow floods to pass through the mined area more rapidly and with less attenuation. This means a probable increase in flood peak sizes downstream from the mined areas, particularly, in floods associated with heavy rains. However, even with these effects, the flood peaks measured on Resurrection Creek by the USGS below the mining are still quite small. The largest flood during the 18 years Resurrection Creek was monitored (1967 to 86) was 3,380 cfs, or a unit runoff of 22.7 cfs/mi^2. Compared with other Kenai Peninsula streams, this is a very low value for flood unit runoff.

It is unlikely that Bear Creek has experienced mining-related increases in flood peaks, since the creek has not been isolated from its floodplain by mining. However, some mining-related increases in stream sedimentation have been measured during mining operations with inadequate settlement systems. Likewise, some increase in sediment loads may occur during peak flow events due to mining-related disturbances of the stream channel.

4.3.5 Effects of Spruce Bark Beetle on Hydrology

Because approximately 50 percent of the forested land within the watershed has been affected by the spruce bark beetle, it is possible that runoff has been affected. This could happen through change in the evapotranspiration. The simplified hydrologic cycle is represented by the following equation:

Precipitation – Evapotranspiration = Runoff + Infiltration

With trees effectively removed, the decrease in evapotranspiration could theoretically lead to increased runoff. Anecdotal remarks by local residents indicate this may be occurring in some areas. However, given that the die-out of spruce trees is gradual, and that understory growth accelerates in response to the overstory removal, it is unlikely that there would be a widespread and significant effect of dying trees on runoff. An unpublished report by the USFS (Kalli and Blanchet 2001, unpublished report) suggests that an increase in runoff of 1 to 2 percent is possible. Furthermore, the report suggests that any significant increase in runoff would have reached its peak in the mid- to late 1980s, and has since likely subsided.

Using the data in the GIS, a graph of forested area affected by the spruce bark beetle, by subwatershed, was developed (Figure 4). This figure indicates that the Resurrection Creek Flats is not only the most forested but also the most affected by infestation. While there are no specific data on the effects of either spruce bark beetle infestation or burning, Figure 4 allows us to speculate on the potential for these effects. Most of the subwatershed contains a very small portion of forested land. Virtually all forested land in Abernathy Creek is infested with spruce bark beetle. Other subwatersheds which are heavily infested include Gold Gulch-Rimrock and Willow Creek.

4.4 Stream Channel

Approximately 250 miles of mapped, perennial stream channel exist in the watershed association. This number does not include ephemeral channels that flow only during the snowmelt season.

Approximately 64 percent of all mapped streams fall within the "high gradient confined process group" (HC) of the Tongass Stream Channel Classification Guide (Paustian et al. 1992). Table 9 shows how the various groups are represented in the watershed association; and miles of stream by channel type in each subwatershed. Table 10 shows descriptions of stream type codes. The HC streams are mostly distinguished by having a gradient of greater than 6 percent, and very incised channels. Their substrate is predominantly bedrock. These streams have a high sediment transport capacity. Another group of streams that is well-represented is the "moderate mixed-gradient control process group." These streams account for 24 percent of all mapped streams in the watershed association. The substrate of these streams is typically boulders and/or bedrock, which limit the erosion and depositional activities of streams.

Most tributaries to Resurrection Creek fall into the HC group. Within this category, at least half of the streams are classified as "deeply incised upper valley" channels. These stream channels are typical of low order streams which occur high in the watershed. These streams typically are transport reaches, that is, sediment entering these reaches is transported quickly out from the reach downstream. The remainder of the high-gradient streams are very high-gradient (greater than 15 percent) streams typical of the uppermost reaches of the watershed. It is logical that these streams make up a majority of the streams in the watershed; low order streams typically are much more numerous in watersheds that have a dendritic drainage pattern (such as Resurrection Creek).

The most critical reaches, in terms of providing fish habitat, are not as common. The "floodplain process group" contains a variety of stream channel types which vary by incision and bankfull width. In the project area, the narrow low-gradient and low-gradient flood plain channels are the most important, and they form almost 16 miles of stream channel along the lower mainstem of Resurrection and Palmer creeks.

A wide variety of placer mining operations from the 1890s up to the present have disturbed Resurrection Creek from about 2 miles to 6.5 stream miles upstream from the mouth. This disturbance is associated with approximately 4-mi^2 of highly disturbed floodplain/riparian area. Figure 5 is a series of aerial photographs taken in 1998 that shows this disturbed area. Both hydraulic mining and larger scale heavy equipment have been used to mine the creek and its associated riparian area. Additionally, recreational gold panning and associated camps are popular on a quarter-mile section of Resurrection Creek directly upstream from the Resurrection Pass trailhead bridge. Recreational gold panning has damaged streambanks and riparian soils.

Palmer Creek is Resurrection Creek's largest tributary, joining Resurrection Creek 5.4 stream miles upstream from its mouth. The lower 0.5 mile of Palmer Creek and its associated riparian area have been highly disturbed by placer mining. Both hydraulic and heavy equipment operations have worked in the area over the past 100 years. Upper sections of Palmer Creek have had some recent, small-scale suction dredging operations.

Past and present placer mining operations have heavily impacted Bear Creek's channel. This activity includes hydraulic mining, some heavy equipment mining, and extensive suction dredging. Nearly 3 miles of Bear Creek's channel, starting 2 miles upstream from its mouth, have been affected to some extent. Several suction dredging and sluicing operations are currently active on the creek, with miners camping adjacent to the creek. Figure 6 illustrates a reworked section of the Bear Creek streambed. Along much of Bear Creek, there is virtually no floodplain. Where some floodplain exists, it has been extensively altered by hydraulic mining, heavy equipment operation, suction dredging, and sluicing. Much of the channel substrate in the affected sections is either bedrock or very coarse substrate. Riparian vegetation has been eliminated in some areas, and the sediment load has likely increased as a result of mining activities. Bear Creek flows through a tightly confined valley before reaching a broad alluvial fan. Little mining activity has occurred on the alluvial fan.

Mining has affected 4 of the 6 miles of lower Resurrection Creek. The upper end of the project area has 1.5 total miles of tailings piles on both sides of the channel. The channel is very confined by these long linear tailings piles. The grain size composition of these tailings ranges between cobble- to truck-sized boulders with an average-sized piece similar to a baseball. For the most part, there does not appear to be any erosion of these lateral tailings piles. The confining nature of these mining tailings keeps the stream from developing any meanders or side channels. What floodplain this reach of stream had historically is now covered with mine spoilings for a total of 1.5 miles. Side channels, floodplains, and meanders are critical habitat components in a healthy salmon stream. This constriction can give rise to higher flows and a larger average substrate size. The smaller-sized particles are deposited in areas where there are lower steam velocities.

A total of approximately 9 miles of stream has been impacted by mining activity; representing about 4 percent of the total stream length. The disturbed portions of Resurrection Creek make up about 40 percent of the low-gradient unconfined floodplain in the watershed association. This disturbance has included adjacent riparian and floodplain areas.

One measure of the effects of mining on stream channels is channel complexity, calculated as the ratio of mainstem, side channel and side slough channel lengths to valley bottom lengths. Channel complexity may be determined from aerial photo interpretation. A complex stream is characterized by meanders, multiple channels and side sloughs, while an simplified stream would be characterized by straight and/or channelized channels with limited connectivity to its floodplain.

LWD is also an important measure of channel function. LWD plays a critical role in many stream systems by the way it traps or slows down movement of sediment. In addition, LWD allows for the creation of pools on the downstream side, which also dissipates stream energy, causing less scour. Within the project area, no known data concerning LWD have been recorded; however, qualitative estimation is sufficient for this analysis. Based on visual inspections of Resurrection Creek by USFS personnel and authors of this report, there is a noticeable absence of LWD in the reaches disturbed by mining. Additionally, the disturbance of the streambanks and other areas adjacent to the stream channels has caused there a lack of recruitable wood in the disturbed reaches. Furthermore, loss of fines in riparian soils, while not quantified, is likely sufficient to greatly slow down natural revegetation, and thus future LWD recruitment, in areas with mining-related disturbance.

Another important aspect of stream channel is substrate size. Due to the high-energy nature of Resurrection Creek, the substrate particles are naturally coarse. With the additional effects of hydraulic and other mining, the median diameter of substrate particles is likely to have increased. However, no reliable data documenting substrate size within Resurrection Creek have been collected. The current substrate in the disturbed reaches is cobble- to boulder-size.

Additional considerations with LWD are the potential effects of the spruce bark beetle infestation. Because almost 50 percent of the spruce trees have been affected, it is likely that there will be a short-term increase in LWD recruitment in areas where spruce trees lie within the riparian zone. The increase is likely to be followed by a long-term decrease in recruitment, since so many spruce trees will have died. Both the short-term increase and the long-term decrease are likely to be minimal, however, because the majority of forest stands in the riparian zone are diverse, containing cottonwood and hemlock, as well as spruce trees. Notably, the riparian zone of approximately the upper third of Resurrection Creek consists of white spruce-dominated forest. Virtually all of this forest type is affected by the spruce bark beetle. Therefore, the effects of beetle infestation may be more significant in these reaches.

4.5 Water Quality

Water quality data prior to mining disturbances within the watershed could not be located, and likely do not exist. However, stream channel and hydrologic characteristics indicate that water quality in Resurrection, Palmer, and Bear creeks were sufficient to support salmonids. The creeks were likely highly oxygenated, and pH balanced, with low temperatures. Changes in land use and riparian corridors have the greatest potential to affect water quality.

Urbanization has been shown to degrade water quality (May 1998). However, since no water quality monitoring occurred before urbanization began, it is impossible to know to what extent urbanization has degraded water quality, if at all. However, USGS collected water quality data in Resurrection Creek at two stations, one in the town of Hope and the other 1.8 miles downstream from Hope. Water quality data were recorded at Hope on 10 occasions between July 1950 and September 1959 (Table 11). Water quality data were recorded downstream of Hope on 25 separate occasions between June 1968 and May 1971 (Table 13). The water quality data collected indicate no violations of state standards established for growth and propagation of fish, shellfish, other aquatic life, and wildlife as established by the Alaska Department of Environmental Conservation (ADEC 1999). Urbanization prior to 1971 has not appeared to degrade water quality in Resurrection Creek.

Mining operations can impact water quality in several ways. The physical actions of mining reroutes a portion of the stream water to shaker boxes to wash the gravel. The sediment-laden wastewater discharges into settling basins or directly into the stream. Improperly sized or maintained settling basins are not able to settle out large volumes of sediment, possibly leading to increased turbidity in the streams. Mining operations also result in the loss of riparian vegetation removal, decreasing stream shade and possibly increasing stream temperatures. A loss of riparian vegetation also increases streambank erosion, likely increasing turbidity.

Conventional water quality parameters were measured in Resurrection and Palmer creeks and adjacent settling ponds during 1980 to evaluate the effects of placer mining operations on water quality. Although degraded water quality was measured in settling ponds adjacent to the creeks, water quality degradation was not always observed downstream of the settling ponds. Increases in turbidity were measured below most mining locations, but were generally within state standards. Temperature, dissolved oxygen, specific conductance, and pH were also all within water quality standards. This is likely due to the relatively small amount of settling pond discharge entering into the creeks. This would cause dilution of the water discharging from the ponds. However, large quantities of sediment from setting ponds inundated during periods of high flows have been observed flowing into Resurrection Creek (Blanchet 1981). It should be noted that during this sampling, stream flows were abnormally high due to an extremely high snow pack and above average summer rainfall. During summers with lower than average flows, mining operations may have a negative impact on conventional water quality parameters such as temperature, dissolved oxygen, and turbidity.

Concentrations of heavy and trace metals were measured at several locations within upstream, within, and downstream of active mining sites in the watershed and wash water (13). Concentrations in excess of state water quality levels were measured on five occasions within the watershed. Manganese concentrations exceeded standards within wash water on Resurrection and Palmer creeks in 1980. Lead concentrations surpassed standards within wash water and downstream of mining on Resurrection Creek in 1980. Lead levels surpassing state standards were also measured in Palmer Creek above but not below the mining site (Table 12) (Blanchet 1981).

Water samples collected for heavy and trace metals analysis in 1994 in Resurrection Creek reported no detectable levels of arsenic, copper, lead, or zinc (Table 12). Water samples collected for heavy and trace metals analysis in 1994 in Bear Creek reported no detectable levels of copper, lead, or zinc. However, arsenic levels were detectable, with a slightly elevated concentration at the downstream location (Table 12) (Kalli and Blanchet 2001, unpublished report).

Although mining operations have been shown to degrade water quality, water quality in the Resurrection Creek watershed appears to meet state water quality standards and the requirements for fish production and survival.

Most water quality sampling programs were associated with evaluating the effects of mining operations. Other variables such as urbanization, trail erosion and shade reduction may contribute to water quality degradation. However, the contribution of these other variables is currently unknown.

4.6 Vegetation

Plant community structure and distribution have been affected by past and present human uses, wildfire, insect epidemics, disease, and other physical and natural processes, as well as land use management (e.g., timber harvesting and prescribed burns).

Among the most influential human uses are development in and around the community of Hope, past and ongoing recreational and commercial mining, and roads that serve Hope and provide access to forest lands within the watershed. Wildfire, the existing spruce bark beetle infestation, and predominance of rock and ice within the higher elevations are the primary factors influencing the distribution and structure of vascular plant communities. Human uses, land use management, and natural processes have influenced timber and fuels management.

4.6.1 Plant Communities

As noted in the Watershed Characterization section on plant communities (Section 2.6), there are 13 consolidated plant cover types identified within the watershed (see Appendix A, Map B). These include different needleleaf, broadleaf, and mixed forest; tall, low, and dwarf scrub; graminoid herbaceous, forb herbaceous, and aquatic herbaceous plant community types described by DeVelice et al. (1999). Their distribution and structure in space and time has developed in response to existing land uses, climate, wildfire, past and present spruce bark beetle infestations, and other natural processes. Because human land use activities have influenced only about 1 percent of the area within the entire watershed association, the distribution of plant communities does not appear to have been significantly adversely influenced by human uses within these watersheds, with a few exceptions. Fire, existing and past spruce bark beetle infestations, avalanches, landslides, and other natural processes appear to be the major determinants of the current patterns and distribution of the various cover types within the watershed association shown (see Table 13).

Residential and commercial development (human uses) have had low to moderate impacts on existing plant community structure and distribution within a small proportion of the entire watershed association area. Impacts outside developed areas have been low. Within developed areas, human uses have had moderate impacts on vegetation by replacing or altering spruce and hemlock-dominated forest plant community types. Alterations have resulted not only from vegetation removal activities, but also from human-induced wildfires and prescribed burns. In areas where vegetation is altered rather than permanently removed, plant communities tend to shift to early seral types, such as those encompassed within the other brush, alder, birch, aspen, cottonwood, and mixed hardwood-softwood cover types. Except where roads have been built up near Palmer Creek, Resurrection Creek, and other creeks to serve residents, access mining operations, and provide recreational access to forest lands and forest campgrounds or where cabins have been developed, impacts have largely been confined to the lower third of the watershed association around Hope and Palmer Creek. This includes those areas below the Gold Gulch-Rimrock Creeks and Willow Creek watersheds.

Mining has altered current vegetation, particularly in riparian areas where most mining is concentrated. Recreational and commercial placer operations in the Resurrection Creek, Palmer Creek, Bear Creek, and other drainages are the most common and widespread form of mining. Because these are typically confined to areas around the creeks, they have influenced riparian and floodplain vegetation plant community types, particularly the other brush, cottonwood, and alder cover types that include pioneer species that are first to colonize disturbed areas. Similar to other development, these tend to shift vegetation assemblages to earlier seral phases like some of the tall scrub and broadleaf or mixed forest types described by DeVelice et al. (1999). The influence of mining also is reflected in the presence of other nonforested cover types shown in Table 13, which show various acreages in the Bedrock Creek, Cripple Creek, Palmer Creek, Resurrection Creek Flats, Turnagain B, Turnagain C, and Wildhorse Creek watersheds. Other nonforested cover types appear to include urban areas as well as tailings from mining operations.

Development and human-caused disturbances have provided for the introduction of non-native and exotic plants, such as butter and eggs (*Linara vulgaris*). Vehicles and human beings (via clothing) are vectors for dispersal and spread of these plants. Seeds cling to vehicles and people and are transported to new areas, spreading the distribution of these plants. Non-native and exotic plants are primarily confined to the immediate areas around developed and disturbed areas within the lower third of the watershed association. Although the distribution and abundance of these plants has not been the subject of detailed investigation nor precisely mapped, they are not generally displacing or threatening native plant distribution and abundance (DeVelice, R.L., personal communication, 2001).

4.6.2 Fire and Spruce Bark Beetle

Wildfire (Potkin 1997) and past and present spruce bark beetle infestations have had a prominent influence on the composition and structure of the forested landscape of the Kenai Peninsula. Both are natural disturbance processes of the Resurrection Creek watershed. Wildfire frequency and existing vegetation structure have clearly been altered since European settlement. In addition, prescribed burns have been used to manage health and safety risks and promote higher quality wildlife habitat, particularly for moose.

Prior to European settlement (circa 1740), fire frequency was likely lower than it is now, ranging from return intervals of somewhere between 100 and more than 600 years. Large stand-replacing fires occurred at long intervals usually ranging between 250 and 500 years. These occur under extreme events of low fuel moisture, high temperature, low relative humidity, and high winds. It is possible that spruce bark beetle infestations were instrumental in predisposing forest landscapes to large fires. Historically, most ignitions in the region resulted in fires of small area and ecological impact because fuel moisture limited the intensity, size, and severity of burns (Agee 1993).

Since European settlement, wildfire frequency has increased, particularly around developed areas. Up until the elimination of the steam engine in 1954, many relatively small fires were common. Since that time, almost all fires have been initiated by other human sources of ignition. Potkin (1997) reported that 99 percent of all fires on the Chugach National Forest are caused by humans.

Both historic wildfires (before European settlement) and more recent wildfires (after European settlement) have contributed to the mosaic of vegetation types that exist on the landscape today, especially the presence of early to mid-seral phases of tall scrub, broadleaf, and mixed forest types described by DeVelice et al. (1999). These include alder, birch, cottonwood, mixed hardwood-softwood, and other brush cover types identified (see Table 13). When fires occur, most are “stand-replacement” because of the lack of fire resistance by the needleleaf conifer and broadleaf forest species.

According to Potkin (1997), the majority of wildfires are human-caused as lightening occurs very infrequently; fewer than three occurrences were reported in the last century. From the early 20th century until the 1950s there was a period of high wildfire frequency from railroad activity on the Kenai Peninsula portion of the Chugach National Forest. These wildfires have decreased in acreages burned as fire prevention techniques improved following the end of the steam engine era around 1953.

The likelihood of wildfires is typically confined to a rather narrow window due to the moderate climate and high fuel moistures that persist most of the year except during periods of drought and El Niño events. Spruce trees are generally flammable in late spring and early summer because of lower live moisture contents and the presence of flammable resins and other volatile oils in their needles. Even though large fires are stand-replacing, fire effects are quite variable. Fires create a mosaic comprising areas that burned with high, moderate, and low severity.

Unburned islands are also common. The result is a diverse mosaic of community types and structure. Most recent large fires in the Kenai Peninsula have occurred between May and July. Causes and areas of acres burned on the entire Chugach National Forest since 1914 are shown in Figures 8 and 9 (Potkin 1997). It is assumed that these causes and acreages are representative of conditions in this watershed association.

The spruce bark beetle on the Kenai Peninsula appears to be an integral part of the normal fire and successional processes and existing plant community structure and distribution in the region. More than 1,000,000 acres have been infected by the spruce bark beetle in south-central Alaska, including more than 12,000 acres in this watershed association. It appears that the current spruce bark beetle epidemic is primarily the result of natural processes where natural outbreaks occur at cycles of 150 to 500 years.

When beetles attack spruce, moisture content of needles decreases, thereby increasing their flammability. This is short-lived, as once trees die and needles drop, stand flammability is decreased. After a decade or so, the trunks begin to fall, creating a suspended and "jack-strawed" fuel bed of sound and decaying large fuels (i.e. fuels in the greater than 1,000-hour timelag class which is wood debris greater than 3 inches in diameter). If a fire were to occur in these sites, it could be of high intensity with extreme resistance to control during the periods of high fire danger (low relative humidity, low moisture contents of the 1,000-hour fuels and high temperatures). Open canopies would also have lower fuel moisture contents than those with a closed or dense forest canopy.

A project is currently being implemented to reduce fuel loading and to provide increased browse for moose. The project was approved in 1999, and includes winter mechanical treatment of forest stands infested with or at risk from spruce bark beetle. It also includes limited prescribed burning, which will reduce fuel loads while providing opportunity for forest stand regeneration and cover diversity.

4.6.3 Sensitive Plant Species

Sensitive plants, like other plants, are influenced by various biological, chemical, and physical environmental gradients or regimes. A habitat diversity model combining bioclimatic, landcover, and landtype GIS database layers into a single GIS layer was developed to identify and model various bioenvironmental regimes for sensitive plants (DeVelice et al. 1999).

This bioenvironmental database was used to create maps of the potential distribution of all rare and sensitive vascular plants known or suspected to occur on the Chugach National Forest. Maps were created by comparing characteristics of the different bioenvironmental model regimes to potential habitat for each of the 10 species of the sensitive plants that are known or suspected to occur on the Chugach National Forest. Of these, five are identified as potentially occurring in the Resurrection Creek watershed, including *Aphragmus eschscholtzianus*, *Draba kananaskis*, *Carex lenticularis* var. *dolia*, *Arnica lessingii* ssp. *norbergii*, and *Papaver alboroseum*.

According to the habitat diversity model, potential habitat for all of these species, particularly *Carex lenticularis* var. *dolia*, *Arnica lessingii* ssp. *norbergii*, and *Papaver alboroseum*, is widespread. The only known documented occurrence of sensitive plants is collections of *Aphragmus eschscholtzianus*, *Draba kananaskis*, and *P. alboroseum* from a location in the upper reaches of the Palmer Creek watershed. This is an apparent data gap. Additional information is needed to refine and validate the habitat diversity model. This would likely include systematic surveys to document the presence and distribution of these plants throughout the watershed association in order to protect existing populations and to improve the predictability of identifying potential habitats identified by the habitat diversity model.

4.7 Aquatic Species and Habitats

Anadromous species known to utilize creeks within the watershed include coho, pink, chinook, and chum salmon. Resident fish include Dolly Varden, whitefish, sculpin, stickleback, and possibly rainbow trout (Seaberg, S. Alaska Department of Fish and Game, personal communication, September 17, 2001). Anecdotal reports suggest that sockeye salmon may occasionally use Resurrection Creek, despite the absence of lakes (Johansen, E. Seward Ranger District, personal communication, December 2001).

Pink salmon spend only 2 years in the ocean before returning to their natal streams to spawn. Pink salmon are less likely to migrate great distances once in fresh water and are more likely to start mating behavior lower in a drainage than the other salmon species. Often the upstream limit for spawning is a waterfall or rapids that other Pacific salmon can surmount (Heard 1991). Some Pinks will even spawn in the estuary. In Resurrection Creek, pink salmon spawning beds are cataloged 6 miles up from the mouth of the stream. After a 5 to 8 month incubation the emergent fry migrate within days to sea, often not feeding while in fresh water. Feeding is primarily on planktonic or small nektonic organisms, including chironomid pupae, dipateral larvae, and drift insects (Heard 1991).

Pink salmon are the most numerous species inhabiting Resurrection Creek, and their plentiful numbers have given rise to a yearly fishing derby held in

Hope. In 1991 the Cook Inlet Aquaculture Association (CIAA) estimated the number of returning pinks at 30,000. The Alaska Department of Fish and Game in the 1980s estimated the numbers of returning pinks at between 20,000 to 35,000 pinks returning on even years.

Chum salmon spend 2 to 5 years in the ocean before returning to their natal streams to spawn. Like pink salmon, chum salmon are less likely to migrate great distances once in fresh water and are more likely to start mating behavior lower in a drainage than the other salmon species. Often the upstream limit for spawning is a waterfall or rapids that other Pacific salmon can surmount (Salo 1991). In Resurrection Creek, chum salmon spawning beds are cataloged 6 miles up from the mouth of the stream. After a 5 to 8 month incubation the emergent fry migrate within 30 days to sea. Feeding is primarily on planktonic or small nektonic organisms, including chironomid larvae, dipateral larvae, and drift insects (Salo 1991). Chum salmon are less numerous than pink salmon in Resurrection Creek. CIAA fish numbers for chum reveal 200 returning yearly to spawn (Seward Ranger District, unpublished report).

Coho salmon typically spend 3 to 4 years at sea before returning to spawn. Coho typically spend 1 or 2 full years rearing in streams and rivers before beginning their migration to sea; however, coho in Resurrection Creek typically only spend 1 year in the stream before migrating to salt water. Wenger (1991) postulated that this shorter freshwater life stage was attributed to limited rearing habitat in Resurrection Creek. Because of their larger size when entering salt water, coho are generally considered less dependent on estuarine rearing than are chinook or chum salmon (Simenstad et al. 1982). Coho tend to move through estuaries more rapidly, using deeper waters along shorelines. Feeding is primarily on planktonic or small nektonic organisms, including decapod larvae, larval and juvenile fish, and euphausiids (Miller et al. 1976, Simenstad et al. 1982). Coho also eat drift insects and epibenthic gammarid amphipods, especially in turbid estuaries (Sandercock 1991). Coho are one of the more numerous species at Resurrection Creek. Peak counts range from 100 to 500 returning adults per year.

Chinook salmon are the largest salmon that spawn and use waters of Resurrection Creek for rearing juveniles. Like all Pacific salmon, chinook reproduce in fresh water, but most of their growth occurs in marine waters. Chinook juveniles rear in Resurrection Creek for periods of a few weeks to more than a year before migrating downstream to Cook Inlet. In watersheds with an unaltered estuary, chinook smolts spend a prolonged period (several days to several weeks) during their spring outmigration feeding in saltmarshes and distributary channels as they transition gradually into more marine waters (Simenstad et al. 1982). Chinook fry and subyearlings in saltmarsh and other shallow habitat predominantly prey on emergent insects and epibenthic crustaceans such as gammarid amphipods, mysids, and cumaceans. As chinook mature and move to neritic habitat, they feed on small nekton (decapod larvae, larval and juvenile fish, and euphausiids) and neustonic drift insects (Simenstad et al. 1982, Healey 1991). Chinook are one of the least numerous species at Resurrection Creek. Peak counts range from less than 100 to 500 returning adults per year (Seward Ranger District, unpublished report).

Dolly Varden have several life history forms including stream resident, stream spawning/lake resident, and anadromous populations. Within the Resurrection Creek watershed, Dolly Varden are typically anadromous unless landlocked by impassible barriers. Dolly Varden, like other char, are fall spawners, utilizing streams with gravel bottoms. After an approximately 4-month incubation, the fry emerge. Dolly Varden are opportunistic feeders, eating larval and adult aquatic insects, snails, leaches, and small fish. Anadromous populations generally spend 3 to 4 years in fresh water before their first migration to sea in the spring. Dolly Varden spend only a few weeks to several months at sea before returning to fresh water for spawning and/or overwintering (Wydoski and Whitney 1979). Dolly Varden are becoming important to anglers when salmon are not available. In the Kenai River, the sport fishery for Dolly Varden appears to be growing at a rate similar to that observed for rainbow trout. Both species are readily caught using similar angling techniques (USFWS 2001). No information is known about the population status of Dolly Varden in the Resurrection Creek watershed.

Rainbow trout may exist above impassible barriers. However, the anadromous form of rainbow trout, steelhead trout, does not inhabit the Resurrection Creek watershed (Seaberg, S. Alaska Department of Fish and Game, personal communication, September 17, 2001). Rainbow trout spawn in early spring and exhibit similar spawning behavior as other salmon, although not all rainbow trout die after spawning. After a 2-month incubation, the fry emerge. Rainbow trout primarily feed on food associated with the substrate such as diptera, mayflies, stoneflies, amphipods, and aquatic worms and eggs. No information is known about the population status of rainbow trout in the Resurrection Creek watershed.

Fish use has been identified up to RM 19.0 of Resurrection Creek, with the lower 6 miles identified as critical habitat for spawning and rearing habitat for coho, chum, pink and chinook salmon. Of the 18 major drainages that flow into Resurrection Creek, eight provide habitat for salmon or Dolly Varden (Table 14). A barrier falls is located at approximately RM 0.5 of Palmer Creek. The lower 0.5 mile of Palmer Creek is known habitat for chinook, coho and pink salmon, and Dolly Varden. Dolly Varden are also found above the barrier falls to approximately RM 8.0. Anadromous salmon and Dolly Varden may also be found in Gold Gulch, Bedrock, Wildhorse, Cannonball, and Cripple creeks.

Fish distributions within the Resurrection Creek watershed were surveyed in 2000 by ADFG (Table 15). During this survey, observations of fish were made in 11 tributaries not previously identified as fish bearing (Table 15). In 10 of these tributaries, Dolly Varden was the only species observed, indicating that these streams are likely limited to resident species only.

Pink salmon are found up to RM 0.7 in Porcupine Creek, a creek flowing directly into Turnagain Arm. Pink and coho salmon are also found up to RM 1.7 in Bear Creek, another stream that flows directly into Turnagain Arm.

A majority of the available fish habitat is confined to the narrow low gradient and low gradient flood plain channels. The natural morphology of these channels allows salmonids to gain access to spawning areas, find adequate water depths and velocities, rest or hide in sufficient cover, and feed on a variety of terrestrial and aquatic food sources (Hogan and Ward 1997). These channel types form almost 16 miles of stream channel along the lower mainstem of Resurrection Creek and Palmer Creek. Although no fish habitat surveys have been conducted in the watershed, habitat characteristics can be inferred from stream channel descriptions. As described in Section 4.4, urbanization, mining, and recreational trails, have affected Resurrection Creek and the associated riparian and floodplain areas up to RM 6.0. The anadromous reaches of Bear Creek and the lower tributaries of Resurrection Creek have also been disturbed by mining. These disturbed portions make up about 40 percent of the low-gradient unconfined floodplain in the watershed.

Habitat complexity (a ratio of pool to riffle) provides the habitat diversity necessary for the success of salmonids. Gravel bars, meanders, LWD, and boulders form habitat complexity. The reaches disturbed by urbanization and mining have resulted in a loss of meanders and LWD, two major pool-forming components, and thus a loss of habitat complexity. Additionally, gravel-dominated riffles associated with the tail-outs of LWD-formed pools provide excellent spawning areas due to the close proximity between the spawning gravel and covered pools.

Habitat and fry surveys conducted in 1991 and 1993 identified side channels as typically having greater channel complexity and higher densities of rearing juvenile chinook and coho, and Dolly Varden (Wenger, unknown; Wenger et al. 1991). Side channels typically had larger pool/riffle ratios than main-channel reaches regardless of whether they were disturbed by placer mining. Additionally, juvenile salmon appeared to prefer pools with cover, whereas resident fish (Dolly Varden) appeared to have no preference for covered pools (Wenger et al. 1991). Although settling ponds are required to construct gravel berms at outlets to prevent access, Dolly Varden were captured in six settling ponds and coho captured in two settling ponds within the Hope Mining Company claims. These fish likely enter the ponds during high flows through either the upstream inlet of the pond or by navigating the outlet channels (Wenger et al. 1991). Regardless, with the lack of habitat complexity in the main channel, settling ponds may be a more important rearing habitat than previously believed.

Channelization of the creeks has lead to monotypic regimes dominated by a single channel with extensive riffles, small shallow pools, cobble-boulder dominated substrate and little LWD. More specifically, mining practices have removed gravels from the streams and streambank soils, leaving poor quality spawning substrate. Mine tailings have prevented the formation of viable floodplains, and side channels, and have likely led to a change in dominant substrate size that has also resulted in the reduction of gravel sizes required for successful spawning. The lack of LWD, the primary pool-forming element for juvenile salmonid summer and winter rearing habitat, has reduced the amount of suitable rearing habitat available. The loss of riparian vegetation reduces the future recruitment of LWD into the stream, maintaining and perpetuating the reduction in suitable rearing habitat. Further, the loss of riparian vegetation decreases the recruitment of terrestrial insects into the stream, decreases shade cover, and increases bank erosion, reducing the quality of available spawning gravels.

Additionally, existing run sizes indicate that rearing habitat is limiting in Resurrection Creek. Pink salmon, which do not overwinter in fresh water, have much larger runs than the other salmon species in Resurrection Creek, all of which overwinter in fresh water. Utilization of existing and abandoned settling ponds may provide additional rearing habitat for juvenile and resident fish.

As stated in Section 4.4.1, the spruce bark beetle infestation will likely not change the LWD recruitment rate and will therefore likely have little effect on salmonid habitat.

Recreational trails in the watershed may result in increased streambank erosion where trails cross streams. However, any potential impact from this is likely obscured by the larger impacts resulting from mining practices.

Although no amphibian surveys have been conducted in the watershed, no indigenous amphibians are known to reside within the watershed creeks. However, the wood frog uses the creek for rehydration, breeding, and egg development (Seaberg, S. Alaska Department of Fish and Game, personal communication, October 1, 2001).

No aquatic insect studies have been conducted within the watershed. Insects likely found in Resurrection Creek and other creeks within the watershed are those typically found in cobble-dominated streams.

4.8 Terrestrial Species and Habitats

The diverse mosaic of habitat types within the watershed association supports populations of an array of large game and other nongame animals. Management has focused on three management indicator species (moose, caribou, and brown bear) and five other species of concern (bald eagle, northern goshawk, wolverine, harlequin duck, and northern red-backed vole) to characterize existing conditions. Apparently limiting habitat factors within the watershed association and HCI have been identified for these species. Notably, other species of concern were identified in the Resurrection Creek and Palmer Creek Salvage Sales EA, including North American lynx, marbled murrelet, Kittlitz's murrelet, olive-sided flycatcher, alder flycatcher, gray-cheeked thrush, and blackpole warbler. These species are not discussed in this document.

Limiting habitat factors for moose, bald eagle, northern goshawk, caribou, brown bear, wolverine, harlequin duck, and northern red-backed vole have been identified (Table 16).

Detailed studies on the use and location of various habitats identified as limiting factors have not been conducted for each of these species. However, the estimated value of available habitat of different existing forested habitat types has been determined using the HCI model. A summary of the existing conditions for each species is presented below.

4.8.1 Moose

Moose are dependent on early seral vegetation types, including young willow, birch, cottonwood, and aspen stands for winter forage. Available winter range habitat is considered the primary factor limiting the size of the existing moose population. Renecker and Schwartz (1998) found that the nearness of feeding and hiding/thermal cover can also be a limiting factor, especially in areas of large-scale disturbance. Winter moose range, shown in Figure 7, are hardwood types below an elevation of 1,500 feet. In the absence of disturbance, such as fire, flooding, mass wasting event, and avalanche, these communities tend to be replaced by needleleaf forest types that may provide cover but have relatively poor quality forage. Winter range is now composed of scrub and broadleaf or hardwood forest vegetation types along flood plains, previously burned areas, avalanche chutes, and riparian zones. In the absence of fire, winter range is limited to permanent shrub fields along flood plains, avalanche chutes, and riparian zones. The juxtaposition of feeding and hiding/thermal cover is also important, especially in areas of large-scale disturbance (Renecker and Schwartz 1998).

The Resurrection Creek watershed association provides the only extensive winter range on the north end of the SRD and may be the core winter range for moose found in the East Fork, Six Mile, and Resurrection Pass areas. According to the GIS database, a total of about 10,500 acres of area fall below an elevation of 1,500 feet. A total of 7,600 acres of this total are forested cover types (e.g., birch, cottonwood, aspen, mixed hardwood/softwood, and spruce) with potential to provide moose browse if disturbed. It is assumed that prescribed burning and silvicultural treatments (e.g., select cuts) of hemlock stands probably will not provide good moose habitat. It is thought that the most accurate estimate of existing productive winter range in a stand initiation phase is 1,770 acres. This habitat has been at least partially the result of prescribed fire and silvicultural treatments over the last 20 years.

Table 17 shows the relative value of selected habitat types for moose and other selected management indicator species based on the HCI model. It should be noted that the habitat types in Table 17 do not correspond exactly to the vegetation cover types that have been mapped and are in Section 4.8. Table 18 shows the approximate stand type distribution and ownership of potential winter range in the Resurrection Creek watershed association.

The continuing spruce bark beetle infestation has altered the habitat structure and function across the watershed association area. Dead or dying spruce forest types are likely to be replaced by early seral phase vegetation communities favorable to moose. In addition, dead and dying spruce have contributed to increased fuel loading that provides opportunities for using prescribed burns to promote early seral vegetation type habitat favored by moose. Potential prescribed burning across the landscape should include an evaluation on potential long-term impacts on late seral vegetation types and habitat dependent species, such as marten and northern goshawk.

Current cover-type mapping in the GIS database must be updated to more accurately reflect the existing distribution of hardwood habitat types used and favored by moose. Existing GIS vegetation-type mapping does not accurately identify early seral vegetation. For example, birch stands mapped in the seedling/sapling size class are typically 80 years old and no longer provide forage. An updated analysis of existing habitat composition, including age and size classes, is needed to estimate the HCI and identify the location and extent of potential habitat enhancement opportunities (e.g., prescribed burning or silvicultural treatments). ADFG considers the overall habitat on the SRD to be of low quality and capable of supporting only 2 to 5 moose per square mile.

4.8.2 Bald Eagle

The nearness of large nest trees to food sources is the primary limiting factor for the bald eagle population in south-central Alaska. Most (82 percent) of all bald eagle nests on the SRD are in mature cottonwood trees with an average diameter of 31 inches, and most of these are within 0.25 mile of an anadromous-fish-bearing stream. There are few individual or stands of cottonwood trees meeting these nest tree criteria. Most stands in the watershed association are the result of disturbance from mining claim development that occurred in the early 1900s. These stands are now in the stem exclusion phase.

There are five eagle nests in the watershed association. Three of these have been active in the last five years. Using the high quality habitat of the Kenai River as a metric, the watershed association should be able to support one or two more territories and three to five additional nests. The most limiting factor is the lack of suitable nest trees in the Bedrock Creek and Cripple Creek watersheds.

Active management is needed to preserve existing nests and potential nest trees and contribute to regeneration of new stands of cottonwoods that could contribute to future recruitment. The growing population of beavers in abandoned settling ponds and clearing from placer mining pose a risk to existing large cottonwoods. There has been little regeneration of cottonwoods in existing riparian zones as a result of stream channelization from placer mining on Resurrection Creek and the major tributaries, disconnection of channels from their historic floodplains, and loss of riparian soils. The SRD is in the process of more accurately mapping cottonwood stands to determine the current size and age class distribution as well as guide management activities.

4.8.3 Harlequin Duck

Harlequin ducks nest along the rapids of inland mountain streams, such as those in the watershed association. Nests are located near the waterline adjacent to rapids but near shallow, quiet pools used for rearing. Bellrose (1976) reported that females and broods feed primarily on aquatic insects found in well-oxygenated streams. According to Rosenberg et al. (1994), the availability of food in nesting and rearing areas is thought to be a primary limiting factor in Alaska. Resurrection Creek appears to provide several miles of potential harlequin duck nesting and rearing habitat, but known use of potential nesting habitat and limiting factors in the watershed are poorly understood. A pair of ducks was observed at the Caribou Creek Bridge in 1984, and a lone female was observed at the trailhead bridge in 2000. No observations of successful reproduction have been observed.

Active placer mining may have adversely affected potential use of the watershed by disrupting potential nesting and rearing habitat and reducing aquatic invertebrate populations. There are no existing data on habitat quality or brood production. Although existing and historical placer mining may have altered existing habitat, unaltered reaches on Caribou Creek and other creeks may provide suitable nesting and rearing habitat.

4.8.4 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 factor limiting 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 association provide a diversity of food sources for bears. Roads and trails, other existing development, and increasing levels of recreational activities in the watershed may reduce the quality of available habitat. According to the HCI, existing habitat capability is 44 percent and 39 percent of historical spring and summer habitat, respectively.

4.8.5 Caribou

Over-hunting and habitat alterations resulted in the extirpation of caribou from the Kenai Peninsula by 1912 (Lutz 1956). Animals were reintroduced to the Kenai Mountains in the 1960s by ADFG. This herd, which averages about 350 animals, summers throughout the Resurrection Pass area and uses alpine habitats in the Resurrection Creek watershed seasonally. The herd exhibits high fidelity to winter range habitat on the south-facing, windblown ridges in the headwaters of Little Indian Creek and Big Indian Creek. Animals in the Kenai Mountain herd do not appear to mix with other lowland herds.

ADFG biologists are uncertain if the limiting factor for this population is winter range or predation. According to ADFG biologist Ted Spraker (personal communication) population size of the herd has been up to over 500 animals and declined three times since 1966. Average yearling weight is among the highest in the state indicating good overall nutrition. Habitat within the watershed association, productivity, and age structure of the herd were likely affected by wildfires during the 1900s. It is uncertain if these effects from wildfire were negative, outside the normal range of variability, or whether effects are still evident (Davis and Franzman 1979).

Prescribed burns and winter recreation have the potential to impact caribou winter range. ADFG and the U.S. Fish and Wildlife Service (USFWS) have initiated a monitoring project to identify, quantify, and monitor core winter range habitat. Closure of the Resurrection Pass Trail to snowmachine use in February prevents animal harassment that could jeopardize the health of the herd. In the future, any overlap in snowmachine use within identified winter range should be monitored annually to ensure there are not adverse effects to the health of the Kenai Mountain herd. The herd appears to use only a portion of the historical habitat available to them, suggesting that the current HCI is lower than historical levels. However, current habitat use is unknown but will be quantified once the winter range study, currently underway, has been completed.

4.8.6 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. Wolverine density on the Kenai Peninsula is estimated to be between 4.7 and 5.2 animals/mi^2, which is comparable to densities estimated for other areas in south-central Alaska (Golden 1996).

Recreational uses and hunting may be population-limiting factors. Average harvest rates of wolverine for the Kenai Peninsula have dropped from 22 to 14 animals per year since 1960. Scientific literature indicates that human disturbance near winter foraging and den sites, and overharvest, can cause declines in populations and extirpation. Although the estimated wolverine density is less than half that of the brown bear, hunting is still allowed. Magoun (1995) assumed that hunting and trapping is the primary cause of mortality. The decline in the moose population has probably contributed to a similar decline in the wolverine population. In addition, as recreational uses near winter foraging and den sites increase, the habitat potential for these animals is likely to decrease. The current estimated HCI for wolverine relative to statewide conditions is 0.6.

4.8.7 Northern Goshawk

An uncommon forest raptor, the northern goshawk feeds in the understory on squirrels, birds, and snowshoe hares. The primary limiting factors for the northern goshawk population appears to be the amount and nearness of feeding and nesting habitat to each other (Iverson et al. 1996). Structural characteristics of forest stands rather than species composition are important in nest site selection. Of the 17 known goshawk nests on the SRD, 13 are in hemlock-dominated stands characterized by a closed canopy with trees of large average diameter and an open understory. Eight nests have been located in lower Resurrection Creek watershed in what appears to be three territories. According to Bill Shuster (personal communication, 2001), the fact that this area supports the highest known nest density is directly related to the fire-generated mosaic of timber stands that exists.

The spruce bark beetle infestation is altering habitat structure in old-growth stands favored by the northern goshawk by accelerating the rate of spruce tree mortality, canopy closure, and understory cover. Although loss of spruce does not directly affect nest stands, it does affect the amount and quality of feeding habitat and prey availability near nest sites. Vegetation analysis based on the current vegetation composition and structural condition is needed to determine the existing HCI.

4.8.8 Northern Red-Backed Vole

The northern red-backed vole is the most abundant and widely distributed microtine in south-central Alaska. This keystone prey species supports a wide array of raptors and carnivores and plays a critical role in the dissemination of seeds and symbiotic fungi necessary for ecological health of the forest. Dissemination of seeds and fungi may be particularly important in forest regeneration following wildfire and timber harvesting.

Preliminary analysis of a 10-year monitoring project shows some unexpected habitat use patterns in the Cooper Landing, Hope, and Caribou Creek areas. Of the six habitat types being monitored, heavily infested spruce stands supported the highest density of voles. Habitat in the 1984 Caribou Creek prescribed burn area supported the lowest density. Higher densities were observed in the mature, fire-generated birch stand near Cripple Creek. These results indicate that vole densities vary in different vegetation types and some infested areas may need to be maintained to ensure reservoirs of these small mammals are provided over time. Although the size and interspersion of forest types may not be optimal for northern red-backed vole, the current HCI estimate for this animal is 0.8.

4.9 Human Uses

4.9.1 Heritage

No native Alaskan historic or prehistoric cultural resources are currently known to be present along Resurrection Creek itself. Although this may be a result of incomplete archaeological surveys of the creek bottomlands, it is possible that mining activities along the Resurrection Creek may have destroyed at least some such sites.

Events connected with late 19th and early 20th century mining in the Resurrection Creek watershed are considered historically significant in the economic and demographic development of south-central Alaska. The remains of pre-World War II mining camps and production sites are themselves considered heritage resources that are potentially eligible for the NRHP. Such resources include, but are not limited to, standing and ruined buildings, tailings piles, historical roads, machinery, ditches and other evidence of waterworks. As such, the effect of mining on heritage resources has been to create them.

USFS management of cultural resources is legislated by Acts of Congress and Executive Orders, which mandate inventories of heritage resources, and preservation and interpretation of all types of heritage resources for the benefit of the public. The requirements of three of these, plus a Programmatic Agreement between Region 10 of the USFS, the State Historic Preservation Officer, and the Advisory Council on Historic Preservation, are summarized in Appendix C.

The preferred alternative for the 2002 Forest Plan designates four different management strategies for the Resurrection Creek Watershed. The northwestern part of the watershed south to the watershed boundary between Bedrock and Rimrock Creeks and just east of the Hope Town site is designated "Forest Restoration," the portion from the watershed boundary between Bedrock and Rimrock Creeks south to the watershed boundary between Wolf Creek and Cannonball Creeks and north and east of Palmer Creek watershed is designated "Fish Wildlife and Recreation Prescription," and the majority of the watershed to the south as "Back Country Prescription." Most of the Palmer Creek watershed is designated a "Fish and Wildlife Conservation Area." The prescriptions relate to historic properties in that the largest number of known historic properties are in the "Forest Restoration" prescription, a lesser number are in the Fish Wildlife and Recreation" and Fish and Wildlife Conservation Area" prescriptions, and the fewest known are in the "Back Country" Prescription. The density of known sites relates directly to their proximity to the town of Hope, and the number of Forest projects undertaken in an area. The Acts which legislate management of cultural resources apply to all of these prescriptions, such that survey for and National Register evaluation of historic properties will occur in all prescriptions, historic buildings will be maintained, and historic properties will be protected from vandalism and natural destruction.

Of the 111,734 acres that comprise the total area of the Resurrection Creek watershed association, about 2,372 acres, or about 2 percent of the total, were surveyed for heritage resources prior to 1992 (Chugach National Forest GIS data). Archaeological surveys in the past 10 years have added about 3,000 acres to this amount, for a total survey area of approximately 5,400 acres within the watershed, or almost 5 percent of the total area (Chugach National Forest Heritage Program files). These surveys have been project-related, for the most part, and so are discontinuous in nature, with a rather patchwork mapped appearance. In-house funding for report completion was often not provided prior to the late 1990s, so that information for numerous surveys completed in the past 20 years, including numbers of acres surveyed, is often available only from field notes, and not from corporate databases or formal reports. For similar reasons, most identified heritage resources within the watershed remain formally unevaluated for the NRHP, although one has been evaluated for, nominated to, and placed on the NRHP. No maps of archaeological surveys are provided because no funding has been provided to update the GIS archaeological survey layer since 1992, and the resulting map would show fewer than half of the areas inventoried.

The two Alaskan Native associated sites known within the watershed are SEW-291, Ephanasy Point, east of the town of Hope on Turnagain Arm (at least historic 19th-early 20th centuries), and SEW-762, the Bear Creek Alpine Features, in the vicinity of the headwaters of Bear Creek (prehistoric). Ephanasy Point was inhabited until the early 20th century. No radio-carbon date is available for SEW-762, but artifacts found during site testing indicate that the site was occupied prehistorically.

Forty mining and Euro-American historic properties are currently documented within the watershed. Looking at the heritage resources by USGS quadrangle designations, there are three in Seward C-8, one in Seward C-7, 20 in Seward D-8, and 16 in Seward D-7. The only district, outside the Hope Historic District, which encompasses the town of Hope, is the Hope Mining Company Historic District. One of these heritage resources has been fully evaluated, nominated to, and placed on, the NRHP. The rest are either partially documented and evaluated, or have not been evaluated at all.

The Hirshey Mine, SEW-002, in the Palmer Creek sub-drainage, is on the NRHP. Although there are no longer any standing buildings, mine machinery is present, and the design of the mine operation is readily apparent.

SEW-425, also known as the Knight Association Claim, the Jack White cabins, and the Mull cabins, is eligible for the NRHP because of its association with early 20th century miner Charlie Mathison. It remains to be fully documented and evaluated. Three standing buildings are present which were maintained until the mid-1980s but are now in very early stages of deterioration. The remains of mining machinery and vehicle ruins are also present. All are becoming overgrown with alders.

The Harry Johnson Cabins, SEW-829, also known as the Abernathy cabins, near the headwaters of the Resurrection Creek, are eligible for the NRHP because of their association with early 20th century pioneer Harry Johnson. Johnson came into the area as a miner, but stayed on as a photographer who was instrumental in the development of wildlife picture postcard photography in Alaska. He was later connected with filmmaker Cecil Rhodes, and participated in providing film footage of the upper Resurrection Creek for use by Walt Disney Corporation. The larger of the two cabins was Johnson's primary residence; the smaller was a guest cabin. Two outbuildings, a storage shed and a privy, are still in excellent condition. This historic property remains to be fully documented and evaluated.

A number of other historic properties are undoubtedly eligible for the NRHP, but they have not yet been documented or evaluated. Six historic roads are identified as heritage resources, and three have been assigned cultural resource numbers. These include the Bear Creek Wagon Road, the Palmer Creek Wagon Road, and the Logman Road.

4.9.2 Cultural Landscapes

Cultural landscapes are a type of historic property addressed in the Secretary of the Interior's Standards and Guidelines, as revised in 1992. A cultural landscape is defined as "a geographic area, including both cultural and natural resources and the wildlife or domestic animals therein, associated with a historic event, activity, or person or exhibiting other cultural or aesthetic values" (Birnhaum 1994). Cultural landscapes generally fall into one of four categories: historic designed landscapes, historic vernacular landscapes, historic site landscapes, or ethnographic landscapes. The size of cultural landscapes can vary from as little as half an acre to hundreds of acres.

Although "Most historic properties have a cultural landscape component that is integral to the significance of the resource" (Birnhaum 1994), the cultural landscape elements have not been fully inventoried or evaluated for any of the historic properties in the Resurrection Creek watershed. Mining landscapes fall under the category of historic vernacular landscape, "a landscape that evolved through use by the people whose activities or occupancy shaped that landscape" (Birnhaum 1994). The Hope Mining Company Historic District can be expected to include a historic vernacular landscape, which has not yet been inventoried and evaluated. The area south of the District to the vicinity of Rimrock Creek has a high probability of constituting another cultural landscape associated with mining along the Resurrection Creek, which also needs inventory and evaluation. The historical period with which the landscapes are associated is the mining period of the early 20th century. The historical period with which the most of the cultural landscapes in the watershed are associated is the early 20th century. The features that contribute to the historical character of both these cultural landscapes include the physical environment and ecological systems of the region, views and vistas, mining areas, living areas, patterns of land division, vegetation and associated changes, tailing piles, ponds and ditches, the historic cabins and outbuildings, the Resurrection Pass Trail and secondary trails, and indigenous and introduced vegetation.

4.9.3 Mining

Mining, while not as prevalent now as it once was, still has a strong presence in the watershed. There are active operations on several claims along Resurrection Creek, Palmer Creek and their tributaries. Recreational activities in the study area, on the other hand, have increased dramatically in the last 20 years. Hope has become a destination town for a wide range of recreational pursuits, and the local economy has evolved to support a growing tourism industry. Another facet of both Hope's economy and the use of the watershed is subsistence activity. Many residents rely, at least partially, on the resources of the forests and creeks in the watershed. All these pursuits are influenced in some way by the work of the USFS, which practices forest management in addition to managing mining, recreation, and subsistence activity. Fire prevention, timber sales, and mitigation of the spruce bark beetle infestation all come under USFS purview.

Placer gold mining operations on Resurrection Creek began in 1888. Extensive hydraulic and hand placer mining began in 1895 and continued intermittently into the 1950s (Jansons et al. 1984). There was an unsuccessful attempt to use a hydraulic elevator on Resurrection Creek. This failed due to lack of water and the presence of large boulders (Moffit 1906). A five-foot Risdon open-connected dredge was installed in 1905 but was unsuccessful due to the shallowness of the ground and the presence of large boulders (Johnson 1912). A large cutter suction dredge rated to process some 500 cubic yards of gravels per hour was installed on HMC claims in 1999, but was never operated. The productive portion of Resurrection Creek is from its junction with Palmer Creek to Turnagain Arm.

The effects of mining on fish, wildlife, and the stream channel are discussed in detail in other sections of this document.

4.9.4 Recreation

This section addresses several topics on recreation, including existing facilities, influences of current and recent activities and processes on recreation, and planned projects and anticipated needs.

4.9.4.1 Recreation Infrastructure

The watershed association is primarily in USFS ownership, and the USFS manages 29.5 miles of trails, two campgrounds, three backcountry cabins, and a recreational gold panning area. Recreation activities include gold panning, camping, hiking, fishing, hunting, guided trips, mountain biking, backpacking, highway sightseeing, skiing, and snow machining. Most activity occurs along Resurrection Pass Trail, Gull Rock Trail, Resurrection Creek Road, and Palmer Creek Road. The recreational gold panning area also sees heavy use. The Chugach National Forest Gold Mining Areas Operation Plan (Chugach National Forest, 1996) provides guidelines for the regulation of this type of mining area. Trails and recreation sites are shown in Map D, Appendix A.

The Resurrection Creek recreational gold panning area is one of only three public panning areas in the larger Seward Ranger District. Rules designed to protect the streambed and bank have been underenforced, however, resulting in environmental damage and one death. A reclamation plan is being developed, but improvements in enforcement and user education are needed.

The potential for conflict exists between current commercial mining claimants and recreational users of the watershed. Many claims are not actively mined at the present time. Some claimants have expressed concern that hikers might collect gold from their claim (claim jumping). USFS staff are sensitive to this concern and direct recreational activities away from registered mining claims.

Porcupine Campground offers 24 campsites, and marks the trailhead for Gull Rock Trail and Hope Point Trails. Amenities include water, toilets, tables, fire pits, and dumpsters. Impressive views of Turnagain Arm could be improved by removing vegetation. Expansion of the campground is recommended for better RV access, improved vehicle parking, and more tent camping. Coeur d'Alene Campground is a much smaller facility with six tent sites. There are toilets, fire pits, and tables, but no water. Large RVs and trailers are discouraged. In addition, three primitive cabins (at East Creek, Fox Creek, and Caribou Creek) are maintained by the USFS and are available by reservation for 3 to 7 days at a time depending on the season.

The Resurrection Pass Trail is identified as a National Recreation Trail; 19 of its 38 miles are within the watershed association and are in generally good condition. Some stream crossings and the parking area at the trailhead may need improvement to prevent sedimentation of Resurrection Creek. There is an opportunity for interpretive signage at the trailhead to describe past mining activities, and the trailhead parking lot is in need of expansion and surfacing. The Gull Rock Trail parallels the shoreline of Turnagain Arm for 6.5 miles; the last mile of the trail is in the Kenai National Wildlife Refuge. There are recommendations to remove vegetation for improved shoreline views, expand the parking area, and introduce interpretive signage. The trail's moderate grade may lend itself to improved accessibility for disabled users. The Hope Point Trail was not designed by the USFS; it has developed through repeated use by hikers attempting to access Hope Point. The 2.5-mile trail needs to be improved and properly located to reduce erosion.

Palmer Creek Road offers spectacular vistas seldom seen from vehicles on the Kenai Peninsula. It is heavily used for recreational uses. Viewsheds could be improved by selectively removing roadside vegetation. There may also be opportunities for expanded motorized trail use. The Palmer Lake Trail begins at the end of the road and extends 1 mile to two alpine lakes.

4.9.4.1 Influences on Recreation

Mining operations tend to restrict access to Resurrection Creek despite requirements that the creek remain open to the public. Gates and signs have been put in place to discourage theft and vandalism, blocking vehicular access to significant stretches of the creek.

The spruce bark beetle infestation has increased the number of dead and hazardous trees in recreation areas, affecting trail maintenance and impacting the scenery.

The USFS planning process is a major determinant of the nature and intensity of recreation in the watershed. The USFS's mission is to achieve quality land management under the sustainable multiple-use management concept to meet the diverse needs of people (FSM 1000—organization and Management, WO Amendment 1000-93-2). The USFS addresses those needs from a planning perspective in its Forest Plans. The Chugach National Forest recently generated a Revised Forest Plan, a long range plan for land management, and recreation is a major consideration of this plan.

Broad goals and objectives for the Chugach National Forest are set out in the Revised Forest Plan. The main goal for recreation is to "manage for a range of recreation settings across the Forest to meet the Chugach National Forest's portion of south-central Alaska's current and future recreation needs within the capability of the land."

In order to meet this goal, the Forest Plan has the following objectives:

1. Maintain natural landscapes or provide landscapes that are natural in appearance when viewed from cruise ship routes, trails, recreation use sites, roads, waterways, and communities.

2. Maintain a managed system of roads, trails, waterways, and open areas for summer and winter motorized recreation opportunities. Provide settings for both summer and winter non-motorized recreation opportunities.

3. Provide a range of settings and facilities for a spectrum of recreational opportunities, including areas in which human-generated noise is minimal.

4. Maintain natural settings close to communities.

5. Provide interpretive and conservation education opportunities that enable people to develop a deeper appreciation of the Forest's resources, an understanding of some of the challenges inherent in managing these resources, and their role in sustaining those resources.

The management alternatives in the Forest Plan Revision divide the watershed into management areas. Management Area Prescriptions outline desired future conditions and acceptable activities in each area.

Prescriptions are assigned categories based on the degree to which human influence is allowed to dominate over natural processes. There are five categories of increasing human dominance. The designations in Resurrection Creek are in categories 2, 3 and 5. In Category 2 areas, direct human influence on the ecological processes is limited as much as possible but is sometimes evident. In Category 3 areas, consideration is given for both ecological processes and human occupancy, so human influence is more evident. Category 5 is assigned to mining areas and allows human influences to dominate ecological processes.

Human use is further defined by a “Recreation Opportunity Spectrum” (ROS) designation. The Standards and Guidelines section in Chapter 2 of the Forest Plan Revision explains the ROS in detail. For instance, the Hope Highway area is designated “roaded natural,” and areas along Resurrection Creek and Palmer Creek Roads as “roaded modified.” Regulations include camping period limitations, stream buffers for saddle and pack animals, food and refuse storage guidelines, and restrictions on motor vehicle and animal use.

Additionally, a Scenic Integrity Objectives (SIO) designation restricts the degree to which any development or management scheme may change the visual quality of the landscape. SIO designations in the watershed range from very low (mining areas; few restrictions) to high (back country areas; highly restrictive).

Five prescriptions are assigned to the Resurrection Creek watershed:

- Back Country

Category 2, ROS semi-primitive non-motorized (winter motorized allowed), SIO moderate to high. This area is managed to emphasize a variety of motorized recreational opportunities in natural-appearing landscapes. The "winter motorized allowed" option restricts the use of motorized vehicles to winter months only.

- Fish, Wildlife, and Recreation

Category 3, ROS roaded natural, SIO moderate. This area is managed to provide a variety of habitats for fish and wildlife species and year-round recreational opportunities in both developed and dispersed settings.

- Fish and Wildlife Conservation Area

Category 2, ROS semi-primitive motorized, SIO high. This area emphasizes the conservation of specific fish and wildlife habitats.

- Forest Restoration

Category 3, ROS roaded modified, SIO moderate to high. This area is managed for multiple-use with an emphasis on managing and/or restoring National Forest plant communities and sustainable forest conditions.

- Minerals Management Area

Category 5, ROS rural, SIO very low. These areas are managed for the exploration, development, extraction, and processing of natural resources (primarily gold in the Resurrection Creek area).

4.9.4.3 Recreation Projects

Specific projects evolve within the framework of Forest Plan prescriptions in response to USFS staff recommendations. Staff consider the age and condition of roads, trails, and facilities, input from users, and their personal familiarity with conditions on the ground. Of particular concern is the impact of overall human presence on the forest's brown bear population. This tends to limit the addition of new facilities or activities that would increase human presence. In general, there is a desire by USFS staff to bring existing facilities into compliance with ADA standards, increase interpretive opportunities, and improve existing trails without adding substantially to human impact. The current and anticipated future projects are as follows. See Table 19 for funding information.

- Gulch Creek Trail and Bridge Reconstruction

  This project has three components: 1) reconstruction of the Gulch Creek Trail; 2) replacement of an old, unsafe suspension bridge across East Fork Creek; and 3) development and construction of a trailhead and parking area. Funding is approved, and the project should be completed by 2005.

- Hope Point Trail Reconstruction

  This project will reconstruct approximately 1.2 miles of the Hope Point Trail starting in the Porcupine Campground. Completion is expected by 2005.

- Trail Bridges Repair/Replacement Deferred Maintenance

  In fiscal year 2000 the USFS assessed the condition of 34 trail bridges in the SRD. Many do not meet standards and present safety hazards to trail users. The maintenance required ranges from simple fixes to complete replacement. Twelve of these bridges are located in the Resurrection Creek watershed along Resurrection Pass Trail. Work is expected to be done by 2005. Funding estimates include all bridges, not just those in the Resurrection Creek drainage.

- Resurrection Trail Reconstruction

  This project will make repairs and improvements in the trail so it meets standards. The project is funded and work will begin in the 2002 field season.

- Vault Toilet Replacement

  This project will add or replace eight toilets and bring the buildings into compliance with ADA. The project is funded and construction will start in 2002.

Anticipated Projects

These projects are still in the planning stage. Project requests will likely be submitted within the next 3 years, with construction expected in 5 to 8 years.

- Resurrection Pass North Trailhead Reconstruction—This project would bring the trailhead up to current standards and include a livestock loading/unloading area.

- Porcupine Campground Reconstruction—This would bring the campground up to current standards and improve trailhead access for the Hope Point and Gull Rock trails.

- Palmer Creek Road Dispersed Sites—Trailheads would be developed in conjunction with the reconstruction of the Palmer Creek Road, including interpretive sites and dispersed camping.

- Coeur d'Alene Campground Reconstruction —This project would bring the campground up to current standards.

4.9.5 Local Economy

The contemporary local economy of Hope relies largely on tourism, although a sub-economy of subsistence is carried on, which includes hunting and gathering for food, barter, trade, and sale.

Hope's residents operate several businesses and services that make the recreational resources of the watershed more accessible. There are stores, restaurants, gift shops, and lodging in Hope. Artists sell their work, and several guide services are also available. In addition to the tourism-oriented businesses, there are many ranges of community services including an elementary/high school, post office, library, historical museum, grocery store, gas station, and laundry. The mining industry is also represented in the business community. The largest single claimant, Hope Mining Company, keeps offices in Hope.

4.9.6 Subsistence

Early Resource Use

Subsistence has a long tradition in Alaska. The Dena'ina people utilized available fauna and flora resources. Four species of salmon spawn in Resurrection Creek watershed. Resident fish include Dolly Varden, Arctic char, whitefish, lake trout, and rainbow trout. Salmon, however, provided the bulk of the diet. The Resurrection Creek watershed has populations of moose, caribou, black and brown bears, Dall sheep, and mountain goats. Furbearers include wolves, coyote, lynx, mink, land otter, marten, wolverine, fox marmot, and beaver. Marine mammals such as beluga and harbor seal were harvested in Turnagain Arm. Sea cliffs just east of Hope overlook deep water where these mammals are frequently seen quite close to the shore and probably were sites of hunting for these mammals.

Trading and bartering of resources were important activities for the early residents of Hope (Barry 1973). Trapping was and continues to be important to Hope residents. Moose, bear, and sheep were hunted (Knecht-Levine 1983). McCart (1983) refers to a moose hunt where dogsleds and snowshoes were the principal means of transportation and sharing of resources was prevalent.

Fish and game have been and continue to be very important to Hope residents. Moose were traditionally harvested in late October and November. Pink and king salmon were caught by nets and seines in Resurrection Creek. Pinks were mainly used as dog food.

A list of subsistence resources is shown in Table 20. The USFWS defines subsistence as the gathering of special forest products (SFP) for customary and traditional uses by rural residents, for direct personal or family use for consumption, barter, sharing, or customary trade (cash sale), that does not constitute a significant commercial enterprise. SFP are non-timber biological resources such as mushrooms, boughs, burls bark, ferns, moss, berries, roots, and flowers. Though they are not governed under SFP regulations, firewood and house logs are also gathered for subsistence use. The USFS has set aside areas for this purpose. Residents also fish, hunt game, and trap furbearing animals for subsistence. Although some hunting and trapping is not officially sanctioned, it is largely tolerated by enforcement agencies.

Contemporary Use

The present harvest of large mammals is limited by regulation. Many of the hunts require permits. In addition, the lower drainage and Palmer Creek watershed have restrictions on moose hunting and method of hunting of black bears. Because of these limitations and reported reduction on populations, many local hunters no longer wish to harvest some species in the areas (USFWS 1993). Wild resources continue to be important to Hope residents, however (Seitz et al. 1992). For the residents of Hope in I990, 26 large mammals were report harvested (Seitz et al. 1992).

5.0 REFERENCE CONDITIONS

This section documents the knowledge of past conditions in the watershed association. With respect to understanding the condition of the watershed, it is important to establish a frame of reference. For this analysis, the reference conditions refer to the conditions prior to major mining activity (about 1880). For some resource areas, little is known about conditions at that time; 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. In these cases, reference conditions may be based on knowledge of reference conditions of other watersheds, or knowledge of processes known to have taken place.

5.1 Erosion Processes

No historical documentation is available that describes the condition of hillslopes and streambanks before development and beetle infestation. Before development, it is likely that erosion occurred in a limited, episodic fashion. A low level of mass wasting likely occurred along the steep valley sidewalls, as today. Avalanches probably delivered sediment as they currently do. Unpublished USFS reports indicate that surface erosion was generally similar to today, except in localized areas.

Without roads and other development, there would have been slightly less erosion that there is today. Prior to the beginning of mining, stream banks were mostly intact, except at the outside apices of meander bends. There is, however, no way to quantify the change in streambank erosion, because there were no quantitative records kept in the late 1800s. While currently not quantified, the amount of windthrow may have been less before spruce bark beetle infestation. More spruce trees were living, and had root strength, making them resistant to wind.

5.2 Hydrology

Photographs or descriptions of the watershed before mining do not exist. The USFS (USDA Forest Service, unpublished) states that flow volume and timing on Resurrection and Bear creeks have changed little from reference conditions. It is assumed that Palmer Creek, having been disturbed for a much shorter length of time, has also changed little. The oldest available aerial photography, from 1950, shows significant mining disturbance along Resurrection Creek from RM 2.1 up to RM 6.6. Most of the disturbance in this photography relates to historical hydraulic mining operations as evidenced by many stacked tailings piles. Some previous steam shovel placer mining had also occurred that is apparent in this photography. Heavy equipment operations continued along this section of Resurrection Creek up through the 1990s, as well as smaller dredging and sluicing operations.

The patterns of precipitation and runoff are assumed to have been similar to today. As discussed in Section 4.3, it is unlikely that spruce bark beetle infestation has caused significant changes in hydrology. In addition, there are no other factors identified which would have altered hydrology. Mining activity has changed hydraulics and stream channels of Resurrection Creek, Palmer Creek, and Bear Creek; this is discussed further in the next section.

5.3 Stream Channel

There are no historical data or detailed descriptions of Resurrection Creek or its tributaries prior to mining. Therefore these reference conditions are based on the portions of the channel that have not been disturbed by mining, and on processes known or suspected to have occurred.

Figure 10 shows an example of a disturbed versus an undisturbed section of Resurrection Creek. The reference channel is a 1-mile segment of Resurrection Creek downstream from the heavy mining, and immediately upstream from Hope (stream mile 0.6 up to 1.6). The disturbed channel is a 1-mile stream section on the Hope Mining Company claims (stream mile 2.7 to 3.8).

The reference and disturbed stream segments in Figure 10 have almost identical gradients. The reference section likely had some past mining activity, but no hydraulic or heavy equipment mining. The reference segment appears to have been impacted and somewhat altered by heavy mining-related sediment loads. The reference segment in the early 1950s had broad gravel bars and the channel was more braided. Reduced sediment loading after 1950 has allowed this lower segment of Resurrection

Creek to stabilize. Streamside vegetation has re-grown and the channel appears to be in a state of quasi-equilibrium (Kalli and Blanchet 2001, unpublished report). Mature cottonwoods and spruce persist along the creek in this reference section that are well in excess of 100 years old, indicating that they predate Resurrection Creek mining activity.

The disturbed stream segment in Figure 10 shows heavy mining disturbance in the Resurrection Creek's stream channel and riparian zone. Throughout the disturbed segment, Resurrection Creek has been channelized, effectively limiting overbank flooding to the most extreme events. Mining tailings piles in some cases act as dikes along the creek, or their hummocky character can exclude the area from acting as a floodplain as it formerly did. Additionally, some areas along the creek may have been diked intentionally. A number of excavated settling ponds are present on the former floodplain. These ponds are generally isolated from the river, or exclude access into them by rearing or spawning salmon, although their water level probably varies directly with the river level. A few of these ponds have resident Dolly Varden.

Figure 11 shows a time series of photographs of a section of Resurrection Creek that spans the Hope Mining Company claims. Frequent, dramatic alterations to the channel and the riparian zones are evident in these photographs. Because the main channel has been straightened, the gradient has increased in the disturbed segment. In combination with diking, this has likely increased the stream power in this reach. Increased stream power may have caused incision in some areas, further entrenching the stream and decreasing floodplain connectivity.

In relation to the disturbed channel segment in Figure 10, the reference channel segment has greater sinuosity (although still relatively low), an available active floodplain, more side sloughs and off channel habitat, and greater amounts and availability of LWD for the channel and the side sloughs. All of these factors are beneficial for fish-rearing habitat. These factors also result in lower stream velocities in the reference sections, which are beneficial to both rearing and spawning fish.

Limited riparian vegetation in the disturbed channel segment is detrimental to bird, mammal, and insect populations, and also limits the stream channel's ability to recover from mining impacts. Stream cover is very limited in the disturbed channel segment.

The coarse alluvium (with a high cobble and boulder content) in the valley bottom of Resurrection Creek has been made coarser still during mining by washing away of the finer fractions. This coarse substrate in mined areas, combined with the relatively small flood sizes on Resurrection Creek, and the limited quantities of LWD, work together and keep Resurrection Creek's rate of natural rehabilitation very low. Areas that were hydraulically mined adjacent to Resurrection Creek almost a century ago still show little natural modification by the creek. Left to recover on its own, it would likely take Resurrection Creek a number of centuries to reestablish its floodplain and fully recover from mining impacts.

As with Resurrection Creek, there is little information on reference conditions of Bear Creek or Palmer Creek. There are no undisturbed reaches of these streams that are comparable to the disturbed reaches. In the disturbed reaches, it is likely that there was significantly more floodplain connectivity, somewhat higher sinuosity, and more spawning and rearing habitat. Substrate materials are likely coarser due to removal of fines during mining activities. A narrower strip of the riparian zone was affected by mining on both of these creeks, as evidenced in aerial photographs. Trees have come back in the riparian zone of the disturbed segments of these creeks.

5.4 Water Quality

Water quality data collected prior to mining disturbances within the watershed does not exist (Kalli and Blanchet 2001, unpublished report). Water quality monitoring has been conducted in two reference reaches, one in Resurrection Creek and one in Palmer Creek, upstream of mining activities (Table 14). Unfortunately, water quality monitoring in the reference reach is limited to a total of three grab samples analyzed only for heavy and trace metals. No conventional water quality data have been collected. However, water quality data collected at the town of Hope and below indicate that the cumulative effects of mining and urbanization has little to no effect on dissolved oxygen concentrations, temperature, pH, or specific conductance. Mining does seem to affect turbidity and heavy metal concentrations. In all likelihood, water quality in a reference reach is probably similar to what has already been measured in other reaches of Resurrection Creek, with the exception that a reference reach would likely have reduced turbidity levels and concentrations of trace and heavy metals.

5.5 Aquatic Species and Habitats

The amount of suitable fish habitat present in Resurrection Creek prior to the start of mining is unknown. There are no photos or information regarding the quality or quantity of fish habitat in the watershed before mining. Therefore, quantifying the loss of salmonid habitat and production is difficult. Additionally, Resurrection Creek is unique in south-central Alaska, and there is no similar watershed to make comparison of orientation, size, geomorphology, and species present. However, within the lower 6 miles of stream, there appears to be a 1-mile reach that has been undisturbed by large-scale placer mining. Unfortunately, no fish habitat assessments have been conducted within this reach.

Despite the lack of knowledge of the quality of fish habitat in undisturbed conditions, habitat conditions prior to mining can be estimated using geomorphic characteristics that existed prior to mining or that currently exist in the reference reach described in Section 5.3.

Typically, streams with geomorphic features similar to the lower reaches of Resurrection Creek, such as an average gradient and bankfull width, will have similar habitat characteristics if left undisturbed. Table 21 shows habitat quality ratings for various habitat parameters for different channel types. For low-gradient streams, high quality habitat characteristics include having frequently spaced pools, a pool frequency of less than two channel widths per pool, and more than 50 percent of the pools with a 1 m or greater residual depth, more than 2 pieces of LWD per channel width, off-channels formed, and unembedded spawning gravel (i.e., fines make up less than 12 percent of the substrate).

5.6 Terrestrial Species and Habitats

Although the existing array and distribution of habitats appears to be within the range of normal variation for the region, there are no quantitative data on pre-European settlement conditions. There apparently has been a shift in the populations of some large game animals in response to natural shifts in habitat patterns that have occurred since European settlement. It is appears that these shifts are part of natural successional changes in habitat that occur in cycles as well as human influences. Although little information is available, some inferences can be made regarding reference or pre-European settlement conditions. Historically, the caribou population was much larger and more widely distributed. Moose were likely less abundant and restricted to riparian and subalpine areas as documented by Lutz (1960). Brown bear, wolf, black bear, wolverine, marten, and other carnivore populations were likely larger due to less human-induced mortality and disturbance. Northern goshawk density would have been lower due to less diversity in feeding habitat.

5.7 Vegetation

There are no historical data or detailed descriptions of vegetation within the Resurrection Creek watershed association prior to European settlement. Because there have not been widespread or continual manmade disturbances in most of the watershed association outside of developed areas, it appears likely that undeveloped areas represent "reference" conditions. These are likely to be more representative of pre-European settlement conditions, or at least conditions that prevail as a result of natural processes and little direct human disturbance.

The fires over the last 150 years of settlement contributed to the present forest mosaic. These fire disturbances have boosted the wide range of diversity in composition of forest types on the Chugach portion of the Kenai Peninsula. Prior to the settlement period of the late 1800's, the majority of the coniferous forests were recorded (Langille, 1904; Holbrook, 1924) to be in late successional stages. The size of the old, charred stumps found within the fire disturbance areas are approximately the same size as today's. Forest and nonforest acreages on the Forest reflect the compositional changes of needleleaf forests bordering the burned areas, which are more than 200 years old.

The evidence for pre-historic fire events, taken from radiocarbon dates on soil charcoal, range from 4500 ybp (Reiger, 1995) to 570 ybp. Historical evidence supporting a climax forest is cited by the following authors Langille (1904) and Holbrook (1924) 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, each succeeding generation diminishing in size and quantity until they are reduced to their present impoverished state. Although large historic fires were recorded on the Forest during the settlement period, we do not now how this compares with the number and size of fires during prehistoric fire history.

Hardwood stands

A key difference that has occurred is that a large portion of what is now deciduous forest (i.e., birch) was predominantly mixed conifer prior to settlement. This area, in the vicinity of Hope, experienced major fires as a direct result of development of the mining industry in the early 1900s. The fires were "stand-replacing." Conversion of the birch stand to mixed conifer has been slow.

5.8 Human Uses

5.8.1 Heritage

Three reference conditions periods exist for the Resurrection Creek watershed: the pre-European fur trade period (prehistoric); the Euro-American fur trade period, which directly impacted the wildlife of the Kenai Peninsula, and indirectly affected on its vegetation; and the American mining period/early Chugach Forest period (1888-1942), during which human use changed some drainage patterns, and resulted in changes to botanical and biological resources.

During the pre-contact period (pre-1778) Alaskan Natives used biological and botanical resources for food, clothing, shelter, and transportation. Although the biological and botanical populations and their distribution as recorded at the time of European contact are often viewed as representative of a "pristine" state, these populations are simply indicative of their state given the technology of the human groups that harvested them, and the population size of those human groups at that time.

During the "Fur trade period" of 1778 to 1888 there was increased harvesting of land mammals, such as beaver, land otter, marmot, fox, lynx, caribou, sheep, wolf, bear, and wolverine, by Alaskan Natives and non-natives. A decrease in the number of beavers would have had an impact on the vegetation and the hydrology of the Resurrection Creek valley. There is documentation from other parts of the Kenai Peninsula of people catching anadromous fish to sell to Euro-American settlers. If this was an economic strategy of the Native Alaskans in the Resurrection Creek watershed, such activities may have had a detrimental effect on Resurrection Creek fish populations. Decreases in populations of fur bearers and related changes in human socialization patterns may have caused changes in human settlement patterns in the Resurrection Creek valley, as is apparent in other parts of the Kenai Peninsula. These would be evident in the locations and types of sites from particular time periods.

The American mining period/early Chugach Forest period (1888-1942) is one of the best documented. Mining camps were established in proximity to streams, whose water was used for placer and hydraulic mining. Water was not as much of a concern as the location of mineral veins for some later hard-rock mines, which were established away from major streams. Mining-related machinery was brought in, and buildings, ditches, and roads were constructed. Early 20th century photos of the areas adjacent to Resurrection Creek show widespread clear-cut areas throughout the valley, as late as the 1930s. Populations of fish and land mammals likely continued to decrease as a result of human subsistence use and changes to the Resurrection Creek stream bed. During this period, the Resurrection Pass Trail was open to trucks and large motorized vehicles.

5.8.2 Contemporary Use

Reference conditions for contemporary use are reflected in the text presented under Section 4.9 Human Uses. The reference and current conditions were combined.

6.0 SYNTHESIS AND INTERPRETATION

In answering the questions in Section 3, several interrelated issues became apparent. This section describes causes that were identified for differences between current and reference conditions, and identifies linkages between the different resource areas. Each of the following descriptions begins with a statement about the symptoms and causes of key issues in the watershed, followed by a synopsis of the issue.

Placer mining has disrupted channel form and function, limited available salmonid habitat, and decreased flood routing times through affected reaches. The Bear Creek, Palmer Creek, and Resurrection Creek drainages historically had relatively modest runs of pinks, and small runs of coho, chum, chinook. Placer mining further reduced a habitat-limited system by physical alteration of the streambed. Not only was LWD removed, but fines were lost, and the bedload coarsened. These conditions have likely affected macroinvertebrate populations, which would further affect fish populations.

Placer mining has also caused a short- and long-term lack of LWD in streams. Mining has removed trees of all species from the riparian zones in sections of streams that are the most used to fish (at least salmonids). Furthermore, the loss of fines and topsoil in riparian zones has created conditions which make revegetation very slow. Large areas of riparian zones are now excessively drained and poor in nutrients, making it difficult for young trees to become established. Those trees that do get established will likely grow slowly. If not addressed, this condition will lead to a long-term low LWD recruitment potential.

In addition, some spruce trees which are left are dead or susceptible to infestation of the spruce bark beetle. Because it is believed that LWD are important to habitat diversity, the low recruitment potential caused from mining activity will have a detrimental effect for some time in the future. In the short term, an increase in LWD recruitment will occur due to the dead and dying spruce trees falling into the stream, where they are within a site-potential tree height. This effect will probably occur over the next 10 years. In the long term, recruitment of spruce will drop sharply. However, it is not clear whether the regrowth of other species (such as cottonwood) will be sufficient to offset the loss of spruce trees. At any rate, the overall LWD recruitment potential will be low compared to reference conditions for some time to come. The poor substrate in the riparian zones in mined areas will take a long time to become revegetated. In addition, stream processes which would normally bring soil-replenishing nutrients to the adjacent floodplain may occur less frequently than under reference conditions, because the channel is cut off from the floodplain in several areas on Resurrection Creek.

Channelization caused by placer mining has simplified channel structure, increased local stream power, and likely has caused flood peaks to move more rapidly through disturbed reaches. Because the floodplain is not well-connected to the stream channel, it is less likely to mitigate flood effects. Decreased flood peak times may also affect the relatively undisturbed reach just upstream of Hope.

Spruce bark beetle infestation has led to increased risk of fire and a short-term increase in LWD recruitment potential. Aside from the effects mentioned above, the infestation may have caused an increase in peak flow several years ago. However, the increase probably was not great enough to have any lasting associated effects. 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 in the community of Hope. Efforts are currently underway to reduce the risk of wildfire. However, because there is no identified feasible way to rid the beetle from the watershed, the need for additional treatment appears to be unwarranted.

Recreation has had small-scale effects on surface and streambank erosion. At certain sites in the watershed, the effect of recreational activities is significant. The most heavily used recreation site is the recreational gold panning area, where streambanks have been eroded by suction dredging, and surface soil has been eroded by vehicular traffic and unofficial camping. Additionally, some erosion of the Resurrection Pass Trail has occurred, but is not well-documented. Given the limited areal extent of the trail and the camping areas, erosion and sedimentation associated with these areas is likely to be negligible on a watershed scale.

Mining and road building do not appear to have an effect on mass wasting. There has been only limited lode mining, and associated road building in the uplands. Placer mining has been conducted in the valley bottom; there has thus been little effect on mass wasting. Road building, with the exception of the Palmer Creek Road, also has been carried out primarily in the valley bottom. The Palmer Creek Road shows no sign of increasing slope instability. However, should lode mining be conducted on a large scale in the future, potential effects of mass wasting should be considered in any mining proposal.

Water quality is affected by mining operations on a short-term basis. While data are scarce, there appear to be no long-term effects of mining on water quality. However, turbidity does increase in water below active mining operations, and when flooding affects the areas of active mining. Affected reaches are limited to RM 0.0 to RM 6.0 of Resurrection Creek, the lowermost reaches of Palmer and Bear creeks.

An unofficial "Overlook Trail" has been created by repeated use between Porcupine Campground's Turnagain Arm Overlook and the beach below. The trail needs to be improved and other routes investigated to provide better access to the shoreline.

The human activity of mining has directly and cumulatively created cultural resources whose eligibility for the NRHP must now be considered. In several instances, this includes standing buildings for which the Federal government, in this case the USFS, is responsible under section 110 of the NHPA. It also includes responsibility for the care and management of these cultural resources, such that they are not damaged, as addressed by section 106 of the NHPA, and the Archaeological Resources Protection Act.

Effects of spruce bark beetle on heritage resources are poorly understood. There has been little effect on the features and buildings that constitute historic properties, although some may have suffered from beetle-killed trees falling on them. The spruce bark beetle epidemic has affected the vegetation of the landscape, in relation to the cultural properties, and may have changed the visual associations of some cultural landscapes. Until cultural landscapes are inventoried and evaluated, however, the effects of spruce bark beetles on cultural resources will be unknown.

7.0 RECOMMENDATIONS

The following section is organized by the primary focus of the restoration effort. Key issues that have been identified in the Synthesis section are addressed here by presentation of restoration options. Cost estimates for the recommendations are found in Appendix B. These cost estimates are intended as a guide; actual costs may vary significantly, depending on a number of factors, including timing, field conditions, accessibility, and inflation.

Each area contains two options for restoration or management. One represents a lower intensity effort, while the other would require a higher level of effort. The options were developed to provide the USFS with a range of treatments. The option actually implemented would be a result of budgetary conditions, establishment of desired future conditions, and public input.

7.1 Aquatic System Restoration Options

This section explores several policy options. Policy options must be examined because land allocations control the amount and degree of restoration. Mining claims are present along most of the affected areas of Resurrection, Bear, and Palmer creeks. Any restoration effort must integrate placer mining claims into an overall plan for the affected reach.

Three options for management have already been discussed in a document produced by the Chugach National Forest (Huber and Peterson 2000). The options for facilitating restoration include conducting mineral withdrawal of areas in need of restoration, requiring changes in mining plans which protect aquatic resources, and conducting mineral validity tests to determine claims null and void where possible.

Note that neither restoration option would involve Bear Creek. Based on discussions with USFS geologist Carol Huber, the mining claims on this creek appear to have the potential to support commercial operations. In addition, the most important reach for potential anadromous fish habitat lies downstream and outside of the Chugach National Forest boundary. Thus, even if restoration efforts were conducted to improve water quality and floodplain connectivity, the quality of habitat in the downstream reach is beyond USFS control. Restoration monies would be better spent on Resurrection Creek and its tributaries.

7.1.1 Recommended Surveys

Existing data on stream channel, available fish habitat, fish use, and riparian characteristics appear to be unanalyzed or insufficient to evaluate detailed restoration alternatives. Additional surveys must be done to assess reach-specific conditions, and in some cases, poorly understood processes acting on the aquatic system.

7.1.1.1 Stream Channel Assessment

The goal of the stream channel assessment is to establish historical changes in channel morphology, to identify past and continuing natural and management-related impacts, to determine which channels segments are likely to respond similarly to changes in input factors (e.g., water, sediment, LWD), to predict future response of channels with and without potential changes to input factors, and to interpret habitat-forming processes dependent on geomorphological processes controlling channel morphology.

To accomplish this goal, stream channel data such as channel dimension (slope, width, and depth), confinement, channel morphology, gravel bar characteristics, fine sediment deposits, channel pattern, flood plain attributes, and bank and riparian conditions will need to be analyzed and mapped. In reaches where this information does not already exist, this data will need to be collected. It is recommended that the methodologies described in the Washington Department of Natural Resources (WDNR's) Standard Methodology for Conducting Watershed Analysis be used. Ideally this analysis would be conducted throughout the watershed. However, at a minimum, this analysis needs to be conducted in representative disturbed and undisturbed reaches, prioritizing reaches proposed for restoration. The cost estimate for conducting this assessment for the whole watershed is detailed in Appendix B.

A critical component of the channel assessment is an investigation into the effects of ice-jam floods on channel morphology. We recommend that a wintertime study be conducted to monitor and measure the effects of ice on the channel.

7.1.1.2 Fish Habitat Assessment

The goal of the fish habitat assessment is to evaluate present availability, quality, and quantity of habitat for anadromous and resident fish species as compared to reference reaches. The assessment will help to determine the limiting habitat parameters within the watershed. Knowing the limiting habitat parameters will aid in designing restoration projects that will most benefit the target species. For example, if it is determined that coho-rearing habitat is limiting, proposed restoration designs should emphasize coho-rearing habitat instead of spawning habitat.

To accomplish this goal, habitat data such as adult holding pools; migration blockages; the quality, quantity, and stability of spawning gravel; pool-to-riffle ratio; LWD quantity and function; shade; and off-channel habitat need to be analyzed and mapped. Further, reaches of poor, fair, good, and potentially good spawning and rearing habitats need to be identified. In reaches where this information does not already exist, including reference reaches, this data will need to be collected. It is recommended that the methodologies described in WDNR's Standard Methodology for Conducting Watershed Analysis be used. Additionally, the effect of ice jams on LWD abundance needs to be understood. Ideally this analysis would be conducted throughout the watershed. However, at a minimum, this analysis needs to be conducted in representative disturbed and undisturbed reaches, prioritizing reaches proposed for restoration. The cost estimate for conducting this assessment for the whole watershed is detailed in Appendix B.

7.1.1.3 Fish Distribution/Use Assessment

The goal of the fish distribution/use assessment is to evaluate which fish species use which reaches throughout their freshwater life history stages. Fish abundance is dependant on the success of each life phase, which is limited, in part, by the quantity and quality of habitat available for each life phase and competition of the available habitat between species.

To accomplish this goal, fish distribution data, such as where and when each species of concern uses Resurrection Creek and its tributaries during each life phase, need to be analyzed and mapped. It is recommended that spawning surveys be conducted in all accessible reaches of Resurrection Creek and its tributaries beginning in June and continuing until December or until no spawning salmon are identified. Juvenile salmonid surveys should be also conducted using an electrofisher. The cost estimate for conducting this assessment for the whole watershed is detailed in Appendix B.

7.1.1.4 Riparian Zone Assessment

The goal of the riparian zone assessment is to evaluate LWD recruitment potential in the short (10 to 20 years)- and long (20 to 200+ years)-term and to evaluate current canopy closure compared to reference reaches. This goal will aid in determining the restoration alternatives and predict future conditions. USFS Tier 3 aquatic reconnaissance surveys may be used to acquire this information.

In addition, riparian zone data, such as vegetation type, tree size, and stand density, need to be analyzed and mapped. In reaches where this information does not already exist, including reference reaches, this data will need to be collected. Ideally this analysis would be conducted throughout the watershed. However, at a minimum, this analysis needs to be conducted in representative disturbed and undisturbed reaches, prioritizing reaches proposed for restoration. The cost estimate for conducting this assessment for the whole watershed is detailed in Appendix B.

7.1.2 Restoration Alternatives

Two conceptual restoration options have been developed. "Full Restoration" (Option 1) is a program for the restoration of all disturbed reaches of Resurrection Creek. "Partial Restoration" (Option 2) involves restoration on a limited scale, combined with changes in surface mining management. The cost estimates for the restoration options are in Appendix B. The cost estimates include the surveys discussed above and National Environmental Policy Act (NEPA)-related work that would be required. Permitting costs are not included. Prior to the initiation of restoration, specific goals for fish species, fish populations, and flood risks should be determined. Any restoration activity must have a goal by which its success or failure can be judged. Goals may be constrained or defined by Chugach National Forest planning documents, and by funding. The timing and the effective life span of restoration should also be established.

These two options are meant to provide an idea of the tools available and the potential costs of restoration and management. They represent two points in a spectrum of potential alternatives. Option 1 represents the most complete restoration effort reasonably possible. Option 2 represents a limited amount of stream restoration. Some elements of the options could be modified or dropped, depending on refinement of desired future conditions for the various resources. The St. Louis claims feasibility and design phase, present in both options, may also determine alternative reach restoration scenarios. Figure 12 shows the components of stream restoration for both options.

7.1.2.1 Full Restoration (Option 1)

This option provides for complete restoration of the affected stream channel reaches to optimum habitat conditions. The full restoration option uses a phased approach. There are three main phases: land acquisition and management, pilot reach restoration, and final restoration of the remaining disturbed portions of Resurrection Creek.

7.1.2.1.1 Phase I—Land Acquisition and Mining Management

To ensure the greatest chances of success of restoration efforts, a program of land acquisition and management should be undertaken. This program would be initiated concurrently with studies on the pilot reach (Phase II), and would include the following:

- Purchase of the Paystreke patented claim when it becomes available; and

- Withdrawal from mineral entry of the HMC, Pearson, and other claims located at the mouths of anadromous salmon tributaries (e.g. Palmer, Cripple, Wildhorse, Bedrock, and Gold Gulch-Rimrock creeks).

These actions could be initiated during the feasibility and design phase on the pilot reach so that these areas would be ready for restoration after implementation of pilot reach construction.

A second component of this phase consists of refining and strengthening the "judicious management" of mining claims not slated for withdrawal (including Bear Creek), as well as other aspects of surface resource management. The following steps should be taken as part of judicious management of the stream channel and riparian zone:

- Prohibit suction dredging in recreational mining areas;

- Limit camping sites of recreational miners to greater than 50 feet from the stream bank; and

- Develop an enforcement program for recreational mining activities.

For remaining mining claims (including Bear Creek and tributaries to Resurrection Creek), operation plan modifications should be required. These modifications should include the following elements:

- Require validity examinations for all mining claims on free and clear federal land (i.e., not on state-selected lands);

- Require sufficient bonds for complete reclamation and 5-year monitoring;

- Require claim holders to salvage and store all topsoil;

- Require mine operators to restore stream channels into reference channel platform and cross-section;

- Regrade riparian zone to pre-mining elevations and cover with stockpiled topsoil; and

- Require revegetation of the riparian zone.

A program of monitoring and enforcement would be required to ensure compliance and efficacy of practices.

The USFS would conduct monitoring of riparian zone and stream channel for 5 years to ensure successful reclamation. At the discretion of the USFS, settling ponds may be part of the reclamation. Timing of reclamation should begin after 5 years of inactivity. Phase II could be conducted concurrently with Phase I.

7.1.2.1.2 Phase II—Pilot Reach Feasibility, Design, and Construction

The pilot study would concern the reach currently withdrawn from mineral entry (formerly the "St. Louis claims"), and upstream of the Paystreke claim (see Figure 12). This reach will serve as a test reach for various restoration prescriptions. A reference reach, such as the reach upstream of the Pearson claims (above about RM 5.5), will need to be identified; the surveys discussed in Section 7.1.1, Recommended Surveys, would also be conducted on the reference reach. The reference reach should have physical characteristics which are desirable for maximum habitat availability for all species of salmonids (depending on the desired future conditions), measured by such characteristics as gradient, cross-section, bankfull width, pool-to-riffle ratio, LWD counts, and pool size and depth.

The pilot reach restoration would be composed of four main tasks: riparian, channel, and fisheries surveys on the pilot and reference reaches (discussed above); feasibility and design; construction; and post-construction monitoring. Notably, heritage resources management would be completed concurrently with design to avoid or mitigate impacts to heritage resources (e.g., mining-related artifacts).

Feasibility and Design of Pilot Reach

Detailed studies would be carried out on the pilot reach as part of a feasibility and design effort. These studies would include the following:

- Hydraulic analysis of critical flows (e.g., bankfull, 10-year, and 100-year). This task would determine the effective discharge for appropriate segments of the pilot reach. Prior to analysis, cross sections would need to be characterized, including the geometry, slope, and bed material compositions. Next, appropriate open-channel flow equations would be determined, for later use in channel design. (Note: hydraulic analysis would need to consider work being conducted by Matt Blank, master's degree candidate at the University of Montana).

- Sediment transport analysis. This task would include selection of appropriate sediment transport equations. Selection would be based on stream characteristics. Two or more sediment transport equations could be tested and compared. The bedload capacity would then be calculated.

- Main channel design. The design of the pilot reach would be based on the understanding of reference channel conditions, current channel conditions, and desired habitat conditions. The first step would be to conduct hydrologic analysis for design. This would determine representative average daily streamflow records for use in calculating annual sediment loading. It would also estimate the design discharge rates for assessing channel-forming flow rates, optimum habitat capability, and flooding potential. Results of LWD and ice jam studies would determine whether and how LWD would be incorporated into channel design. Engineering analysis of wood structures would be performed.

  Design of the main channel would incorporate characteristics desired for fish habitat, but would likely be constrained by geomorphic and hydraulic processes. For example, the steep channel gradient (up to 2.5 percent), combined with high snowmelt runoff, creates considerable stream power capable of displacing or washing out LWD, moving a substantial sediment load, and scouring the stream bed. Channel design would have to account for the high stream power by appropriately designing and sizing habitat structures and channel modifications to persist under these conditions. The energy associated with high stream power can be effectively dissipated through local reductions in gradient, creation of pools, and other channel modifications. Design would be an iterative process, in which the effects of a proposed design stream power (and sediment transport) are determined, followed by adjustment of the design toward the desired channel characteristics.

The effects on nearby roads would need to be considered. Portions of the Resurrection Creek Road may need to be relocated. Portions of the Resurrection Pass Trail may also be affected.

The pilot reach includes the confluence with Palmer Creek. The design would need to incorporate the effects of Palmer Creek. The assessment phase would likely distinguish subreaches upstream and downstream of the confluence. While restoration of Palmer Creek would depend on the determination of desired future conditions, it is recommended that restoration be conducted concurrently with restoration on pilot reach.

- Side channel design. Through input from channel habitat surveys, and determination of limiting habitat, design of side channels would be incorporated into overall restoration. Existing pools created from past mining activity would be evaluated for their connectivity and function. Final side channel design would determine the feasibility of using these pools, or creating new side channels with pools.

Upon completion of the feasibility and design studies, construction would begin on the pilot reach. This would occur during low flow (April), but would be subject to other variables, such as equipment availability, biological considerations, and permitting restrictions. Riparian zone restoration could include some small-scale experiments, including various soil treatments (e.g., fertilized vs. unfertilized or topsoil vs. fines from ponds), species compositions (e.g., success of mixing conifer/deciduous species), grazing (e.g. species resistant/preferred by moose), and success of various size class plantings.

Finally, a monitoring program would be established, with resurveying of critical cross sections, and periodic examination of in-stream structures and pools. Monitoring should also include fish-use surveys, vegetation survival and growth surveys, re-surveying of channel cross-sections and other visual surveys. Monitoring is important to evaluate the physical stability of restoration measures, and to determine what kinds of improvements could be made. Monitoring would also determine whether or not fish usage increases as a result of restoration efforts. Information on vegetation growth rates and survival is essential to determine the success of riparian restoration. Feedback from these types of monitoring is critical to provide input into additional phases of restoration.

7.1.2.1.3 Phase III—Final Restoration of Remaining Reaches

Phase III would begin after the withdrawal of the HMC claims and claims at the mouths of tributaries connected to this reach (between the lowermost mining workings and the Resurrection Pass trailhead). This phase of restoration would use knowledge gained from the pilot study, along with sediment, hydraulic, and hydrologic analyses similar to those conducted for pilot study. Feasibility and design studies of these reaches would be conducted, followed by implementation and construction. Construction could be phased in over a number of years. However, it is recommended that riparian revegetation begin as soon as possible to expedite LWD recruitment. Any existing large cottonwood trees should be left remaining, where possible, to provide eagle nesting sites.

As part of the restoration design, trails and interpretive signs would be designed and constructed describing and providing access to the aquatic systems, the restoration projects, and the effects of placer mining. This is discussed further under the Human Uses recommendation section.

As with the work done in Phase I, monitoring of the restoration projects would be essential. Monitoring would determine the success and identify use by wildlife and fish. Monitoring should include fish use surveys, vegetation survival and growth surveys, re-surveying of channel cross-sections, and other visual surveys.

7.1.2.2 Partial Restoration (Option 2)

The Partial Restoration option consists of two phases. The strategy of the partial restoration option is to restore Resurrection Creek in the area already withdrawn from mineral entry (St. Louis claims) and provide a setting for natural recovery in smaller reaches as individual claims become reclaimed or are determined invalid. Many of the recommendations are similar to those described in Option 1. This option would allow for long-term recovery of the aquatic and riparian system but at a much slower rate than Option 1. This option would also be considerably less expensive to implement, and require less NEPA-related work.

7.1.2.2.1 Phase I—Mining Management

Phase I begins with refining and strengthening the judicious management of mining operations in areas not slated for withdrawal. This component of restoration would be similar to Phase I under the Full Restoration option, except that it would also apply to the reach that contains the HMC and Pearson claims. No restoration design would occur along this reach, and therefore modifications to the existing operating plans would be critical in surface resources management. Requirements for regrading, revegetation, and monitoring would be the same as under Option 1, Phase I.

7.1.2.2.2 Phase II—Reach Feasibility, Design, and Construction

Phase II would begin following the channel, riparian, and fisheries surveys discussed above. This phase will be essentially the same as Phase II under Option 1, but without installation of trails and interpretive signs. The pilot reach in Option 1 would be the only restoration reach in Option 2.

Monitoring of the restored reach would be critical. Monitoring should include fish-use surveys, vegetation survival and growth surveys, re-surveying of channel cross-sections, and other visual surveys. The results of monitoring will determine if additional work is needed (such as additional plantings, or planting of different species), and will help guide future restoration decisions.

7.2 Vegetation

Because of the widespread effects of the spruce bark beetle infestation on fuel loading and plant community composition and structure, management of vegetation may be warranted. Vegetation management must balance costs, values, and risks, including water and air quality, fisheries, biological diversity and integrity, human and environmental health and safety, protection of public and private property, sustainable economic development, and subsistence and recreational uses. Because the current infestation and its potential effects on plant community structure are within the historical range of variation, management of potential risks to private property and human health appear to be the most important decision-making criteria. Consequently, management recommendations focus on maintaining vegetation within the natural range of variation while minimizing the risks to property and human health. The report on wildlife within the Resurrection Creek watershed association (Seward Ranger District, 2001) indicates that a mixture of 25 percent each of stand initiation, stem exclusion, understory re-initiation and old growth stages should be maintained. This section also includes recommendations specifically for management of hardwoods, which have different issues than spruce.

7.2.1 Vegetation management for fuels reduction

An optimum management scenario would preserve the biological diversity and integrity of plant communities while reducing the potential risks of property damage or loss of human life. Management actions that could be implemented to achieve these objectives include a combination of silvicultural approaches, mechanical removal of dead or dying timber, and prescribed burning. Each of these manipulative approaches has various pros and cons that must be considered in any decision analysis. In all cases, it appears that these activities should be small-scale silvicultural prescriptions (2 to 5 acres), and prescribed burns should be implemented with the primary objective of reducing fuel loads and the risks of catastrophic wildfire. Management activities should be concentrated in and around the community of Hope and in those areas within the lower third of the watershed association that contain existing beetle infestations or are at high risk of infestation.

Option 1—Reduce fire risk in the lower watershed

A wide range of silvicultural prescriptions and prescribed burning options exist as outlined here. The least intensive management option entails a combination of silvicultural prescriptions and prescribed burning to create a 200-foot shaded fuel break in and around Hope and developed areas within the lower third of the watershed (below Gold Gulch-Rimrock Creek and Willow Creek watersheds). Silvicultural prescriptions and prescribed burning should be conducted in patch sizes that emulate natural disturbances and promote regeneration and natural succession processes. Management goals would be to create a vegetation mosaic within the natural range of variation. Mechanical treatments could include harvesting of standing dead, live at-risk, or downed material. Cutting and removal of fuels would reduce fire risk, and promote regeneration of early successional communities. Negative elements include loss of snags or downed woody material that provides habitat to wildlife species, and are important carbon and nutrient pools affecting nutrient cycling and, potentially, ecosystem productivity. Another potential disadvantage is that mechanical methods may result in disturbance that promotes the spread of non-native or exotic plants. Potential selective prescriptive treatments in 2- to 5-acre tracts could include the following:

- **Spruce and hemlock.** Salvage and sanitation thinning of dead spruce and mature live spruce trees. Assumes a viable market for cut materials.

- **Birch, alder and mixed hardwood/softwood.** Patch clearcutting to promote sprouting and higher quality browse for moose within areas of mature or stem exclusion stands. See Section 7.2.2 below.

- **Selective thinning and fuel reduction for firewood and house logs.** Patch cuts of needleleaf and broadleaf forest types for consumptive uses. Advantages of this treatment are free labor and potential revenue generation. Permit fees could cover enforcement of slash management and removal. Many segments of a potential fuel/fire break around the community could be accomplished through the harvest of trees for construction and firewood purposes.

Large clearcuts may promote spread and dominance of bluejoint reedgrass (*Calamagrostis canadensis*). When it is present in the understory, bluejoint reedgrass can greatly increase if forest canopies are disturbed. This is particularly true if canopies are disturbed by logging, which has minimal effects on understory species. Bluejoint reedgrass is a highly productive and competitive grass, and can create an extremely flashy fuel load. In open sites with greater solar exposure, fuels dry more quickly, temperatures may be higher, and relative humidity may be lower. The cumulative effect of a dense bluejoint reedgrass invasion in an open site is the creation of a continuous fuel bed of up to 5 feet in height with the potential to create wildfires with high/extreme rates of spread and high/extreme resistance to control during prolonged dry fire seasons. This may last for a period of 30 or more years until forest species begin to shade out the grass (USFS 1996). Because of the negative effects of bluejoint reedgrass on fire hazards, land use activities that increase its abundance (clear cuts where it exists) should be avoided. Thus, silvicultural treatments should be carefully planned to avoid sites susceptible to dominance by bluejoint reedgrass following treatment.

Within a shaded fuel break around the urban areas, fuels treatments would consist of removing or changing natural and activity fuels. The objectives would be to alter loadings and arrangement where the probability of fire starts, as well as the intensity, rate of spread, and resistance to control, would be lessened. The shape and arrangement of fuels is an important factor that influences fire behavior. The amount and arrangement of fine fuels (grasses, lichens, litter, leaves, needles, and wood fuels less than 3 inches in diameter) determines the rate of spread and the fireline intensity. For example, these are the fuel parameters that are used to determine rate of spread in the BEHAVE model. In contrast, LWD (coarse fuels) affects fire severity (the ecological effect) and resistance to control.

Fuel hazard reduction at the “urban” interface with Hope, areas with other dwellings, and in areas with high recreational use, is recommended. Here we recommend a shaded fuel break as well as the implementation of a program to inform residents of approaches to decreasing the fire danger around their dwellings. We recommend these actions because (a) for human safety, it is important to have areas where wildland fires can be effectively suppressed; and (b) most ignitions in this landscape arise from human sources of ignition. Actions here would include construction of shaded fuel breaks, and removal of ladder fuels, snags, and dead and downed wood. This could be best accomplished through forest thinning, selective harvest, and pile and burn of the excess fuels. Areas for public fuel wood and pole gathering could be incorporated into fuel hazard planning.

Prescribed burning is a potential land management activity occurring away from dwellings. Prescribed burns should be conducted so they emulate a natural disturbance that would promote regeneration of fire dependent species. Sizes of these burns should be determined based on climatic factors, fuel moisture, size of natural wildfires, terrain, and public safety. Potential benefits of prescribed burning include promotion of natural successional and ecological processes, including nutrient cycling, control of insects and disease organisms, and promotion of early successional vegetation with its attendant wildlife attributes (e.g., improved moose browse). Another advantage of burning compared to mechanical treatments is that variable intensity of fire over the burn unit can result in greater habitat diversity, such as islands of intact (unburned) vegetation. Disadvantages include temporary degradation of air quality and potential related health effects, potential view and tourism impacts, aesthetic impacts, and risks associated with escapes. Both mechanical and prescribed burn treatments would require access to the forest, and this could increase costs of management.

The size and intensity of both management actions would be dependent on the desired level of protection, available resources, and other ecological, economic, and social factors. Because of the advanced nature and extent of the current beetle infestation, it is impractical and not recommended that management activities be attempted throughout the entire watershed.

Option 2—Reduce fire risk in both lower and upper watershed

A more intensive and widespread treatment strategy would include, in addition to the Option 1 treatments in the lower watershed, a combination of management activities around all amenities in the watershed, including USFS campgrounds, cabins, and mines in the middle and upper reaches. This would be more labor intensive, require a larger commitment of resources, and require a longer period of time to attain, assuming a comparable level of staff is available for planning and implementing management actions. A cost-benefit analysis should be undertaken to justify any such widespread actions.

7.2.2 Hardwood Management

The presence of extensive stands of mature birch and other hardwoods presents a special challenge, as well as some opportunities, to management. Two options are presented to give an indication of the variety and extent of treatments available. A crude estimate of the cost of hardwood management was made; for Option 1, it would cost an estimated $7,500 per year, while

Option 2 would cost about $15,000 per year. Both estimates assume cost recovery through firewood sales. Notably, the costs estimates could vary significantly from actual costs, based on a number of factors, including inflation, accessibility, and staff and equipment availability. Cost savings could occur if hardwood management actions are conducted in coordination with other vegetation management actions (i.e., those aimed at removing dead spruce trees).

The Resurrection Creek watershed is divided into three birch populations for management discussion purposes: (1) the area immediately adjacent to Hope; (2) the lower one-third of the watershed; and (3) the upper two-thirds of the watershed. The divide between the upper two-thirds and the lower one-third is at the Palmer Creek/Resurrection Creek confluence. Attributes and management recommendations by birch population are discussed below, followed by a discussion of the other important hardwood species.

Option 1—Lower intensity hardwood management

Birch (Betula papyrifera)

Large stands of even-aged birch exist throughout the Resurrection Creek watershed having originated following extensive fire around 1920. Approximately 6,300 acres (~6 percent) of the watershed are covered by birch. The stands consist primarily of dense pole-sized birch in the overstory with varying amounts of coniferous understory. Remnant patches of large live white (Lutz) spruce (*Picea X lutzii*) and western hemlock (*Tsuga heterophylla*) and patches of dead spruce and hemlock are interspersed in these stands.

The desired future condition for birch at the watershed level is to attain four age/size classes of approximately equal percentage area. The age/size classes desired are seedlings, saplings, poles, and large trees. Approximately ten percent of the existing birch stand is desired in spruce and hemlock. The desired future condition would substantially increase moose browse (and general wildlife habitat diversity), break up the large blocks of dense pole-sized birch, increase age and size class tree diversity, and structure and reduce fuel loading.

Birch should be regenerated by age 100 to encourage vigorous sprouting. Considering the total area of birch in the watershed (100 percent of birch area), the desired future condition would allocate 10 percent for conversion to coniferous patches and 25 percent each for the seedling, sapling, pole, and saw timber. Poles are in abundance, so management to regenerate seedlings and saplings and grow larger trees from poles would be necessary.

An intensive management approach for the first decade might establish 1 percent coniferous patches, 3 percent seedlings and 3 percent thinned areas spatially dispersed across the watershed. Relatively small patches (5 to 10 acres) and spatially dispersed across the watershed may help disperse moose browse and reduce its impact in regenerated areas.

Adjacent to Hope

The forest-urban interface lies mostly within the largest birch stand in the watershed association. The birch stand adjacent to Hope is highly visible and therefore of special interest and a high priority for management. Fuel loading, moose habitat/browse, and aesthetics are key issues management must address. The stand consists primarily of pole-sized birch with a dense spruce and hemlock seedling/sapling understory with some patches of larger dead conifers. The conifer component (understory and dead) is of particular concern as a fuel ladder fire hazard to the birch overstory.

A shaded fuel break, as described in section 7.2.1, along with thinning is recommended for this area. This feature would be 200 to 300 feet wide but up to 500 feet wide depending on stand conditions and property boundary configurations. This treatment would include removal of the live conifer understory and dead conifers and selective thinning of birch to reduce fuel loading, remove the potential fuel ladder to the birch overstory, and reduce the fire hazard to Hope. Thinning also would promote release and increase growth for residual birch. In addition, over the next decade or more, small, irregular-shaped and -spaced patch cuts (less than 1 acre) of birch in the break would increase browse for moose and begin to establish a seedling birch cohort. Winter thinning patches of pole-sized birch may provide immediate moose browse and release pole-sized birch to grow larger.

Lower One-third of the Watershed

Outside the shaded fuel break zone around Hope but within the lower one-third of the watershed similar recommendations are proposed to promote cultural uses (e.g. firewood, poles for homes) and wildlife habitat, including improvement of moose browse. Management of birch in this area is of second-highest priority. The area has established roads and trails that allow for mechanized management.

The stands are primarily dense pole-sized trees with some conifer component. Five to 10-acre patch cuts would develop moose browse and a birch seedling component. An occasional patch release of conifers would help break up the birch stand and diversify wildlife habitat. Patch thinning of birch would help develop larger-diameter birch trees and increase structural diversity. Patch cuttings and thinnings of 5 to 10 acres throughout the birch stand would help develop a mosaic of age classes, size classes and species.

Cottonwood (Populus trichocarpa)

Cottonwood generally occurs as very small patches of even-aged trees in riparian areas on the mainstem and tributaries and cover approximately 350 acres in the watershed. Cottonwood provides stream shading for fish and nesting/roosting trees for bald eagle and northern goshawk. Small patch cuts (less than 1 acre) and planting of cottonwood cuttings/seedlings in areas of other cover types adjacent to existing cottonwood clumps would help establish a new cohort of cottonwood most quickly. Plantings may need to be tubed for protection from browse to help get them established (above browse). No existing larger cottonwood should be cut. Selective thinning of even-aged stands may promote more rapid growth and recruitment of trees into sizes utilized for nesting/roosting. Cottonwood planting should be coordinated with any riparian zone restoration of placer-mined areas.

Small patch cuts and/or burns which expose mineral soil to cottonwood seed may help natural regeneration of cottonwood into areas downwind of existing cottonwood trees. These treatments should be focused primarily in anadromous-fish bearing portions of the watershed where recruitment of large trees may result in habitat enhancement for fish, bald eagle and northern goshawk.

Option 2—Higher intensity hardwood management

In addition to the treatments recommended under Option 1 for the birch stand adjacent to Hope and the lower one-third of the watershed, this option would include treatment in the upper two-thirds of the watershed.

The birch population in the upper two-thirds of the watershed is important for moose browse/habitat. Recreation and hunting are also important. Management of this birch population will help achieve the watershed-level desired future condition, but is of lower priority than the Hope and lower one-third of the watershed populations.

The birch stands are primarily dense pole-sized trees. Mechanized removal is not feasible, since existing stands are not accessible by an existing road network. Prescribed burns of 5 to 10 acres in size dispersed across the area would provide moose browse, create a seedling birch component and develop multiple age classes and size classes over time.

Cottonwood (Populus trichocarpa)

In addition to treatments described in Option 1, which focus on the anadromous fish-bearing stream reaches, Option 2 would include treatment as feasible in the upper two-thirds of the watershed. Thinning of select stands of cottonwoods, along with seedling/cutting plantings would be implemented, with sites selected based on suitability and accessibility.

Aspen (Populus tremuloides)

Aspen is a minor component in the watershed, covering a total of approximately 220 acres. Expansion of aspen is desirable to increase moose browse and tree species diversity. Aspen, along with birch, is the preferred species for winter moose browse. Under this option, mature aspen would be cut and/or burned hot to expose mineral soil. Prescribed burning would be conducted opportunistically, and in conjunction with birch stand treatment. Sprouting is most vigorous if trees are not overmature and mineral soil is exposed. Aspen treatments should be focused in known winter range habitat for moose.

7.3 Terrestrial Species and Habitats

Population and habitat surveys

Maintaining a diverse mosaic of habitat types is conducive to maintaining wildlife diversity. However, additional information is needed to identify existing distribution and potential limiting factors of several management indicator species and other species of concern in order to make informed decisions on potential vegetation management actions. We recommend that the following studies be conducted:

- Identify population size and structure and map core spring and summer feeding habitat of brown bears, and assess the effects of existing human activities on these areas;

- Identify and more accurately map moose and caribou winter habitat areas; assess the effects of existing human activities on the health of these areas and existing populations;

- Identify population sizes and map mountain goat, dusky Canada goose, and harlequin duck habitat, and assess the effects of existing human activities on these areas;

- Identify wolverine population size and map late spring feeding and winter/denning habitat; assess potential effects of existing human activities on these habitats; and

- Assess the potential effects of prescribed burning and potential silvicultural treatments of forest types infested with spruce bark beetle on habitats and population stability of management indicator species and other species of concern, particularly northern goshawk, brown bear, and other animals that are susceptible to displacement from human activities or habitat that may be disproportionately affected by management actions, such as old growth forest types and other mid- to late-seral communities.

ADFG is a partner on at least some (e.g., caribou), and likely would be on others too. The cost of these efforts will be dependent on a number of factors, including access, size of the areas being investigated, and methods used to document existing conditions.

Identification of existing habitat is expected to be a two-part effort consisting of first using aerial photo interpretation to identify habitat types followed by limited ground truthing and field studies to confirm existing use of identified habitats. It is assumed that identification of habitat will be at least partially completed under the vegetation section recommendations or that these have already been completed from ongoing aerial photo interpretation efforts of tracking the spruce bark beetle infestation. It will take some additional time by a wildlife biologist and botanist to develop the species habitat layer for each of the management indicator species and other species of concern. Other than development of the GIS database layers, this is anticipated to be a nominal effort. The development of the GIS database layers will depend on the level and quantity of habitat that must be entered into the GIS.

Following completion of the habitat mapping, field studies will be conducted to confirm identified habitat for each species and the level of use of these areas. It is expected that this would be a limited effort focusing on those areas most vulnerable to human activities, such as recreation or potential prescribed burns and silvicultural treatments. Methods used to identify and confirm habitat use may include track stations, scent stations, low-level aerial surveillance, and limited telemetry studies. Similar levels of investigation and primarily noninvasive methods (such as observations of avoidance behavior rather than capture and release studies) are anticipated to be used to document apparent effects of human activities on these species.

These investigations would focus on those areas in and around Hope that would be expected to be treated first. Studies would then move outward into more remote areas of the watershed association and be completed over the next 5 to 10 years. It is assumed that completion of these studies would require the use of one full time employee (FTE) wildlife biologist (GS-9-10-11 or 12) plus 3 or 4 seasonal staff (GS-5-6-7). The FTE wildlife biologist would direct all office and field work, design appropriate field studies, train seasonal staff, and provide appropriate quality control and assurance to develop the information needed to guide management decisions. It appears that there are opportunities to share costs with other agencies, including ADFG and the USFWS. In addition, there likely would be opportunities to use graduate students to conduct some of this work at relatively low cost, perhaps instead of hiring additional seasonal staff.

Hardwood management

Although there are some gaps in information on the existing quality and abundance of habitat and ecology of some of the management indicator and other species of concern, proposed management recommendations have been identified for reducing the fuel loading and risk of fire in birch, cottonwood, and aspen cover types. As indicated in Section 7.2.2, Hardwood Management Recommendations, management actions will focus first in the shaded fuel break around Hope followed by actions in the lower one-third of the watershed and lastly in the upper two-thirds. These activities will cover a relatively small proportion of the total watershed area. According to current GIS data, these three cover types combined comprise only a little more than 6 percent of the total vegetated portions of the watershed. Most of this consists of birch-dominated habitats. Cottonwood and aspen vegetation types each cover less than 1 percent of the watershed. Because these data need to be updated and ground truthed, actual areas may be somewhat higher or lower than those identified.

Under the proposed management options, birch-dominated habitat types around Hope will would be thinned or selectively cut. These actions will promote development of a more diverse distribution of uneven-aged birch-dominated habitat types. Younger stands will provide improved browse for moose, which appear to be limited by available high quality winter habitat. Other animals also will benefit from this more diverse assemblage of birch stand types. None of the management indicator or other species of concern are likely to be adversely affected by these proposed activities.

Thinning and small patch cuts of birch stands outside Hope in the lower one-third of the watershed and prescribed burns of stands in the upper two-thirds of the watershed will have similar benefits. One of the primary benefits will be increased availability of winter habitat for moose. Treatments should be distributed broadly across the watershed in time and space to create uneven-aged stand types that are not concentrated close together.

Black cottonwood trees form small even-aged stands primarily in flood plains and low-lying areas adjacent to streams. Selectively culling trees to promote more rapid growth of remaining trees is recommended to accelerate potential recruitment to sizes and age classes that could provide a source of stable, habitat-forming LWD to the stream channels as well as potential roosts or nest trees for bald eagle and northern goshawk. Proposed cottonwood thinning and small patch cuts to promote new stands should be concentrated within a half mile of anadromous fish-bearing portions of streams in the watershed. This will maximize potential recruitment of roost and nest trees. In addition to increasing potential habitat for bald eagle and goshawk, thinning and small patch cuts will promote development of early seral vegetation that likely includes willows. These early seral phase cover types also will increase the quality of winter habitat for moose and summer habitat for neotropical migrant songbirds, especially those often associated with riparian habitat types.

Proposed recommendations for managing aspen stands will have similar benefits to moose and migratory songbirds. None of the proposed cottonwood or aspen management alternatives being considered is likely to have any measureable adverse affects on any management indicator species. Instead, these alternatives will result in a broader distribution of early seral vegetation types across the watershed that will support a more diverse array of plants and animals than the predominantly even-aged stands that exist now.

7.4 Recreation and Heritage Resources Restoration and Management Options

Human activities and the heritage/historical resources in the watershed will bear on decisions regarding stream restoration and forest management. In particular, issues surrounding the preservation of historic mining sites will be a key factor. Likewise, restoration efforts and management schemes will influence the nature and timing of improvements to recreational facilities, the preservation of viewsheds, and the availability of forest resources. The following recommendations address issues that will either have influence on or be influenced by the restoration process.

7.4.1 Recreation-Level Panning, Sluicing, and Suction Dredging

These hobby-scale activities are conducted in ways that degrade the stream channel and compromise personal safety. There appears to be widespread disregard or ignorance of proper mining methods, abuse of equipment, and operation of vehicles too close to the stream. The following recommendations are designed to reduce damage to the stream banks and improve safety. Since they can be implemented independent of a larger restoration process, they could be initiated before a restoration plan is in place.

Option 1

Option 1 would be to establish a registration process in which mining enthusiasts acknowledge and accept responsibility for acceptable mining practices. This option would provide for enforcement of acceptable mining techniques and hold violators accountable (e.g., fines, expulsion, etc.). This option would also provide signage that instructs miners to avoid the stream bank and warns of safety issues, and establish and enforce stream setbacks for vehicles. An outside contractor would likely be employed to design and construct the signage, but the USFS could perform the installation. Enforcement costs are based on a single officer monitoring mining activities 25 hours per week for six months out of the year. In addition, the diameter of suction dredging equipment would be limited to 4 inches or less.

Option 2

In addition to implementing Option 1, Option 2 would prohibit suction dredging. This action is also contained in both options under aquatic restoration recommendations (Section 7.2). This would significantly reduce, perhaps eliminate, severe erosion of the stream bank. There are no additional costs associated with this alternative; however, it might be considered by the recreational miners to be an extreme measure. This alternative might be considered a fallback if Option 1 does not yield the desired change in behavior. A forest order would be necessary to enforce the ban on suction dredging.

7.4.2 Subsistence Use

There is little detailed information quantifying the collection of special forest products, fish, game, and furbearers for subsistence use by either the local community or individuals from outside communities. Without that information it will be difficult to predict how forest management scenarios might affect subsistence use (and vice versa). It is important to establish what resources and quantities subsistence users gather or hunt. This should be completed prior to planning restoration/forest management scenarios.

Option 1

Option 1 would include subsistence as a topic for discussion during public input phases of restoration and management design. This is an extremely low level of action and should only be taken if subsistence use is determined to be a very small issue in the watershed. There are no costs associated with this option since it could be incorporated into an ongoing process.

Option 2

Option 2 would be to discuss with the local community the best way to track its use of watershed resources, and to explain to the community that this is an effort to enable, not restrict, their subsistence activities. Community input would be enlisted to design a reporting process. This option includes coordination with the ADFG to track resources that overlap within their jurisdiction. The cost estimates for this option allow for four public meetings to develop the program.

7.4.3 Heritage Resources and Cultural Landscapes

Over 95 percent of the watershed remains uninventoried for heritage resources, such that the Chugach National Forest is currently out of compliance with NHPA Section 110 and Executive Order 11593. Of the 40 known heritage resources in the watershed, 39 either need to be documented and evaluated for the NRHP, or need to have evaluations and nominations completed. None of the known historic buildings eligible for the NRHP have been rehabilitated, and there are neither management nor maintenance plans in place for them, putting the USFS further out of compliance with NHPA Section 110. There is currently no interpretive signage of any sort for heritage resources along the Resurrection Pass Trail. The USFS is out of compliance with NHPA Section 106 in that it has never completed the mitigation of the adverse effects of the Resurrection Creek Road construction project. The required mitigation is signage at the northern trailhead of the Resurrection Pass Trail to interpret historic mining heritage resources.

Therefore, the following two options are presented to address these issues.

Option 1—Custodial Management of Heritage Resources

This management option would call for some additional measures to preserve and protect heritage resources, beyond the current level of management.

This option would include a complete inventory and evaluation of cultural resources of the watershed over a period of 40 years, building a predictive model from existing samples after completion of survey of 28,000 acres, or 25 percent of the watershed. An estimate of the time necessary to complete a 25 percent sample would be about 10 years. Project-specific inventory of cultural resources would also continue, as projects would be initiated. Historic properties and cultural landscapes would be evaluated for the NRHP for management purposes. Historic properties would be avoided if possible.

Additionally, partnerships would be developed with the Hope-Sunrise and Kenai Peninsula Borough Historical Societies for documentation, preservation, and interpretation of prehistoric and historic sites, cultural landscapes, and rehabilitation of historic buildings. Relationships would be developed with other partners if they indicate interest.

Required interpretive mitigation for the Resurrection Creek Road project, at the northern end of the Resurrection Pass Trail would be completed. Additional cultural resources would be interpreted only if necessary for mitigation of adverse effects. Historic properties, such as the Mull Cabins and Harry Johnson Cabins, would be evaluated and maintained, but would not be rehabilitated unless necessary for maintenance.

Heritage resources would be managed in conjunction with other options for other resources. Human use of the Resurrection Creek watershed has been generally due to the presence of various biological, botanical, geological and hydrological resources. Managing, and interpreting for the public, other resources simultaneously will provide a holistic view of the natural resources that were important to the people who created the existing cultural resources of a given site. A crude estimate of the costs of this option is presented in Appendix B.

Option 2—Comprehensive Management of Heritage Resources

Option 2 would complete the inventory and evaluation of cultural resources of the watershed over a period of 20 years, building a predictive model from existing samples after completion of a survey of 28,000 acres, or 25 percent of the watershed. An estimate of the time necessary to complete a 25 percent sample is about 5 years. Although some of the districts, cultural landscapes, sites, buildings, structures, and objects that are in the watershed have been documented, less than 5 percent of the watershed has been inventoried for heritage resources. A complete inventory will allow better interpretation of the significant historic Gold Rush period heritage resources in the watershed. In addition to bringing the USFS into closer compliance with NHPA Section 110 and Executive Order 11593, it will also proactively make compliance with Section 106 much easier, as resources and their eligibility for the NRHP will already be known for specific project areas.

Because of the rich history of use by indigenous peoples, followed by Gold Rush miners and pioneers, there are many interested potential partners for a variety of heritage resource-related projects. A mutually beneficial relationship would result from partnering with interested entities for the documentation, preservation, and interpretation of historic and prehistoric sites, cultural landscapes, and rehabilitation of historic buildings. Further, collaborative stewardship relationships could be developed with interested parties for protection and interpretation of heritage resources. A pilot stewardship partnership with an outfitter-guide for historic sites in Prince William Sound has already paved the way for such a stewardship project in the Resurrection Creek watershed. Many of the members of the Alaska Mining Association and Gold Panners Association of America are interested in the history of mining on the Kenai Peninsula, and within the Resurrection Creek watershed in particular. Three historical societies—Kenai Peninsula, Hope-Sunrise, and Alaska Historical Societies—have already demonstrated interest in partnering with the Chugach National Forest on documentation, preservation, and interpretation of heritage resources in the Resurrection Creek watershed. The State of Alaska's Office of History and Archaeology staff have also partnered with the USFS in the past on historical research, and likely would be future partners. Partnerships would be developed with university programs for research work to provide background information for management and interpretation. The University of Alaska Departments of Anthropology and History have partnered with the USFS in the past and likely would be willing to do so in the future.

The supporters of the Kenai Mountains-Turnagain Arm National Heritage Corridor national legislation, specifically aim to "recognize, preserve, and interpret the historic and modern resource development and cultural landscapes" of the corridor, "promote and facilitate public enjoyment of these resources," and "foster…cooperative planning and partnerships among communities, within the heritage corridor, as well as among individuals, businesses, the corridor communities and borough, state, and federal governments." While this legislation has not yet been passed, work on its format continues, and it is not unlikely that it will be considered by Congress in the near future. The long list of public supporters for this bill provides a wide variety of potential project partners.

An interpretive walking tour of the 38.6 miles of the Resurrection Pass Trail and its auxiliary trails would be developed. This includes approximately 10 miles of trail outside the watershed association. Significant and unique heritage resources exist along the trail, which is, itself, a historic feature eligible for the NRHP, dating from at least the Gold Rush period, and was the main transportation corridor for travelers within the Resurrection Creek watershed. The Resurrection Pass Trail is a designated National Recreation Trail, and is used year-round by a large number of people whose activities include hiking, biking, skiing, snow machining, horseback riding, hunting, and fishing.

The Mull Cabins (SEW-425) and the Harry Johnson Cabins (SEW-829) would be rehabilitated for fully accessible public use. This option would develop a management plan for these historic properties and associated cultural landscapes. Both properties are eligible for the NRHP, by virtue of their association with particular individuals, and have been maintained over the years to an extent that would allow relatively easy rehabilitation and managed public use. Each building needs to be evaluated for its rehabilitation and maintenance needs. The two Harry Johnson Cabins need new sill logs. Two of the three Mull Cabins need new roofs and floors. The third of these cabins needs to be stabilized, as it is beginning to lean towards the west. Such rehabilitation could be accomplished through partnerships, and/or through volunteer assistance in Passport In Time projects, as exemplified by similar projects on other USFS forests in the United States. It would also fulfill the Chugach National Forest's responsibilities for these buildings under NHPA Section 110.

Finally, it is recommended that heritage resources be managed in conjunction with other options for other resources. Human use of the Resurrection Creek watershed has been generally due to the presence of various biological, botanical, geological, and hydrological resources. Managing, and interpreting for the public, other resources simultaneously will provide a holistic view of the natural resources that were important to the people who created the existing heritage resources of a given site. A crude estimate of the costs of this option is presented in Appendix B.

7.4.4 Cultural Landscape Management Plan

Occupation and use of the watershed by Native peoples in the period prior to the arrival of large numbers of prospectors and miners late in the 19th century is poorly understood. The traditional use of watershed resources by Alaskan Natives from the early historical to present times is similarly not well understood. No recent interactions with the descendents of these peoples have yet defined a traditional cultural landscape within this area.

The goal of these recommendations is to identify and further define cultural landscapes before making changes to the watershed that could impact them. This should be completed prior to planning restoration and forest management recommendations.

Option 1

Option 1 involves conducting a thorough inventory of cultural landscapes that involves past and present users of the watershed, and generating a comprehensive Cultural Landscape Preservation Management Plan for long-term protection of the resource. This process should include extensive public involvement. The suggested approach would delineate Cultural Resource Zones (akin to visual quality objectives [VQOs]) and identify restrictions on activity in each zone. Examples might be a Mining Preservation Zone or a Mining Modification Zone. Zones would inevitably overlap, and the more restrictive zone would take precedence. Subsequent plans for stream restoration, forest management, recreational development, or mining would look to this over-arching document for guidance on appropriate treatment of historical and cultural resources in the area under consideration.

Option 2

In addition to implementing Option 1, Option 2 would establish a Cultural Resources Committee to assist in the development and subsequent interpretation of the above-mentioned Cultural Landscape Preservation Management Plan. The Committee, facilitated by USFS staff, should include representatives with historical ties, managers, residents, and users of the watershed. The committee should serve as an advisor to the USFS in matters affecting the historical and cultural resources of the watershed. Annual cost estimates assume bi-weekly meetings, which may not be necessary once the Plan is established.

7.4.5 Recreation

7.4.5.1 Preserving Viewsheds

Forest management scenarios and restoration activities may impact the goals and/or timing for campground and trail improvements. Dramatic changes in viewsheds could result from restoration activities. It is necessary to identify critical viewsheds that are important to recreational users before restoration and/or forest management scenarios are planned.

Option 1

Option 1 would include the use of SIOs to evaluate the impact of management scenarios on trails and viewpoints, and would ground truth the SIOs with respect to viewsheds and trailside views, and amend them if necessary. This option would specifically outline the viewshed needs for campground and trail improvements creating a document to refer to when considering restoration alternatives.

Option 2

In addition to implementing the Option 1, Option 2 would assign SIOs a high priority in decisions regarding restoration and (especially) forest management activities.

7.4.5.2 Identified Improvements

Many recreational improvements were identified by USFS staff; these projects are discussed above, in section 4.9.2.3. Internal documents have determined cost and established the need for and the intent to proceed with specific projects. These projects are listed in Table 19. It can be easily updated as projects come to light in order to be more current than the Forest Plan. Of particular importance are areas identified where inadequate facilities have led to resource damage. The Coeur d'Alene Creek campground and the hobby mining area are examples.

The USFS staff has identified needed improvements to trails and camping areas. Projects range from upgrading parking areas to installing interpretive signage. It is important that the restoration process consider these projects when designing and evaluating alternatives. To ensure that they are implemented, and to ensure that restoration efforts recognize them, these projects should be reflected in USFS planning documents. Since the

Resurrection Creek drainage is a small piece of the Chugach National Forest, some important projects may not be reflected in the Forest Plan.

These projects should be considered in conjunction with restoration activities. For example, the proposed trail from the Palmer Creek Road down Alder Creek should be considered when mechanical treatment or prescribed burns are considered. Installation of interpretative signage should reflect desired conditions identified in the Hope Area Interpretive Opportunity Plan (Seward Ranger District report 1993).

7.4.5.3 Accessibility

The USFS is considering improved accessibility for the disabled on some trails and campgrounds. These areas will likely need to be located away from active restoration activities because of the degree of trail maintenance required for wheelchair access and secure footing. There is a need to incorporate accessibility goals into official planning documents so that restoration and forest management planners can consider special access needs in their design.

It is suggested that the USFS clearly define areas suitable for improved accessibility and develop project cost estimates. These projects should be included as updates to the CIP suggested above. Interpretive trails included in the Option 1 of the aquatic restoration recommendations could be made accessible to those with disabilities.

7.4.6 Erosion Control at Recreational Sites

While erosion at several sites in the watershed was mentioned in the Statement of Work for this project, and at an analysis team meeting, there has been no documentation of the areal extent, depth, or general severity of the problem. Locations of erosion were identified as various points along the Resurrection Pass Trail, at Coeur D'Alene Campground, and at the Hope Point Trail. Streambank erosion was also identified as occurring along Resurrection Creek due to recreational mining. Recommendations for that area are in Section 7.1, Aquatic Restoration Recommendations. A cost estimate for these assessments is included in Appendix B.

Before recommending erosion control measures at these sites, it is essential to document the areas affected, and suspected causes. Corrective measures may include not only physical treatments, but also operational treatments. For instance, if camping traffic is causing erosion at a campground, the use of some sites may be closed temporarily to allow revegetation. If compaction is severe, scarification may be necessary, followed by reseeding and planting with appropriate seed mixtures and plants. Eroding sites should be assessed along both the Resurrection Pass Trail and the Hope Point Trail. Specific corrective measures could then be designed. Because the Hope Point Trail is not an engineered trail, a more thorough assessment is warranted. Based on usage, it may be advantageous in the long term to design and construct an engineered trail that uses switchbacks, water bars, and culverts among other features. Portions of the existing trail would be assessed for inclusion in the designed trail. We recommend that a geologist or hydrologist trained in erosion and sediment control conduct the assessments and design specific erosion control measures, along with any appropriate operational measures (best management practices [BMPs]). The capital improvement plan for the Resurrection Creek indicates that some assessment has already been conducted on the Resurrection Pass Trail, and some BMPs may have been identified. These efforts should be reviewed and built upon.

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TABLES

Table 1 - Summary of Resurrection Creek Landscape Analysis Restoration and Management Options

Aquatic Ecosystem Restoration					
	Recommended Surveys	**Mining Operation Management**	**Land Acquisition; Withdrawal from Mineral Entry**	**Stream Restoration**	**Other**
Option 1- Partial Restoration	Stream Channel - type, structure, LWD Fish Habitat - in coordination with channel survey Salmonid distribution/use Riparian Zone Survey - lower 7 miles of Resurrection Creek	Mineral validity examinations* Bonding for reclamation Salvage topsoil at new excavations Post-mining channel platform restoration Restore riparian zone topography Revegetate riparian zone		Pilot reach restoration to meet reference reach conditions; riparian zone restoration Monitoring	Limit suction dredging diameter to 4".
Option 2 - Complete Restoration	Stream Channel - type, structure, LWD Fish Habitat - in coordination with channel survey Salmonid Distribution/Use Riparian Zone Survey - lower 7 miles of Resurrection Creek	Mineral validity examinations* (concurrent w/withdrawal) Bonding for reclamation Salvage topsoil at new excavations Post-mining channel planform restoration Restore riparian zone topography Revegetate riparian zone	Withdrawal from mineral entry selected sites Purchase of Paystreke property	Pilot reach restoration to meet reference reach conditions; riparian zone restoration Monitoring Restoration of remaining reaches Monitoring of all restoration projects	Prohibit suction dredging Prohibit camping on streambanks Develop enforcement program Establish permit system Install signage on mining regulations
Vegetation Management and Restoration					
	Shaded Fuelbreaks	**Wildfire Education**	**Hardwood Management**		
Option 1 - Reduce Wildfire Risk in Lower Watershed/Increase Moose Browse	Around the community of Hope and infrastructure in the lower watershed	Develop campaign for wildfire risk education	Shaded fuel breaks cut within the Hope birch stand; develop even distribution of birch size classes; small patch clearcuts within birch stand, lower watershed; replant cottonwoods - in coordination with aquatic restoration		
Option 2 - Reduce Wildfire Risk in Upper and Lower Watershed/Increase Moose Browse	Around the community of Hope and infrastructure in the lower watershed; Around the recreation sites and facilities in the upper watershed	Develop campaign for wildfire risk education	Option 1, plus small prescribed burns in birch stand in upper watershed; increase aspen stands opportunistically; cottonwood restoration on all reaches of mainstem		
Recreation and Cultural Resources Management					
	Gold Panning/Hobby Mining	**Cultural Resources**	**Viewsheds**	**Recreation Improvements**	**Subsistence**
Option 1 - Lower Intensity	Limit size of suction dredges to 4"	Conduct limited inventory; maintain current partnerships with State and Historical Societies; assess and maintain historic cabins Assess and maintain historic cabins	Evaluate viewshed needs with respect to all proposed projects	Conduct erosion control on Hope Point trail Improve visibility by clearing vegetation	Include as a topic in discussions of proposed projects
Option 2 - Higher Intensity	Prohibit suction dredging Develop Forest Order to create authority for enforcement	Conduct complete inventory; maintain existing partnerships, establish new partnerships for documentation; develop interpretive program; Assess, rehabilitate and maintain historic cabins	Assign a high importance to visual quality objectives	Conduct erosion control on Hope Point trail Improve visibility by clearing vegetation	Develop a program to track and describe subsistence.
Terrestrial Species	**Species and Habitat Surveys**				
	Determine brown bear size population and structure Map moose and caribou winter habitat Determine mountain goat and harlequin duck populations and habitat Assess potential effects of prescribed burning and logging on the above				

*On free and clear land, or by use of the provisions of the Wyden amendment (1999)

Table 2 - Land Ownership in the Resurrection Creek Watershed Association

Land Owner	Acres
USFS Lands	109,358
State	1,232
State Selected	510
Private	393
Municipal	241
Total	111,734

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Source: Chugach National Forest GIS data

Table 3 – Geologic Formation, by Watershed

	Rock Type			
Watershed	**McHugh Complex Melange**	**Sedimentary Valdez Group**	**Undifferentiated Quaternary Deposits**	**Grand Total**
Abernathy Creek		5,363.3	2,033.2	7,396.5
American Creek	217.2	1,981.2	831.6	3,030.0
Bear 1		3,876.4	219.8	4,096.2
Bedrock Creek	556.8	2,003.7	1,242.8	3,803.3
Cannonball Creek	366.9	3,859.8	649.9	4,876.6
Caribou Creek		5,265.3	369.7	5,635.0
Cripple Creek	2,236.6	677.8	424.1	3,338.5
East Creek		6,051.7	2,054.3	8,106.0
Fox Creek		7,117.4	1,084.3	8,201.7
Gold Gulch-Rimrock Creeks	700.7	3,620.5	1,479.8	5,801.0
Hungry Creek	467.9	2,644.3	1,479.0	4,591.2
Palmer Creek		11,337.8	2,024.3	13,362.1
Pass Creek		5,517.7	193.2	5,710.9
Resurrection Creek East RM 12-15		1,231.1	909.7	2,140.8
Resurrection Creek East RM 15-19		868.5	819.0	1,687.5
Resurrection Creek Flats		947.4	3,129.3	4,076.7
Turnagain B	2,802.7		547.3	3,350.0
Turnagain C		476.8	579.2	1,056.0
White Creek		5,174.1	1,931.8	7,105.9
Wildhorse Creek	50.1	1,565.2	1,574.2	3,189.5
Willow Creek		5,491.5	1,729.5	7,221.0
Wolf Creek #1	225.8	2,910.8	813.4	3,950.0
Grand Total	7,624.7	77,982.3	26,119.4	111,726.

Table 4 - Stream Distribution in the Resurrection Creek Watershed Association by Stream Class Value (USFS 1992)

Stream Class Value	I	II	III	Total
Miles	27.5	90.5	133.0	251.0
Percent of Total Stream Miles	11	36	53	100

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Table 5 - State Water Quality Standards for all Streams Within the Resurrection Creek Watershed

Parameter	Criterion
Dissolved oxygen	7 mg/l
Fecal coliform bacteria (FC)	In a 30-day period, the geometric mean may not exceed 20FC/100ml, and not more than 10% of the samples may exceed 40FC/100ml
pH	Between 6.5-8.5 units and must be ±0.5 units from natural conditions
Turbidity	< 5 NTU above natural conditions when natural turbidity is ≤ 50 NTU and may not have more than a 10% increase when natural conditions are greater than 50 NTU, not to exceed a maximim increase of 25 NTU
Temperature	13°C
Dissolved inorganic substances	TDS< 1,000 mg/l
Sediment	No imposed loads that will interfere with established water suply treatment levels
Toxic and other deleterious organic and inorganic substances	< EPA quality criteria for water
Color	< 15 color units or natural condition, whichever is greater
Petroleum hydrocarbons, oil, and grease	TDS< 1,000 µg/l TAH < 10 µg/l

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Table 6 – Soil Types in the Resurrection Watershed Association

	Soil Type, in Acres									
Subwatershed	**Typic Cryorthods**	**Lithic Cryorthods**	**Histic Cryaquepts**	**Dystric Cryochrepts**	**Typic Cryumbrepts**	**Typic Cryaquents**	**Typic Crytorthents**	**Mining Spoils**	**Terric Borosaprists**	**Grand Total**
Bear 1	399						27			426
Bedrock Creek	133		128	605		73	21	58	9	1,027
Cripple Creek	113		0	11		0				124
Gold Gulch-Rimrock Creeks	800	14	200	620		82				1,716
Palmer Creek	1,754	34	16	1,718	10	2	157	5		3,696
Resurrection Creek Flats	1,363	28	48	805		59	0	122		2,425
Turnagain B	209		2	2						213
Turnagain C	550	56	93	38					20	757
Wildhorse Creek	853		196	209		7		54		1,319
Willow Creek	1,038	8		116		102		15		1,279
Wolf Creek No.1	264		4	162		3				433
Grand Total	7,476	140	687	4,286	10	328	205	254	29	13,415

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Table 7 - Miles of Trails and Roads in the Resurrection Watershed Association

Watershed	Trails In Miles	Roads In Miles
Abernathy Creek	4.8	
Abernathy Creek Tributaries	0.1	
Bear 1		3.7
Bedrock Creek	1.9	
Caribou Creek	0.8	
East Creek	0.1	
East Creek Tributaries	3.7	
Fox Creek	0.6	
Gold Gulch-Rimrock Creeks	3.2	
Palmer Creek	0.6	13.2
Pass Creek	0.0	
Resurrection Creek East RM 12-15	3.0	
Resurrection Creek East RM 15-19	2.4	
Resurrection Creek Flats	0.0	11.9
Turnagain B	6.5	2.2
Turnagain C		2.3
Willow Creek	0.2	
Wolf Creek #1	1.6	
Grand Total	29.5	33.3

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Table 8 - Wetland Types, in Acres

Wetland Type	Acres
Estuarine	178
Palustrine	2,521
Riverine	38
Total	2,744

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Table 9 - Miles of Stream by Channel Type in Each Subwatershed

	Miles of Stream by Channel Type																		
Watershed	**AF1**	**AF2**	**ES4**	**FP3**	**FP4**	**FP5**	**HC2**	**HC3**	**HC5**	**HC6**	**L**	**LC2**	**MC1**	**MC2**	**MC3**	**MM1**	**MM2**	**PA5**	**Grand Total**
Abernathy Creek								3.6	1							10.9		1.1	16.6
American Creek	0.2								0.7					0.9		3.9			5.7
Bear 1			0.4				0.2	3.7	3	1.3						1.3			9.9
Bedrock Creek					1.3		1.2	3.4	1.2	3.1		0.7				2.1			13
Cannonball Creek					0.8			8.5	0.8	0.9							1.4		12.4
Caribou Creek							1.3	3.1	1.9	2						4			12.3
Cripple Creek							0.5	3.9	2.5	5.4						1.4			13.7
East Creek	0.2			0.5			2.2	8.2	0.6	2.9	0.1			0.2		7.6			22.5
Fox Creek		0.3					0.5	8.2	3.6	2.8	0.3		0.3			3.1		0.3	19.4
Gold Gulch-Rimrock Creeks					3.2		1.9	5.5	3	2.6		0				1.1			17.3
Hungry Creek							0.4	1.6	1.5							6.2			9.7
Palmer Creek	0.2	0.3		6.9			4	4.5	1.3	2.9	0.2				2.1	2.2		1	25.6
Pass Creek							0.6	7.5	1.9	2.1	0.1					3.1			15.3
Resurrection Creek East RM 12-15							1.1			1.7									2.8
Resurrection Creek East RM 15-19							0.6	1.4	0.3										2.3
Turnagain B			0.2			0.5													0.7
White Creek		0.6					0.4	6.8	1.2	0.7		2.4				5.1	1.5		18.7
Wildhorse Creek					0.4	2.2	0.8	2.3		2.2		0.9				1			9.8
Willow Creek							1.6	3.5	2.6	1.6						2			11.3
Wolf Creek #1					2.6		0.7	4.6	1.2	1.7						1.4			12.2
Grand Total	0.6	1.2	0.6	7.4	8.3	2.7	18	80.3	28.3	33.9	0.7	4	0.3	1.1	2.1	56.4	2.9	2.4	251.2

Table 10 – Channel Type Code Descriptions

Code	Channel Type Description	Code	Channel Type Description
AF1	Moderate gradient alluvial fan channel	HC6	Deeply incised mountain slope channel
AF2	High gradient alluvial cone channel	LC2	Moderate gradient contained narrow valley channel
ES4	Large estuarine channel	MC1	Narrow shallow contained channel
FP3	Narrow low gradient flood plain channel	MC2	Moderate width and incision, contained channel
FP4	Low gradient flood plain channel	MC3	Deeply incised contained channel
FP5	Wide low gradient flood plain channel	MM1	Narrow mixed control channel
HC2	Shallowly to moderately incised footslope channel	MM2	Moderate width mixed control channel
HC3	Deeply incised upper valley channel	PA5	Beaver dam/pond channel
HC5	Shallowly incised very high gradient channel		

Table 11 - Water Quality Data Collected at USGS Stations in Resurrection Creek

		Resurrection Creek					
		RM 2.1			RM 3.9 (Hope)		
Parameter	**Unit**	**Average (n)**	**Maximim**	**Minimum**	**Average (n)**	**Maximim**	**Minimum**
Temperature	(°C)	3.6 (25)	10.5	0	8.4 (8)	12	5.5
Specific Conductance	(ms/cm)	113 (25)	164	73	97 (8)	122	76
pH	(units)	7.7 (18)	8.2	7	7.0 (6)	7.5	6.1
Dissolved CO^2	(mg/l)	1.9 (18)	7.2	0.5	15.5 (6)	52	1.9
Dissolved NO^3 as N	(mg/l)	0.22 (14)	0.45	0.02	0.19 (8)	0.56	0.02
Dissolved NO^3 as NO^3	(mg/l)	0.9 (15)	2	0.1	0.9 (8)	2.5	0.1
Total Hardness	(mg/l)	48 (18)	74	33	44 (8)	51	37
Dissolved Ca	(mg/l)	16 (15)	25	11	14 (8)	16	12
Dissolved Mg	(mg/l)	1.9 (15)	2.6	1	2.3 (8)	3.2	1.2
Dissolved Na	(mg/l)	3.8 (15)	6.6	1.7	2.7 (4)	3.2	2.2
Dissolved K	(mg/l)	0.3 (15)	1.3	0	0.3 (4)	0.6	0.2
Dissolved Na + K	(mg/l)				2.6 (4)	5.6	0.9
Dissolved Cl	(mg/l)	5.6 (15)	12	1.1	3.6 (8)	6.8	1.5
Dissolved SO^4	(mg/l)	8.4 (15)	28	4.8	6.6 (8)	8.8	3.3
Dissolved F	(mg/l)	0.1 (15)	0.4	0	0.1 (4)	0.2	0
Dissolved SiO^2	(mg/l)	6.0 (15)	7.3	2.8	7.4 (8)	9.3	5.7
Dissolved Fe	(mg/l)	112 (13)	360	0	25 (8)	50	0
Mn	(mg/l)	17 (9)	80	0	3 (4)	10	0

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Source: Kalli and Blanchet 2001

Table 12 - Heavy and Trace Metals in Parts Per Million (ppm)

Parameter[†]	Resurrection Creek above mining (reference)		Resurrection Creek below mining (current)		Resurrection Creek wash water (current)	Palmer Creek above mining (reference)	Palmer Creek wash water (current)	Bear Creek (upstream of placer mine reach)	Bear Creek (downstream of placer mine reach)	Resurrection Creek (upstream of placer mine reach)	Resurrection Creek (within placer mine reach)	Resurrection Creek (downstream of placer mine reach)
Date	8/13/1980	9/16/1980	8/14/1980	9/16/1980	8/14/1980	7/19/1980	7/19/1980	1994	1994			
Zinc (5.0)	0.018	0.04	0.02	0.032	0.069	0.015	0.046	>5.0*	>5.0*	>5.0*	>5.0*	>5.0*
Manganese (.05)	0.004	0.002	0.008	0.008	0.216	< 0.005	0.052					
Iron (0.3)	0.008	0.008	0.012	0.012	0.099	0.007	0.005					
Copper (1.0)	0.01	0.01	0.01	0.015	0.015	< 0.005	0.008	>1.00*	>1.00*	>1.00*	>1.00*	>1.00*
Nickel	< 0.01	< 0.01	< 0.01	< 0.01	0.02	< 0.04	< 0.04					
Cadmium (.01)	0.002	0.001	0.001	0.001	0.002	< 0.005	< 0.005					
Lead (.05)	0.03	0.03	0.03	0.11	0.11	0.17	0.08	>0.5*	>0.5*	>0.5*	>0.5*	>0.5*
Chromium (.05)	0.01	0.012	0.01	0.012	0.012	< 0.005	< 0.005					
Molybdenum	0.2	0.2	0.22	0.26	0.21	< 0.10	< 0.10					
Strontium	0.094	0.107	0.093	0.109	0.12	0.07	0.057					
Zirconium	0.016	0.014	0.016	0.016	0.016	< 0.005	< 0.005					
Antimony	0.05	0.05	0.08	0.08	0.02	< 0.04	< 0.04					
Cobalt	0.12	0.07	0.12	0.12	0.12	< 0.04	< 0.04					
Aluminum	0.08	0.08	0.08	0.1	0.24	< 0.04	< 0.04					
Boron (1.0)	0.009	0.007	0.012	0.014	0.026	< 0.005	< 0.005					
Vanadium	0.01	0.014	0.01	0.014	0.01	< 0.005	< 0.005					
Arsenic								0.0055	0.0066	>0.05*	>0.05*	>0.05*

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[†] Values in parentheses are state water quality standards.
* Actual values unknown, reported as non-detected.

Sources: Blanchet, 1981 and Kalli and Blanchet 2001

Table 13 - Area (Acres) of Vegetation and Other Cover Types Within the Resurrection Creek Watershed Association

Watershed Name	Cover Type[1]														Total
	Ald	Asp	Bir	Bl. Spr	Cot.	Mus	Grass & Alp	Hem	Hem -Spr	Mixed H-S	Si. Spr	Wh. Spr	Oth Bru	Oth Non[2]	
Abernathy Creek	940						4257	56	26			967	666	485	7397
American Creek	213	28					1840	91				248	341	269	3030
Bear 1	813		215				1584	398	48	93	2		64	879	4095
Bedrock Creek	424		858	117	59		1392	357	254	91	62	122		69	3803
Cannonball Creek	552	46	60		10		2952	905	245	11		67		31	4877
Caribou Creek	49		83				2150	673	121	33		42	600	1885	5635
Cripple Creek	689		524				1318	216	503	1	1	85		1	3339
East Creek	10	18					5626	90	34	29		336	1239	724	8106
Fox Creek	45	80	106				6271	406	7			291	271	724	8202
Gold Gulch-Rimrock Creeks	586		490	65			2464	1155	679	117		39		205	5801
Hungry Creek			53			36	2412	107				619	984	381	4591
Palmer Creek	1934		389		27		4684	644	625	37	115	11	1240	3654	13362
Pass Creek	335		43				3743	614	16	37		60	249	615	5711
Resurrection Creek RM 12-15	172		76				708	383	352	69		340		42	2141
Resurrection Creek RM 15-19	180						795	71		99		542		0	1688
Resurrection Creek Flats	499		983		126		180	74	471	996	665			84	4077
Turnagain B	1068		940	43			623	193	139	105	84	24		130	3350
Turnagain C	56		304				24	291	307	7				66	1056
White Creek	316	50	227		17		4994	256		19		1105	62	62	7106
Wildhorse Creek	601		809	49	80		506	154	879	13	67	15		15	3189
Willow Creek	1552		100		37		1553	1073	1002	18	48	24		1816	7221
Wolf Creek #1	616		34				1995	747	437	6		92		23	3950
Total	11,650	223	6,293	275	354	36	52,070	8,953	6,145	1,780	1,044	5,029	5,715	12,159	111,725
Percent of Total	10.4	0.2	5.6	0.2	0.3	0.0	46.6	8.0	5.5	1.6	0.9	4.5	5.1	10.9	100

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[1] Cover Types - Are as defined in the Resource Information Management Data Dictionary for the Chugach National Forest dated 8/24/2001except for Oth Non, which is defined below.

[2] Oth Non - Other nonforested areas include urban areas, rock, snow and ice, and water.

Ald - Alder
Asp - Aspen
Bir - Birch
Bl. Spr - Black Spruce
Cot - Cottonwood
Mus - muskeg meadow
Grass & Alp - Grass & Alpine
Hem - Hemlock
Hem-Spr = Hemlock-Spruce
Mixed H-S = Mixed Hardwood-Softwood
Si Spr = Sitka Spruce
Wh Spr = White Spruce
Oth Bru = Other Brush
Oth Non = Other Nonforested

Table 14 - Length of Stream Used by Fish by Subbasins Within the Resurrection Creek Watershed

Subbasin	Species	Length (mile)
Bedrock Creek	chum, coho, dolly varden, chinook, pink	2
Gold Gulch-Rimrock Creeks	chum, coho, dolly varden, chinook, pink	0.2
Porcupine Creek	chum, coho, dolly varden, chinook, pink	0.7
Wildhorse Creek	chum, coho, dolly varden, chinook, pink	3.5
Cannonball Creek	coho, dolly varden, chinook	0.2
Gold Gulch-Rimrock Creeks	coho, dolly varden, chinook	3
Wolf Creek #1	coho, dolly varden, chinook	2.6
Palmer Creek	coho, dolly varden, chinook, pink	0.6
Cannonball Creek	dolly varden, chinook	2
White Creek	dolly varden, chinook	1.3
White Creek	chinook	2.1
Bear Creek	pink	1.7
Caribou Creek	dolly varden	0.4
Cripple Creek	dolly varden	0.4
Gold Gulch-Rimrock Creeks	dolly varden	0.4
Palmer Creek	dolly varden	8

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Source: USFS (however we are referencing the GIS data given to us electronically)

Table 15 - ADGF Surveyed Tributaries of Resurrection Creek

Tributaries	Species	Date
Western Tributaries		
Cripple Creek	Dolly Varden, Pink Salmon	16-Aug-00
* No Name Creek	Dolly Varden	16-Aug-00
Wildhorse Creek	No Fish	30-Aug-00
Bedrock Creek	Dolly Varden	25-Jul-00
* Rimrock Creek	Dolly Varden	26-Jul-00
Gold Gulch Creek	No Fish	26-Jul-00
No Name Creek	No Fish	4-Oct-00
Wolf Creek	Dolly Varden	2-Aug-00
Cannonball Creek	Dolly Varden	27-Sep-00
White Creek	No Fish	27-Sep-00
Moose Creek	No Fish	22-Aug-00
* Hungry Creek	Dolly Varden	22-Aug-00
* American Creek	Dolly Varden	23-Aug-00
* Abernathy Creek	Dolly Varden	23-Aug-00
* Afanasa Creek	Dolly Varden	23-Aug-00
Eastern Tributaries		
* No Name Creek	Dolly Varden	1-Sep-00
Palmer Creek	Dolly Varden	1-Aug-00
Highland Creek	No Fish	5-Oct-00
Island Creek	No Fish	5-Oct-00
Willow Creek	No Fish	4-Oct-00
No Name Creek	No Fish	4-Oct-00
Caribou Creek	Dolly Varden, Juvenile Chinook	2-Aug-00
* Pass Creek	Dolly Varden	3-Aug-00
No Name Creek	No Fish	27-Sep-00
* Fox Creek	Dolly Varden	22-Aug-00
No Name Creek	No Fish	22-Aug-00
* East Creek	Dolly Varden, Juvenile Chinook, Slimy Sculpin	23-Aug-00
* Coer D'Alene Creek	Dolly Varden	1-Aug-00
Resurrection Creek	Dolly Varden, Juvenile Chinook, Slimy Sculpin	23-Aug-00

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* Creek not previously identified as fish-bearing.

Table 16 - Limiting Habitat Factors for Selected Management Indicator and Other Species of Concern for the Resurrection Creek Watershed Association

Species	Limiting Habitat Factors
Moose	Winter forage, nearness of habitat providing feeding and cover to each other
Bald Eagle	Nest trees near anadromous-fish-bearing streams
Northern Goshawk	Nest habitat, nearness of nesting and feeding habitat to each other
Caribou	Winter range, predation
Brown Bear	Human disturbance in spring/summer habitat
Wolverine	Late spring feeding habitat, human disturbance during winter/denning
Harlequin Duck	Nesting/rearing habitat, human disturbance of nesting habitat
Northern Red-backed Vole	Micro-distribution of feeding/hiding habitat

Table 17 - HCI Value of Existing Forest Habitat Types for Seven Selected Management Indicator Species and Other Species of Concern in the Resurrection Creek Watershed Association

Habitat Type	Moose	Brown Bear	N. Red-backed Vole	Wolverine	N. goshawk	Harlequin Duck	Bald Eagle
Mixed Hardwood							
Initiation	1F-3H-1R	1F-3H	1F-2H-1R	1F-3H-3R	2F-3H-3R	NA	NA
Exclusion	3F-3H-3R	3F-3H	3F-3H-3R	3F-3H-3R	1F-2H-3R	NA	NA
Re-initiation	2F-2H-2R	3F-3H	2F-1H-1R	2F-3H-3R	1F-2H-2R	NA	NA
Cottonwood							
Initiation	1F-3H-1R[1]	1F-3H	1F-2H-1R	1F-3H-3R	2F-3H-3R	NA	NA
Exclusion	3F-3H-3R	3F-3H	3F-3H-3R	3F-3H-3R	2F-2H-3R	NA	2R
Re-initiation	2F-2H-3R	2F-3H	2F-1H-1R	2F-2H-3R	2F-1H-3R	NA	1R
Mixed Hard/Soft Wood							
Initiation	2F-3H-3R	2F-3H	1F-2H-1R	2F-3H-3R	2F-3H-3R	NA	NA
Exclusion	3F-3H-3R	3F-3H	3F-3H-3R	3F-3H-3R	1F-2H-3R	NA	NA
Re-initiation	2F-2H-3R	3F-2H	2F-1H-1R	2F-2H-3R	1F-1H2R	NA	NA
Mixed Conifer							
Initiation	3F-3H-3R	3F-3H	2F-2H-2R	3F-3H-3R	3F-3H-3R	NA	NA
Exclusion	3F-3H-3R	3F-3H	3F-3H-3R	3F-3H-3R	3F-2H-3R	NA	NA
Re-initiation	3F-2H-3R	3F-2H	2F-1H-2R	2F-2H-3R	2F-2H-2R	NA	3R
Old Growth	3F-1H-2R	2F-1H	2F-1H-2R	2F-1H-2R	1F-1H-1R	NA	3R
Riparian	1F-1H-1R	1F-1H	1F-1H-1R	1F-1H-3R	1F-2H-3R	1F-1R	1F-1R
Alpine	NA	1F-3H	NA	1F-1H-1R	2F-3H-3R	NA	NA

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[1] 1 – optimum; 2 – moderate; 3 – low quality; F – Feeding; H – Hiding; R – Reproduction

Table 18 - Timber Size Class, Acreage and Ownership of Potential Moose Winter Range in the Resurrection Creek Watershed Analysis Area

Timber Size Class	Forest Service in acres	Non Forest Service in acres	Total in acres
Unknown	1960	70	2030
Seedling/Sapling	1840	790	2630
Pole-Old Growth	2310	680	2980
Total	6100	1540	7640

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Table 19 - Planned and Anticipated Recreation-Related Projects in the Resurrection Creek Watershed Association

Project	Funding Sources	Survey and Design	Proposed Year	Construction/ Reconstruction Year 1	Proposed Year	Construction/ Reconstruction Year 2	Proposed Year	Annual Operations and Maintenance
Gulch Creek Trail and Bridge Reconstruction	CMFC			$12,500	2003			
	CMTL	$85,000	2002	$515,000	2003	$91,000	2004	$1,000 without snow removal, $11,000 with
	CMRD	$11,500	2002	$166,000	2003			
	Totals	$96,500		$693,500		$91,000		
Hope Point Trail Reconstruction	CMFC							
	CMTL	$10,000	2003	$53,000	2004			$1,200
	CMRD							
	Totals	$10,000		$53,000				
Trail Bridge Repair/Replacement Deferred Maintenance	CMFC							
	CMTL	$91,000	2002	$733,000	2003			$2,000 pre- and $2,000 post-project
	CMRD							
	Totals	$91,000		$733,000				
Resurrection Trail Reconstruction	CMTL		2002	$642,000				
Vault Toilet Replacement	CMFC		2002	$211,000				
Resurrection Pass North Trailhead Reconstruction	Project in planning stages							
Porcupine Campground Reconstruction	Project in planning stages							
Palmer Creek Road Dispersed Sites	Project in planning stages							
Coeur d'Alene Campground Reconstruction	Project in planning stages							

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Table 20 – Subsistence Resources in the Vicinity of Resurrection Creek Watershed

Resource	Species
Fish	Pink Salmon,
Game	Black bear, caribou, deer, goat, moose, sheep
Furbearers	Lynx, coyote, beaver, mink, wolverine, marten, muskrat
Berries	Raspberry, currents, watermelon berry, crowberry, cranberry, blueberry
Mushrooms	Boleta, chicken of the woods
Other	Burls, birchbark, firewood, house logs

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Table 21 - Indices of Fish Habitat Conditions (WFPB 1997)

Habitat Parameter	Channel Type	Life Phase Influenced	Habitat Quality		
			Poor	Fair	Good
Percent Pool	<2%; <15 m wide	Summer/winter rearing habitat	<40%	40–55%	>55%
	2-5%; <15 m wide	Summer/winter rearing habitat	<30%	30–40%	>40%
	>5% <15m wide	Summer/winter rearing habitat	<20%	20–30%	>30%
Pool Frequency	<2%; <15 m wide	Summer/winter rearing habitat	>4 channel widths per pool	2–4 channel widths per pool	<2 channel widths per pool
	2-5%; <15 m wide	Summer/winter rearing habitat	>4 channel widths per pool	2–4 channel widths per pool	<2 channel widths per pool
	>5% <15m wide	Summer/winter rearing habitat	>4 channel widths per pool	2–4 channel widths per pool	<2 channel widths per pool
Total LWD/ channel width	<20 m wide	Summer/winter rearing habitat	<1	1–2	>2
Key piece LWD/ channel width	BFW <10 m	Summer/winter rearing habitat	<0.15	0.15–0.30	> 0.30
	BFW 10-20 m	Summer/winter rearing habitat	<0.20	0.20–0.50	>0.50
Substrate	all	Winter rearing habitat	Intersticies filled	Intersticies reduced	Intersticies clear
Off-channel	<3%; all widths	Winter rearing habitat	Few or no backwaters and no off-channel ponds	Some backwaters and high-energy sidechannels	Backwaters with cover and low energy off-channel areas
Holding Pools (>1m residual depth)	all	Upstream adult migration	<25%	25-50%	>50%
Access to Spawning Areas	all	Upstream adult migration	Access blocked (low water, culverts, falls)		No blockages
Gravel Presence	all	Spawning and incubation	Absent/infrequent spawnable areas		Frequent spawnable areas
Gravel Quality	all	Spawning and incubation	Sand dominant in some units	Sand is subdominant	Sand is never dominant or
Fines in Gravel	all	Spawning and incubation	>17%	12–17%	<12%
Redd Scour	all	Spawning and incubation	Potential or evidence of scour	Some potential or evidence of scour	Stable or low potential or evidence of scour

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FIGURES

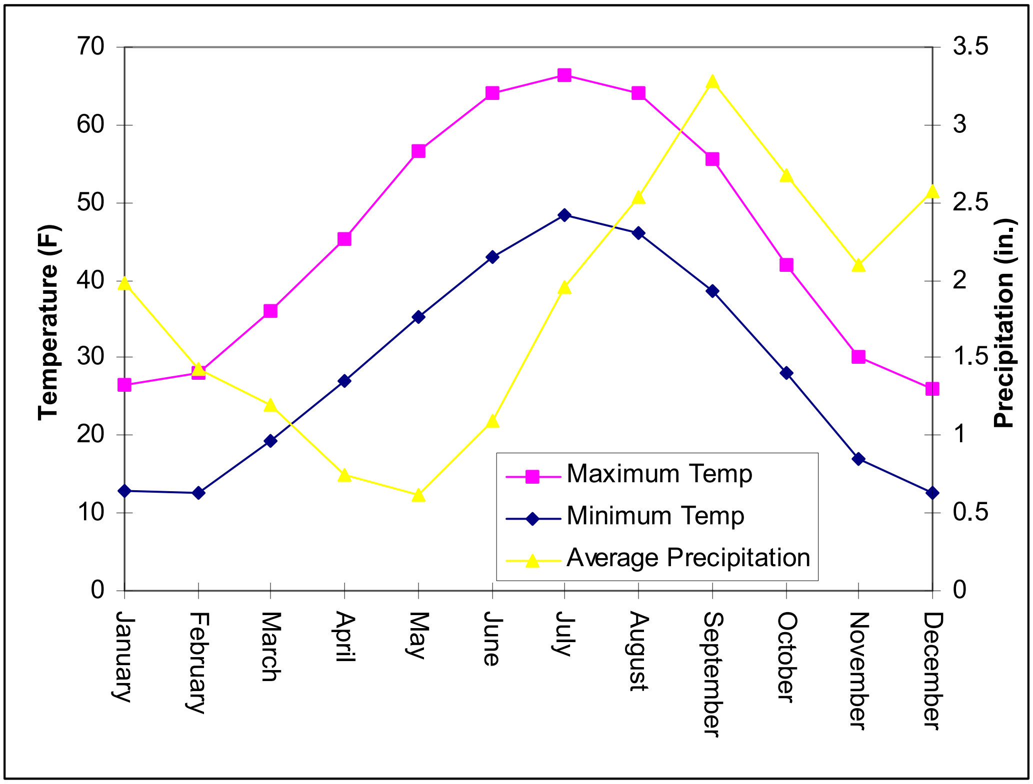


Figure 1 - Average Temperature Maxima and Minima and Average Precipitation

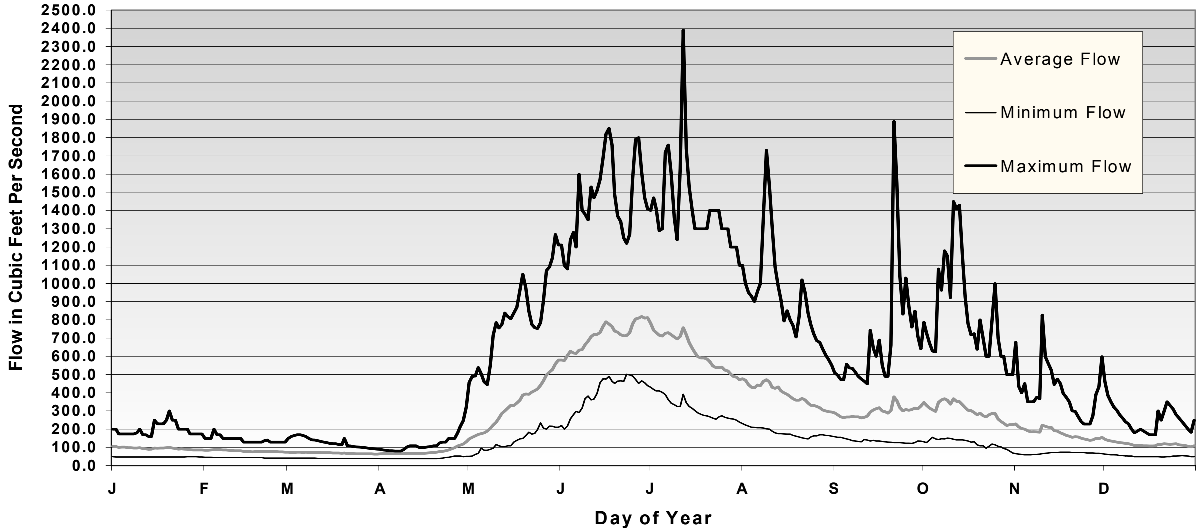


Figure 2 – Maximum, Minimum, and Average Daily Flows from October 1967 to March 1986 at Resurrection Creek Near Hope, USGS Gage 15267900

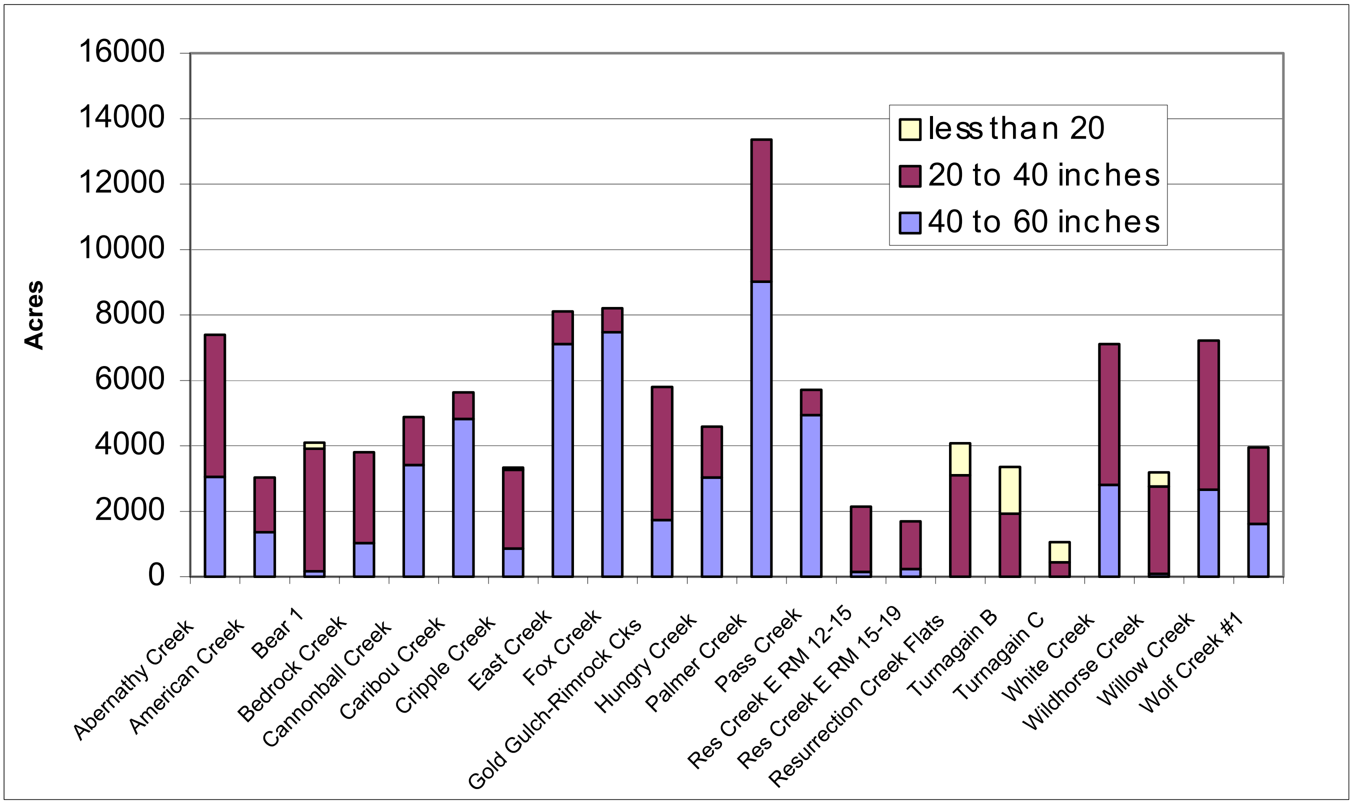


Figure 3 – Approximate Average Annual Precipitation Zones by Subwatershed

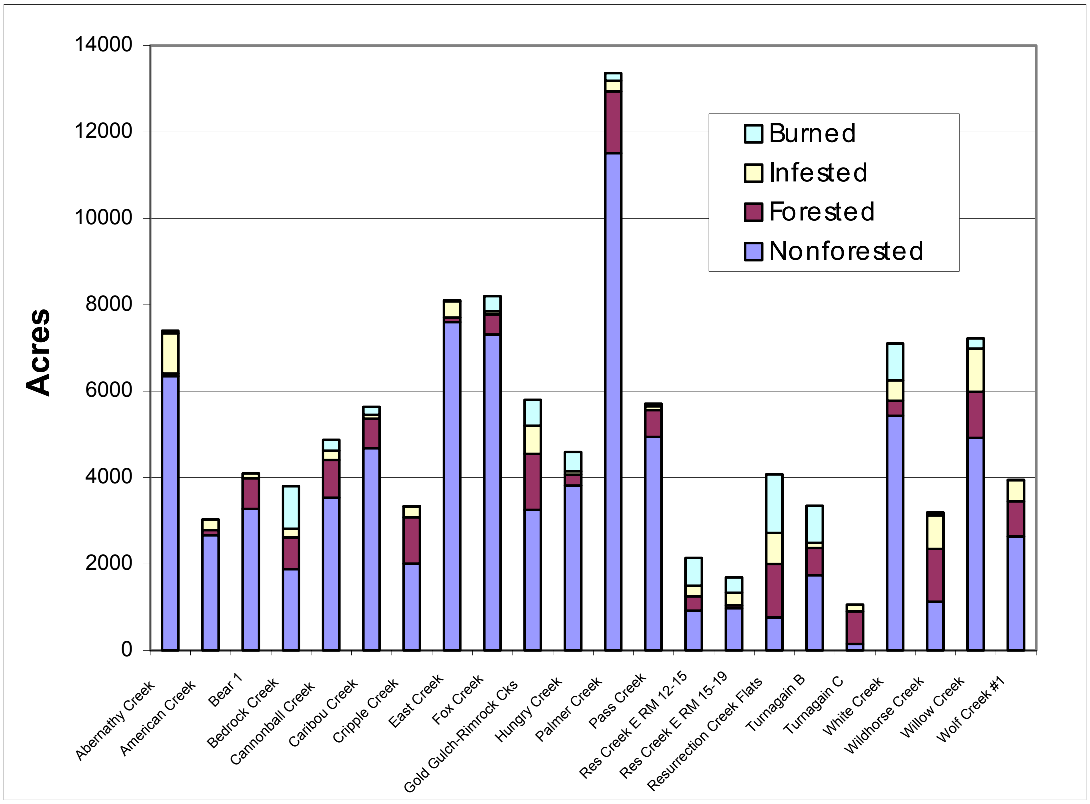


Figure 4 - Forested Area, Spruce Bark Beetle-Infested Area, and Recently Burned Area, by Subwatershed. (Infested And Burned Areas Are a Subset of Forested Area)

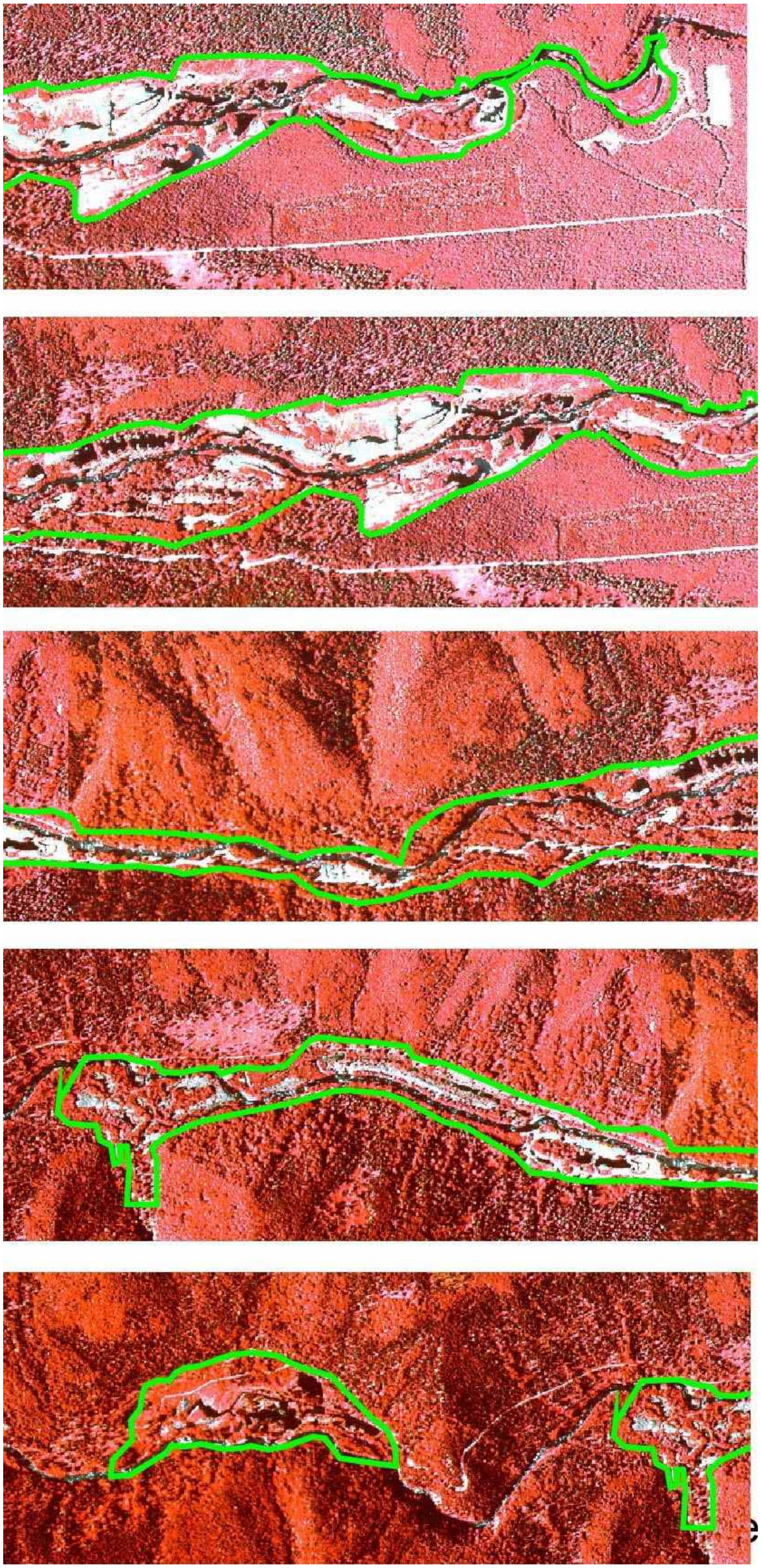
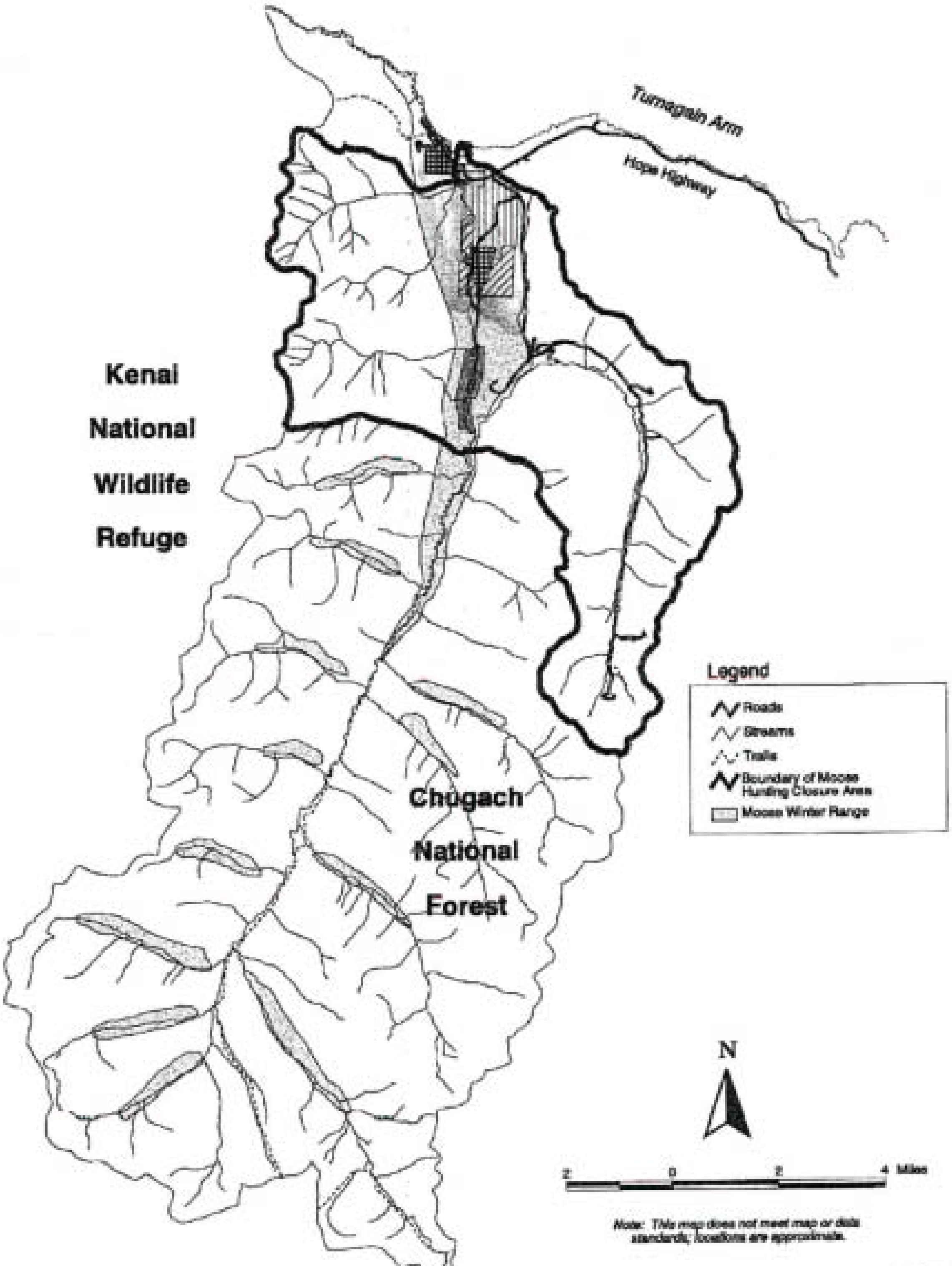


Figure 5 - Aerial Photograph Showing Extent of Mining Disturbance on Resurrection Creek and Lower Palmer Creek (areas of disturbance are outlined in green)

Figure 6 - Photo of Mining Disturbance on Bear Creek, ca 2000

Moose Winter Range in the Resurrection Creek Watershed Association



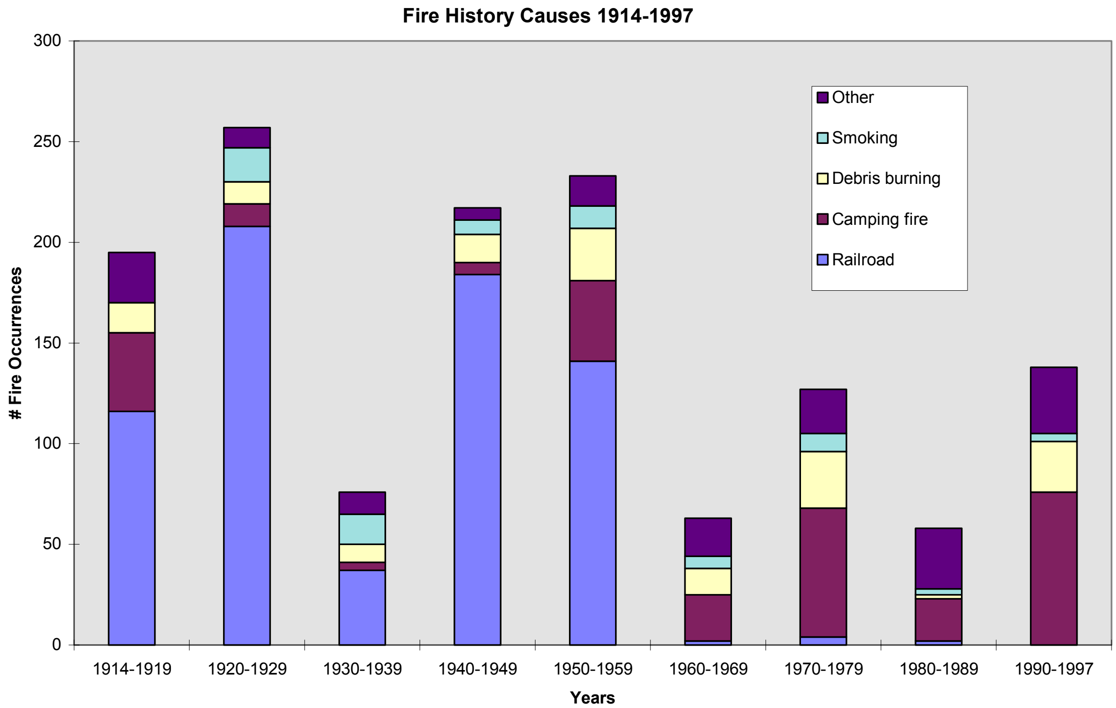


Figure 8 – Causes of Fire, 1914-1997

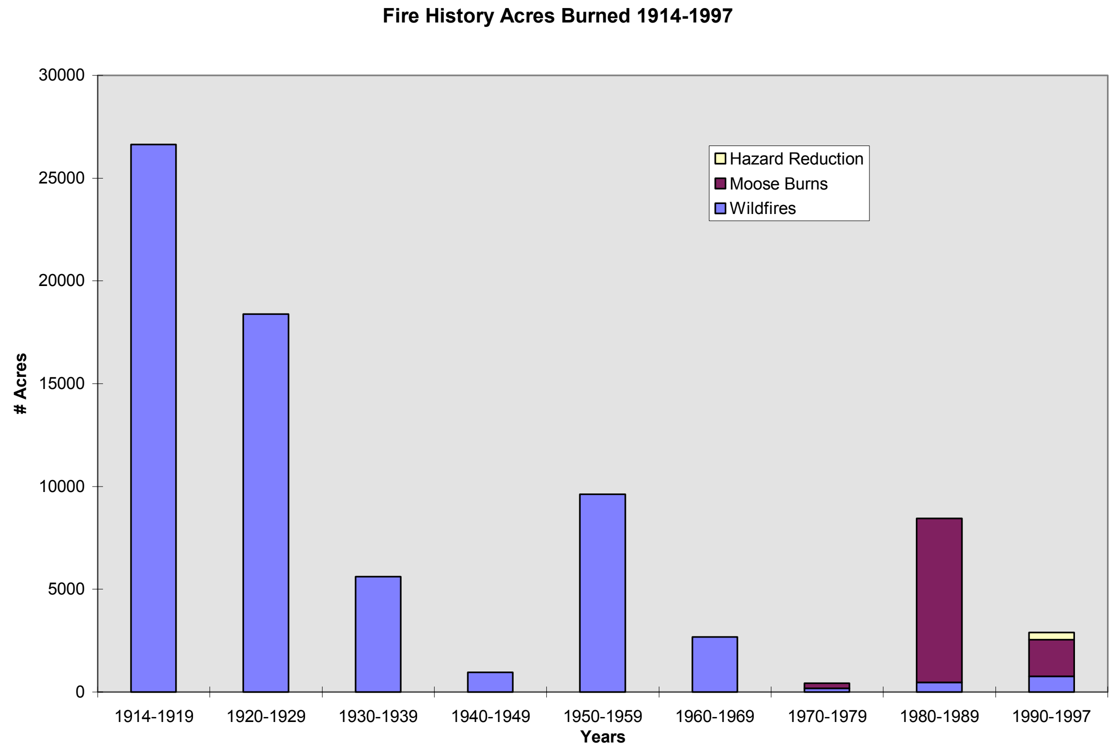


Figure 9 – Acres Burned by Fire, 1914-1997

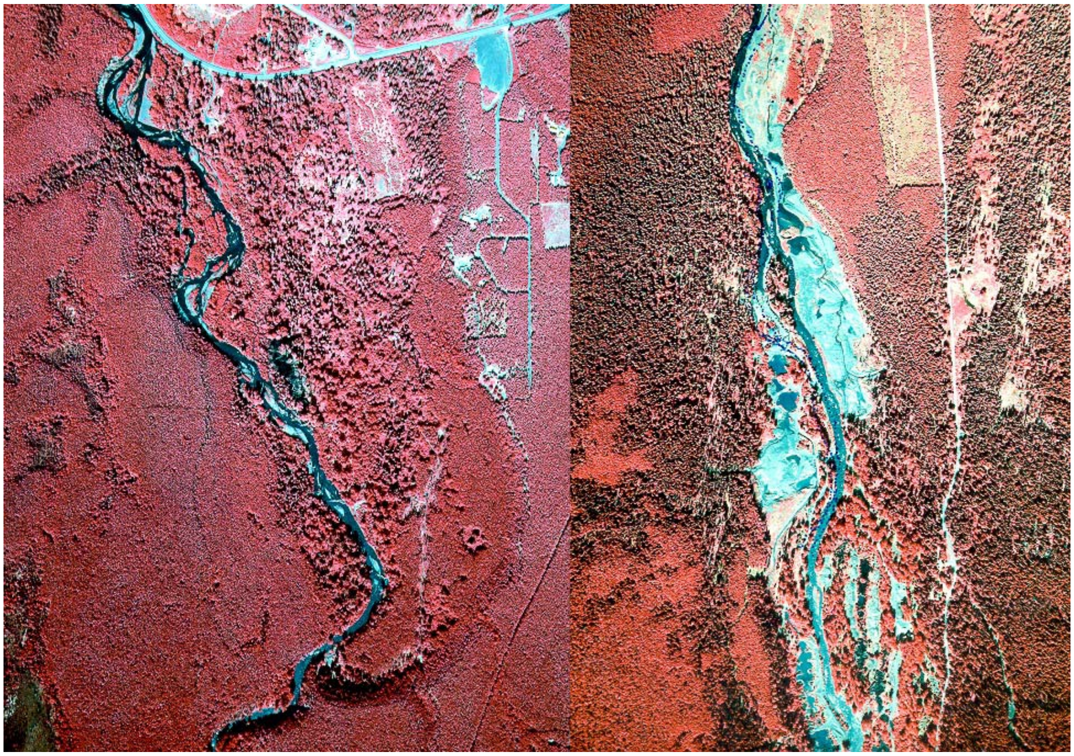


Figure 10 - Comparison of Resurrection Creek in Unmined (left) and Mined (right) Reaches

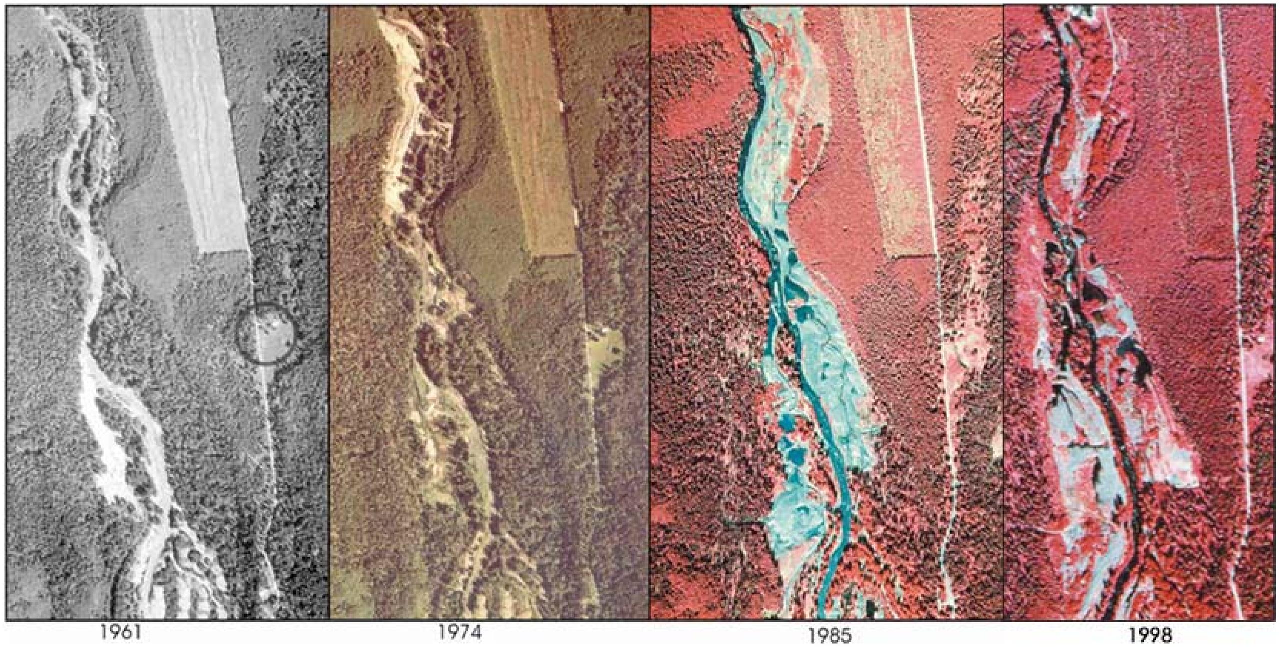
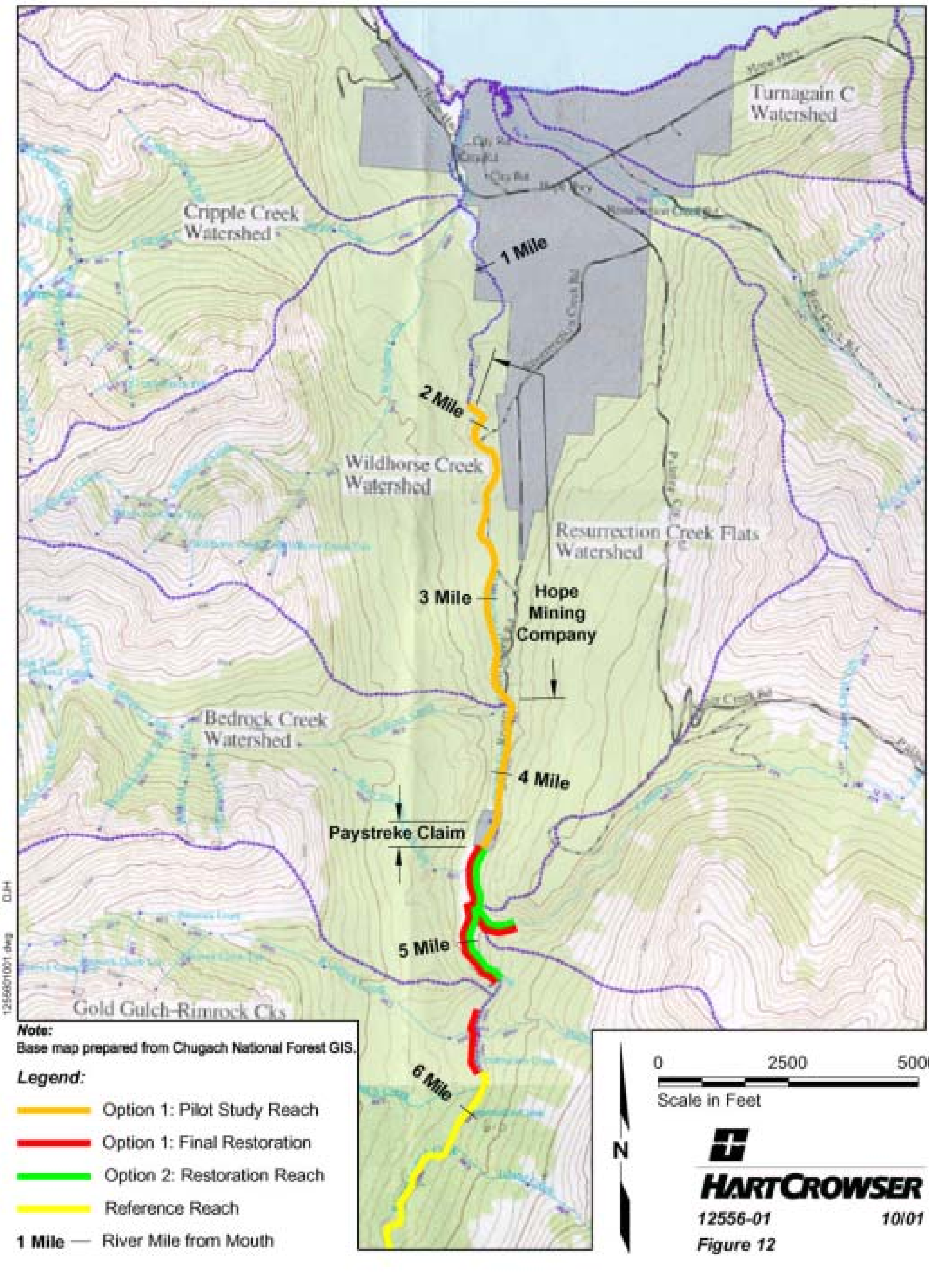


Figure 11 – Photo Series of Resurrection Creek at Hope Mining Company Claims

Restoration Option Features



APPENDIX A

MAP A – PRECIPITATION

MAP B – COVER TYPE AND BEETLE INFESTATION

MAP C – PALMER/RESURRECTION CREEK SALVAGE SALES DECISION MAP

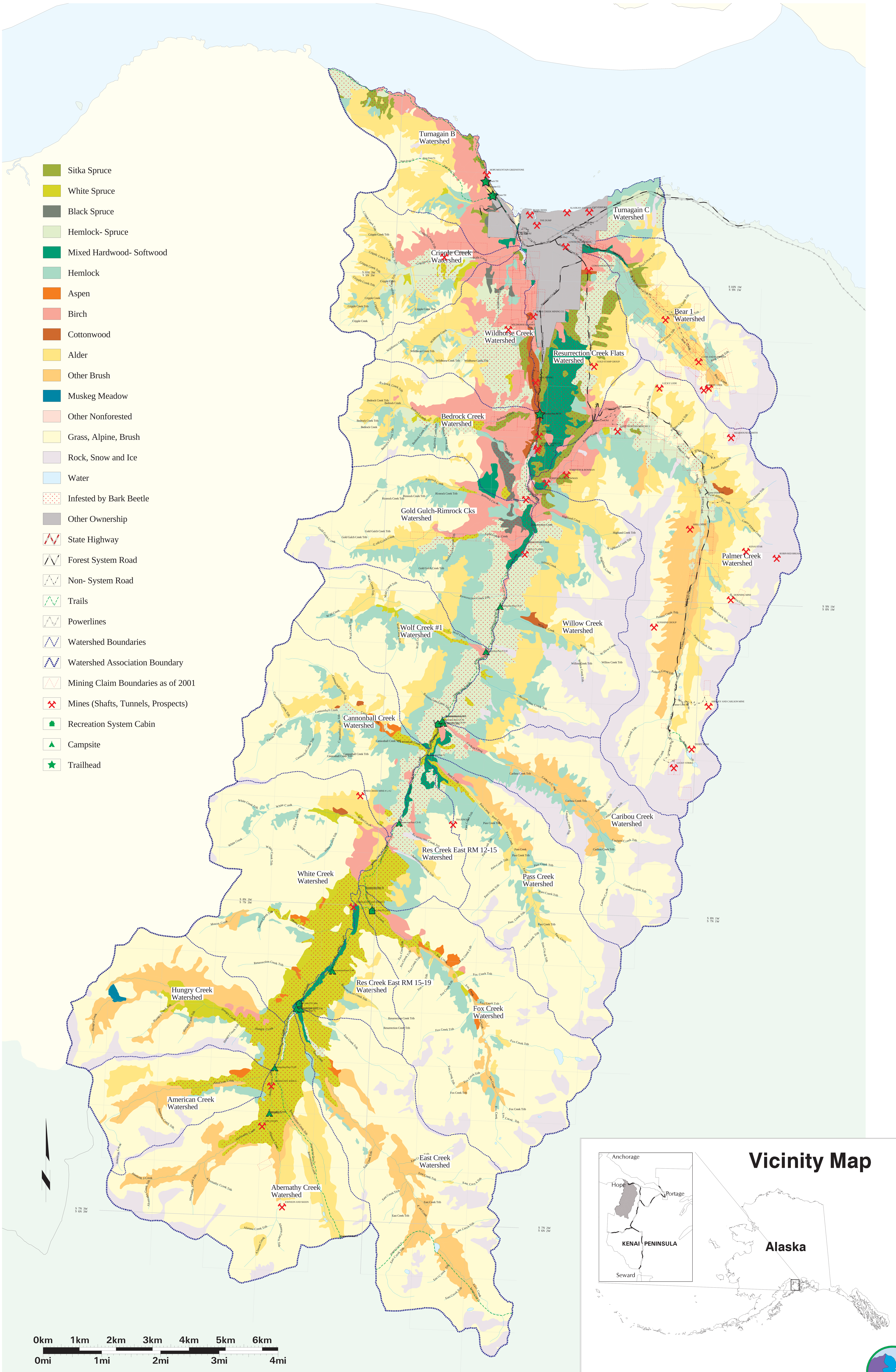
MAP D – TRAILS AND RECREATION SITES

RESURRECTION CREEK LANDSCAPE ANALYSIS

Map A - Precipitation

RESURRECTION CREEK LANDSCAPE ANALYSIS

Map B - Cover Type and Beetle Infestation



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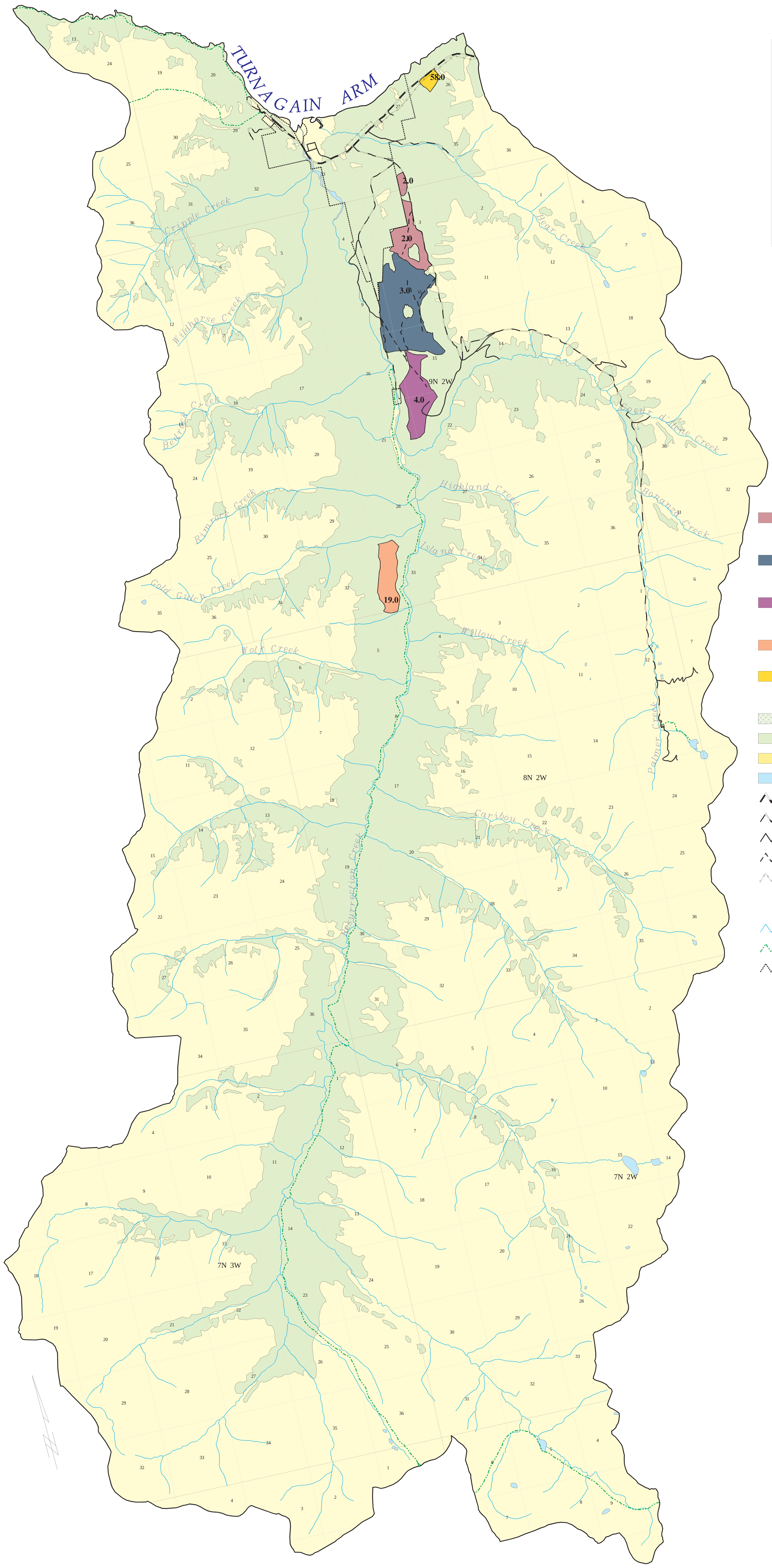
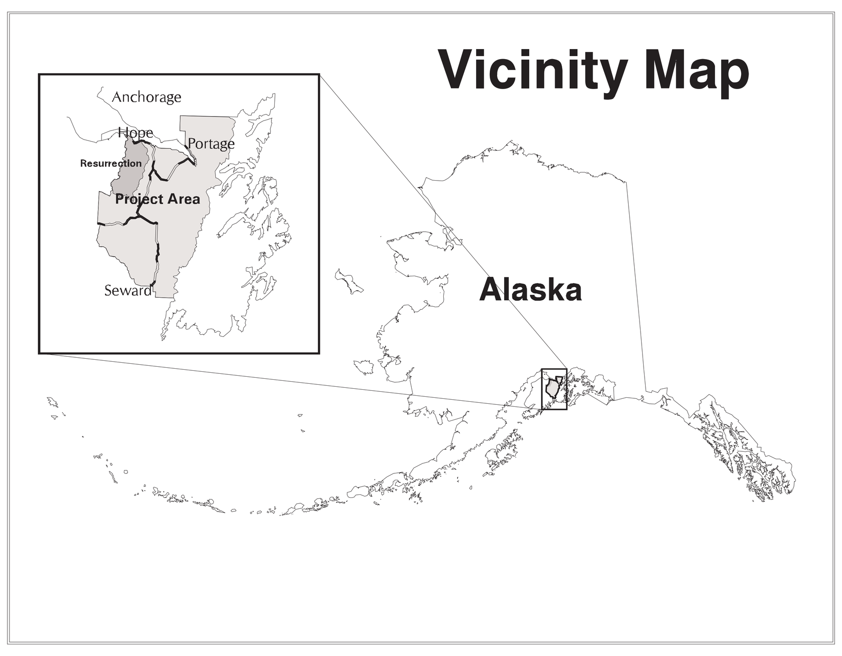
RESURRECTION CREEK LANDSCAPE ANALYSIS

Map C - Palmer/Resurrection Creek Salvage Sale Decision Map





LEGEND

- Unit 2.0 — Group Selection (16 @ 2 acres) Salvage Cut/Thin (92 acres treated)
- Unit 3.0 — Group Selection (28 @ 2 acres) Salvage Cut/Thin (400 acres treated)
- Unit 4.0 — Group Selection (8 @ 2 acres) Salvage Cut/Thin (120 acres treated)
- Unit 19.0 — Prescribe Burn (170 acres treated)
- Unit 58.0 — Salvage Cut and Sanitation Cut (25 acres treated)
- Other Ownership (1,800 ac)
- Forested - outside of treatment units (30,200 ac)
- Nonforested - outside of treatment units (81,000 ac)
- Water (120 ac)
- Hope Road (4.0 mi)
- System Road (18.5 mi)
- Non-System Road (8.5 mi)
- Proposed Road (3.5 mi)
- Utility Corridor (2.5 mi)

NOTE: Road distances are accurate to 1/2 mile.

- Stream (250 mi)
- Trail (29.5 mi)
- Other Ownership Boundary (1,800 ac)

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October 22, 2001

RESURRECTION CREEK LANDSCAPE ANALYSIS

Map D - Trails and Recreational Sites

October 22, 2001

APPENDIX B
COST ESTIMATES

APPENDIX C
LAWS, EXECUTIVE ORDERS, AND PROGRAMMATIC AGREEMENTS THAT APPLY TO MANAGEMENT OF CULTURAL RESOURCES IN THE RESURRECTION CREEK WATERSHED

APPENDIX B
COST ESTIMATES

1. Aquatic Restoration Option 1
2. Aquatic Restoration Option 2
3. Vegetation Management Options 1 and 2
4. Terrestrial Species Survey Recommendations
5. Cultural Landscapes Option 1
6. Cultural Landscapes Option 2
7. Preserving Viewsheds, Options 1 and 2
8. Recreation, Identified Improvements
9. Recreation, Accessibility
10. Recreation-level Panning, Dredging, and Sluicing Options 1 and 2
11. Subsistence Use Option 2
12. Erosion Control Survey and Design
13. Heritage Resources and Cultural Management, Option 1
14. Heritage Resources and Cultural Management, Option 2

Resurrection Creek Landscape Analysis **Aquatic Restoration Cost Estimate**

Option 1 - Full Restoration

		Land Acquisition & Mining Management Program						Assessments				Pilot Study Feasibility and Design						Permitting/NEPA		Pilot Study Construction & Monitoring				Final Restoration			
		Task 1		Task 2		Task 3		Task 4		Task 5		Task 6		Task 7		Task 8		Task 9		Task 10		Task 11		Task 12		Total	
		Mineral Validity Examinations[1] (10 claims)		Land Assessment and Purchase		Mining Operation Plan Administration		Aerial photograph/ channel mapping of test reach		Habitat/Channel/ Riparian Survey[2]		Topographic Survey of All Disturbed Reaches		Sediment, Hydrology, Hydraulic Analysis		Test Reach Restoration Design		NEPA Documentation		Test Reach Restoration Construction[3]		Test Reach Restoration Monitoring[2]		Restoration of Remaining Reaches[4]			
Staff/Item [5]	***Rate***	***Person-hours***	***Cost***	***Person-hours***	***Cost***	***Person-hours***	***Cost***	***Person-hours***	***Cost***	***Person-hours***	***Cost***	***Person-hours***	***Cost***	***Person-hours***	***Cost***	***Person-hours***	***Cost***	***Person-hours***	***Cost***	***Person-hours***	***Cost***	***Person-hours***	***Cost***	***Person-hours***	***Cost***	***Person-hours***	***Cost***
Fisheries Biologist	30.0		$0		$0	30	$900		$0	200	$6,000		$0	30	$900	100	$3,000	160	$4,800		$0	80	$2,400	357	$10,710	957	$28,710
Geomorphologist/Hydrologist[5]	101.0		$0		$0	20	$2,019	40	$4,038	160	$16,154		$0	120	$12,115	180	$18,173	140	$14,134	40	$4,038	60	$6,058	680	$68,653	1,440	$145,382
Hydraulic Engineer[5]	101.0		$0		$0	0	$0	10	$1,010	30	$3,029		$0	140	$14,134	200	$20,192	40	$4,038	40	$4,038		$0	646	$65,220	1,106	$111,662
Wildlife Biologist	27.4		$0		$0	15	$411		$0	40	$1,096		$0		$0	50	$1,370	100	$2,740		$0		$0	85	$2,329	290	$7,946
Landscape Architect[5]	90.0		$0		$0	0	$0		$0		$0		$0		$0	50	$4,500	120	$10,800		$0		$0	105	$9,450	275	$24,750
GIS analyst	26.0	4	$104	10	$260	0	$0	30	$780	50	$1,300	20	$520		$0		$0	80	$2,080		$0	60	$1,560	102	$2,652	356	$9,256
Staff technician	18.0		$0		$0	40	$720	8	$144	200	$3,600		$0	40	$720	140	$2,520	70	$1,260		$0	80	$1,440	442	$7,956	1,020	$18,360
Forester	42.0		$0	2	$84	5	$210		$0	20	$840		$0		$0	50	$2,100	60	$2,520	20	$840		$0	119	$4,998	276	$11,592
Project Manager	42.0		$0		$0	10	$420	4	$168	40	$1,680	20	$840	8	$336	120	$5,040	100	$4,200	120	$5,040	15	$630	447	$18,778	884	$37,132
Real Estate evaluator	28.0		$0	40	$1,120	0	$0		$0	40	$1,120	4	$112	8	$224		$0		$0		$0		$0	14	$381	106	$2,957
Mineral examiner	12.9	454	$5,857		$0	0	$0		$0		$0		$0		$0		$0		$0		$0		$0	0	$0	454	$5,857
Review Mineral examiner	18.8	400	$7,520		$0	0	$0		$0		$0		$0		$0		$0		$0		$0		$0	0	$0	400	$7,520
District Attorney	22.5	300	$6,750		$0	0	$0		$0		$0		$0		$0		$0		$0		$0		$0	0	$0	300	$6,750
			$0		$0	0	$0		$0		$0		$0		$0		$0		$0		$0		$0	0	$0	0	$0
		1,158	$20,231	52	$1,464	120	$4,680	92	$6,140	780	$34,818	44	$1,472	346	$28,430	890	$56,895	870	$46,573	220	$13,957	295	$12,088	2,997	$191,127	7,864	$417,874
Other costs		Units						Units		Units		Units		Units		Units		Units		Units		Units		Units			
Lodging + meals	$25	20	$500		$0	10	$250		$0	20	$500		$0		$0		$0		$0		$0		$500		$850	40	$2,100
Field supplies	$50	4	$200		$0	2	$100		$0	4	$200		$0		$0		$0		$0		$0		$0		$0	8	$300
Employee mileage	$0.350	300	$105	150	$53	300	$105		$0	600	$210		$0		$0		$0		$0		$0		$0		$0	900	$315
Surveying													$50,000												$0		$50,000
Copies/Reproduction/Drafting	$100		$0		$0		$0		$0		$0		$2,500		$300		$100		$1,000		$0		$250		$2,805	0	$6,855
Construction[3]	-																				$900,000				$1,810,000	-	$2,710,000
Land Purchase[3]	-				$110,000																					-	$0
Contingency estimate[7]	-				$22,000															0	$180,000				$362,000		$542,000
Total other direct costs			$105		$132,053		$105		$0		$210		$52,500		$300		$100		$1,000		$1,080,000		$250		$2,174,805		$3,309,170
Grand totals			$20,336		$133,517		$4,785		$6,140		$35,028		$53,972		$28,730		$56,995		$47,573		$1,093,957		$12,338		$2,365,932		$3,727,044

C:\Documents and Settings\scarlton\My Documents\Ressurection Creek LSA\Cost Estimates\[Aquat Rest CE Op 1.xls]Option 1

Assumptions:
1 - Based on cost estimates developed in Huber and Peterson 2000.
2 - Costs equivalent to 1 year monitoring
3 - Costs estimate for discussion only; further research necessary to refine estimate
4 - Includes tasks 7,8,9,10, 11, applied to 2.4 miles of disturbed channel outside of test reach; includes trail construction and signage
5 - Does not include administrative and secretarial costs
6 - Assumes outside contracting
7 - Contingency estimate included as a conservative buffer for unanticipated expenses related to market variables

Resurrection Creek Landscape Analysis **Aquatic Restoration Cost Estimate**

Option 2 - Partial Restoration

		Mining Management		Assessments				Feasibility and Design						Construction and Monitoring							
		Task 1 Mining Operation Plan Administration		**Task 2** Aerial photograph/ channel mapping		**Task 3** Habitat/Channel/ Riparian Survey[1]		**Task 4** Topographic Survey of Test Reach		**Task 5** Sediment, Hydrology, Hydraulic Analysis		**Task 6** Test Reach Restoration Design		**Task 7** NEPA Documentation		**Task 8** Test Reach Restoration Construction[2]		**Task 9** Test Reach Restoration Monitoring[1]		**Total**	
Staff/Item[3]	***Rate***	***Person-hours***	***Cost***	***Person-hours***	***Cost***	***Person-hours***	***Cost***	***Person-hours***	***Cost***	***Person-hours***	***Cost***	***Person-hours***	***Cost***	***Person-hours***	***Cost***	***Person-hours***	***Cost***	***Person-hours***	***Cost***	***Person-hours***	***Cost***
Fisheries Biologist	30.0	120	$3,600		$0	200	$6,000		$0	30	$900	80	$2,400	100	$3,000		$0	60	$1,800	590	$17,700
Geomorphologist/Hydrologist[4]	101.0	80	$8,077	35	$3,534	160	$16,154		$0	120	$12,115	80	$8,077	90	$9,086	24	$2,423	40	$4,038	629	$63,504
Hydraulic Engineer[4]	101.0		$0	10	$1,010	30	$3,029		$0	140	$14,134	160	$16,154	30	$3,029	24	$2,423		$0	394	$39,778
Wildlife Biologist	27.4	60	$1,644		$0	40	$1,096		$0		$0	24	$658	80	$2,192		$0		$0	204	$5,590
Landscape Architect[4]	90.0		$0		$0		$0		$0		$0	40	$3,600	70	$6,300		$0		$0	110	$9,900
GIS analyst	26.0		$0	30	$780	50	$1,300	20	$520		$0		$0	70	$1,820		$0	60	$1,560	230	$5,980
Staff technician	18.0	160	$2,880	8	$144	200	$3,600		$0	40	$720	140	$2,520	50	$900		$0	10	$180	608	$10,944
Forester	42.0		$0		$0	2	$84		$0	10	$420		$0	40	$1,680	16	$672	24	$1,008	92	$3,864
Project Manager	42.0	20	$840	4	$168	40	$1,680	20	$840	8	$336	40	$1,680	80	$3,360		$0		$0	212	$8,904
Real Estate evaluator	28.0		$0	4	$112	40	$1,120	4	$112	8	$224		$0	0	$0		$0		$0	56	$1,568
Mineral examiner	12.9		$0		$0		$0		$0		$0		$0	0	$0		$0		$0	0	$0
Review Mineral examiner	18.8		$0		$0		$0		$0		$0		$0	0	$0		$0		$0	0	$0
District Attorney	22.5		$0		$0		$0		$0		$0		$0	0	$0		$0		$0	0	$0
			$0		$0		$0		$0		$0		$0	0	$0		$0		$0	0	$0
		440	$17,041	91	$5,747	762	$34,062	44	$1,472	356	$28,850	564	$35,088	610	$31,367	64	$5,518	194	$8,586	3,125	$167,732
Other costs				Units		Units		Units		Units		Units		Units		Units		Units			
Lodging + meals	$25	10	$250		$0	20	$500		$0		$0		$0		$0		$0		$500	20	$1,250
Field supplies	$50	2	$100		$0	4	$200		$0		$0		$0		$0		$0		$0	4	$300
Employee mileage	$0.350	300	$105		$0	600	$210		$0		$0		$0		$0		$0		$0	600	$315
Surveying									$15,000											0	$15,000
Copies/Reproduction/Drafting	$100		$0		$0		$0		$1,000		$300		$100		$500		$0		$250	0	$2,050
Construction[2]	-																$900,000			0	$900,000
Contingency estimate[5]	-								$147		$2,885		$3,509				$180,000			0	$183,032
Other	$10		$0		$0		$0		$0		$0		$0		$0				$0	0	$0
Total other direct costs			$105		$0		$210		$16,147		$3,185		$3,609		$500		$1,080,000		$250		$1,100,397
Grand totals			$17,146		$5,747		$34,272		$17,619		$32,035		$38,697		$31,867		$1,085,518		$8,836		$1,268,129

C:\Documents and Settings\scarlton\My Documents\Ressurection Creek LSA\Cost Estimates\[Aquat Rest CE Op 2.xls]Option 2

Assumptions:

1 - Costs equivalent to 1 year monitoring

2 - Costs estimate for discussion only; further research necessary to refine estimate

3 - Does not include administrative and secretarial costs

4 - Assumes outside contracting

5 - Contingency estimate included as a conservative buffer for unanticipated expenses related to market variables

Resurrection Creek Landscape Analysis **Vegetation Management Recommendations Cost Estimate**

		Option 1			**Option 2**			
Activity	Cost	Acres	Prescribed Burn	Mechanical Treatment	Acres	Prescribed Burn	Mechanical Treatment	Total
Broadcast Burn Openings	$160				49.5	$7,920		
Fuel Inventories[1]	$5				49.5	$248		
Handpile	$702				49.5	$34,749		
Burn Handpiles	$64				49.5	$3,168		
Cut, Yard, Process, and Load[2]	$1,025	98.5		$100,962.50	98.5		$100,962.50	
Piling Slash[3]	$220	98.5		$21,670.00	98.5		$21,670.00	
Burning Slash	$20	98.5		$1,970.00	98.5		$1,970.00	
Hauling	$1,000	98.5		$98,500.00	98.5		$98,500.00	
Total				**$223,102.50**		**$46,085**	**$223,102.50**	**$269,187**

All prescribed burning costs (except as noted) are based on 1996 USFS rates identified in the Resurrection Creek & Palmer Creek Salvage Sales EA adjusted upward 5% per year

NOTES:
1 - Fuels inventories would entail much more than the planar intersect technique to determine fuel loads so costs are doubled here.
2 - Assumes a minimum of 5 MBF/acre and $205/MBF to cut, yard, process and load or a total per acre cost of $1,025/acre.
3 - Assumes a medium high rate of $110/hr and a total cost of $220/acre.
4 - Does not include cost of hardwood management.

Resurrection Creek Lanscape Analysis **Terrestrial Habitat and Species**

		Task 1		**Task 2**		**Task 3**		**Task 4**		**Task 5**		**Total**	
		Map Habitats - Aerial Photos		**Map Habitats - Field**		**Habitat Studies - Field Work**		**Habitat Studies - Reports**					
Staff/Item	***Rate***	***Person-hours***	***Cost***	***Person-hours***	***Cost***	***Person-hours***	***Cost***	***Person-hours***	***Cost***	***Person-hours***	***Cost***	***Person-hours***	***Cost***
Fisheries Biologist	30.0		$0		$0		$0		$0		$0	0	$0
Geomorphologist/Hydrologist[2]	101.0		$0		$0		$0		$0		$0	0	$0
Hydraulic Engineer	101.0		$0		$0		$0		$0		$0	0	$0
Wildlife Biologist	27.4	40	$1,096	600	$16,440	7,280	$199,472	4,850	$132,890		$0	12,770	$349,898
Landscape Architect	30.0		$0		$0		$0		$0		$0	0	$0
GIS analyst	26.0	40	$1,040	160	$4,160		$0	800	$20,800		$0	1,000	$26,000
Staff technician	18.0		$0		$0		$0		$0		$0	0	$0
Project Manager	28.0		$0		$0		$0		$0		$0	0	$0
Plant Ecologist	27.4	40	$1,096	40	$1,096		$0		$0		$0	80	$2,192
			$0		$0		$0		$0		$0	0	$0
			$0		$0		$0		$0		$0	0	$0
			$0		$0		$0		$0		$0	0	$0
		120	$3,232	800	$21,696	7,280	$199,472	5,650	$153,690	0	$0	13,850	$378,090
Other costs													
Lodging + meals	$25		$0		$0		$0		$0		$0	0	$0
Field supplies	$50		$0		$0		$0		$0		$0	0	$0
Employee mileage	$0.350		$0		$0		$0		$0		$0	0	$0
Copies	$100		$0		$0		$0		$0		$0	0	$0
Other	$10		$0		$0		$0		$0		$0	0	$0
Other	$10		$0		$0		$0		$0		$0	0	$0
Total other direct costs			$0		$0		$0		$0		$0		$0
Grand totals			$3,232	$800	$21,696	$7,280	$199,472	$5,650	$153,690	$0	$0	$13,850	$378,090

Assumptions:
Studies will be completed in the next seven years and be directed by a full-time wildlife biologist (GS-10-11 or 12) with assistance from 3 or 4 seasonal staff (GS-5-6-7).
Much of habitat mapping will be completed under the vegetation section recommendations or ongoing aeiral photo interpretation efforts to track the spruce bark beetle infestation.
Habitat use studies will focus on species susceptible to disturbance and areas most vulnerable to high levels of use (i.e., recreation and management activities).
Methods used to identify and confirm habitat use and study sensitivity to disturbance may include track stations, scent stations, low-level aerial surveillance, and limited telemetry studies.
Studies will focus on areas in and around Hope first and then move outward into the upper two thirds of the watershed.
No equipment costs are included in this estimate.
It is expected that costs will be shared with other agencies including ADFG and the USFWS.
Habitat studies will include evaluation of timber management activities including thinning, selective cuts, and prescribed burns on wildlife habitat and use.
Reports will provide adaptive management recommendations for maintaining habitat capable of sustaining viable populations of management indicator species and other species of concern.
Habitat studies include 26 weeks of field work 40 hrs per week for 7 years plus 17.3 weeks of 40 hrs per week for 7 years for the wildlife biologist to complete reports.
Completion of habitat studies includes 4 weeks of 40 hrs per week for a GIS analyst for 7 years to support completion of the reports.
The wildlife biologist will manage the project and estimated costs include project management responsibilities.
All administrative assistance, aerial photos, copies, and logistical support for completing these studies are expected to be covered by existing regional budgets.

Resurrection Creek Landscape Analysis **Cultural Landscape Management Plan**

Option 1 - Moderate Alternative

		Task 1		Task 2		Total	
		Public Input, Research		Management Plan			
Staff/Item	***Rate***	***Person-hours***	***Cost***	***Person-hours***	***Cost***	***Person-hours***	***Cost***
Forest Service Staff	30	200	$6,000	600	$18,000	800	$24,000
			$0		$0	0	$0
			$0		$0	0	$0
			$0		$0	0	$0
			$0		$0	0	$0
			$0		$0	0	$0
			$0		$0	0	$0
			$0		$0	0	$0
			$0		$0	0	$0
			$0		$0	0	$0
		200	$6,000	600	$18,000	800	$24,000

Other costs		Units		Units			
Lodging + meals	$25		$0		$0	0	$0
Field supplies	$50		$0		$0	0	$0
Employee mileage	$0.350		$0		$0	0	$0
Printing	$100	1	$100	3	$300	4	$400
Construction/materials	$100		$0		$0	0	$0
Other	$10		$0		$0	0	$0
Total other direct costs			$100		$300	4	$400
Grand totals			$6,100		$18,300		$24,400

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Assumptions: 6 public meetings with two staffers for five hours

Resurrection Creek Landscape Analysis Cultural Landscape Management Plan

Option 1 - Intensive Alternative

		Task 1		Task 2		Task 3		Total	
		Public Input, research		Management Plan		Committee Operation			
Staff/Item	***Rate***	***Person-hours***	***Cost***	***Person-hours***	***Cost***	***Person-hours***	***Cost***	***Person-hours***	***Cost***
Forest Service Staff	30	200	$6,000	600	$18,000	150	$4,500	950	$28,500
			$0		$0		$0	0	$0
			$0		$0		$0	0	$0
			$0		$0		$0	0	$0
			$0		$0		$0	0	$0
			$0		$0		$0	0	$0
			$0		$0		$0	0	$0
			$0		$0		$0	0	$0
			$0		$0		$0	0	$0
			$0		$0		$0	0	$0
			$0		$0		$0	0	$0
			$0		$0		$0	0	$0
			$0		$0		$0	0	$0
			$0		$0		$0	0	$0
		200	$6,000	600	$18,000	150	$4,500	950	$28,500

Other costs		Units		Units		Units			
Lodging + meals	$25		$0		$0		$0	0	$0
Field supplies	$50		$0		$0		$0	0	$0
Employee mileage	$0.350		$0		$0		$0	0	$0
Printing	$100	1	$100	3	$300	4	$400	8	$800
Construction/materials	$100		$0		$0		$0	0	$0
Other	$10		$0		$0		$0	0	$0
Total other direct costs			$100		$300		$400	8	$800
Grand totals			$6,100		$18,300		$4,900		$29,300

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Assumptions:
- 6 public meetings with two staffers for five hours
- Committee meetings facilitated by one FS staffer
- Committee estimates for bi-weekly meetings for one year

Resurrection Creek Landscape Analysis **Recreation, Preserving Viewsheds**

Option 1 - Moderate Alternative

		Task 1		**Task 2**		**Total**	
		Evaluate Vistas		**Define Needs for Forest Plan**			
Staff/Item	***Rate***	***Person-hours***	***Cost***	***Person-hours***	***Cost***	***Person-hours***	***Cost***
Forest Service Staff	30	30	$900	20	$600	50	$1,500
			$0		$0	0	$0
			$0		$0	0	$0
			$0		$0	0	$0
			$0		$0	0	$0
			$0		$0	0	$0
			$0		$0	0	$0
			$0		$0	0	$0
			$0		$0	0	$0
			$0		$0	0	$0
			$0		$0	0	$0
		30	$900	20	$600	50	$1,500
Other costs		Units		Units			
Lodging + meals	$25		$0		$0	0	$0
Field supplies	$50		$0		$0	0	$0
Employee mileage	$0.350		$0		$0	0	$0
Printing	$100		$0		$0	0	$0
Construction/materials	$100		$0		$0	0	$0
Other	$10		$0		$0	0	$0
Total other direct costs			$0		$0	0	$0
Grand totals			$900		$600		$1,500

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Assumptions:

Resurrection Creek Landscape Analysis **Recreation, Identified Improvements**

		Task 1		Task 2		Total	
		Develop CIP		Update with current projects			
Staff/Item	***Rate***	***Person-hours***	***Cost***	***Person-hours***	***Cost***	***Person-hours***	***Cost***
Forest Service Staff	30	120	$3,600	80	$2,400	200	$6,000
			$0		$0	0	$0
			$0		$0	0	$0
			$0		$0	0	$0
			$0		$0	0	$0
			$0		$0	0	$0
			$0		$0	0	$0
			$0		$0	0	$0
			$0		$0	0	$0
			$0		$0	0	$0
			$0		$0	0	$0
		120	$3,600	80	$2,400	200	$6,000
Other costs		Units		Units			
Lodging + meals	$25		$0		$0	0	$0
Field supplies	$50		$0		$0	0	$0
Employee mileage	$0.350		$0		$0	0	$0
Printing	$100		$0		$0	0	$0
Construction/materials	$100		$0		$0	0	$0
Other	$10		$0		$0	0	$0
Total other direct costs			$0		$0	0	$0
Grand totals			$3,600		$2,400		$6,000

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Assumptions:
- estimate is for initial document and updating in initial year.
- document should be updated on an ongoing basis
- does not include cost of project implementation; see Table 19

Resurrection Creek Landscape Analysis Recreation, Accessibility Recommendations

		Task 1		Task 2		Total	
		Evaluate Accessibility Needs		Update CIP			
Staff/Item	***Rate***	***Person-hours***	***Cost***	***Person-hours***	***Cost***	***Person-hours***	***Cost***
Forest Service Staff	30	30	$900	20	$600	50	$1,500
			$0		$0	0	$0
			$0		$0	0	$0
			$0		$0	0	$0
			$0		$0	0	$0
			$0		$0	0	$0
			$0		$0	0	$0
			$0		$0	0	$0
			$0		$0	0	$0
			$0		$0	0	$0
		30	$900	20	$600	50	$1,500
Other costs		Units		Units			
Lodging + meals	$25		$0		$0	0	$0
Field supplies	$50		$0		$0	0	$0
Employee mileage	$0.350		$0		$0	0	$0
Printing	$100		$0		$0	0	$0
Construction/materials	$100		$0		$0	0	$0
Other	$10		$0		$0	0	$0
Total other direct costs			$0		$0	0	$0
Grand totals			$900		$600		$1,500

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Assumptions:

Resurrection Creek Landscape Analysis Recreation-level Panning, Dredging, and Sluicing Recommendations

Options 1 (Allow suction dredging) and 2 (Ban suction dredging)

		Task 1		Task 2		Task 3		Task 4		Task 5		Total	
		Registration Process/Amend Rules		Provide Enforcement		Design Signage		Construct Signage		Install Signage			
Staff/Item	***Rate***	***Person-hours***	***Cost***	***Person-hours***	***Cost***	***Person-hours***	***Cost***	***Person-hours***	***Cost***	***Person-hours***	***Cost***	***Person-hours***	***Cost***
Forest Service Staff	30	80	$2,400		$0	5	$150		$0	10	$300	95	$2,850
Forest Service Ranger	27.4		$0	600	$16,440		$0		$0		$0	600	$16,440
Forest Service Technician	18		$0		$0		$0		$0	30	$540	30	$540
Construction Contractor	60		$0		$0	20	$1,200	10	$600		$0	30	$1,800
			$0		$0		$0		$0		$0	0	$0
			$0		$0		$0		$0		$0	0	$0
			$0		$0		$0		$0		$0	0	$0
		80	$2,400	600	$16,440	25	$1,350	10	$600	40	$840	755	$21,630

Other costs		Units		Units		Units		Units		Units			
Lodging + meals	$25		$0		$0		$0		$0		$0	0	$0
Field supplies	$50		$0		$0		$0		$0		$0	0	$0
Employee mileage	$0.350		$0		$0		$0		$0	200	$70	200	$70
Copies	$100	3	$300		$0		$0		$0		$0	3	$300
Construction/materials	$100		$0		$0		$0	10	$1,000	1	$100	11	$1,100
Other	$10		$0		$0		$0		$0		$0	0	$0
Total other direct costs			$300		$0		$0		$1,000		$170	214	$1,470
Grand totals			$2,700		$16,440		$1,350		$1,600		$1,010		$23,100

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Assumptions: sign construction is contracted
enforcement figure is annual

Resurrection Creek Landscape Analysis Subsistence Use Recommendations

Option 2 (Develop Reporting Process)

		Task 1		Task 2		Task 3		Total	
		Public Meetings		Design Reporting Process		Implement Reporting Process (annual)			
Staff/Item	***Rate***	***Person-hours***	***Cost***	***Person-hours***	***Cost***	***Person-hours***	***Cost***	***Person-hours***	***Cost***
Forest Service Staff	30	40	$1,200	80	$2,400	200	$6,000	320	$9,600
			$0		$0		$0	0	$0
			$0		$0		$0	0	$0
			$0		$0		$0	0	$0
			$0		$0		$0	0	$0
			$0		$0		$0	0	$0
			$0		$0		$0	0	$0
			$0		$0		$0	0	$0
			$0		$0		$0	0	$0
			$0		$0		$0	0	$0
			$0		$0		$0	0	$0
			$0		$0		$0	0	$0
			$0		$0		$0	0	$0
			$0		$0		$0	0	$0
		40	$1,200	80	$2,400	200	$6,000	320	$9,600
Other costs		Units		Units		Units			
Lodging + meals	$25		$0		$0		$0	0	$0
Field supplies	$50		$0		$0		$0	0	$0
Employee mileage	$0.350		$0		$0		$0	0	$0
Printing	$100		$0		$0	2	$200	2	$200
Construction/materials	$100		$0		$0		$0	0	$0
Other	$10		$0		$0		$0	0	$0
Total other direct costs			$0		$0		$200	2	$200
Grand totals			$1,200		$2,400		$6,200		$9,800

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Assumptions: implementation figure is annual
4 public meetings with two staffers for five hours

Resurrection Creek Landscape Analysis **Erosion Control Survey and Design Cost Estimate**

		Task 1		**Task 2**		**Task 3**		**Task 4**		**Total**	
		Review Maps, Literature		**Field Assessment**		**BMP Design**		**Report Writing**			
Staff/Item	***Rate***	***Person-hours***	***Cost***	***Person-hours***	***Cost***	***Person-hours***	***Cost***	***Person-hours***	***Cost***	***Person-hours***	***Cost***
Fisheries Biologist	30.0		$0		$0		$0		$0	0	$0
Geomorphologist/Hydrologist	101.0	8	$808	24	$2,423	20	$2,019	24	$2,423	76	$7,673
Hydraulic Engineer	101.0		$0		$0	4	$404		$0	4	$404
Wildlife Biologist	27.4		$0		$0		$0		$0	0	$0
Landscape Architect	30.0		$0		$0	4	$120		$0	4	$120
GIS Analyst	26.0		$0		$0		$0		$0	0	$0
Staff Technician	18.0		$0		$0		$0		$0	0	$0
Project Manager	28.0		$0		$0		$0		$0	0	$0
		8	$808	24	$2,423	28	$2,543	24	$2,423	84	$8,197
Other Costs											
Lodging + meals	$134		$0	3	$402		$0		$0	3	$402
Field supplies	$50		$0	1	$50		$0		$0	1	$50
Employee mileage	$0.350		$0	150	$53		$0		$0	150	$53
Copies	$100		$0		$0		$0		$0	0	$0
Other	$10		$0		$0		$0		$0	0	$0
Other	$10		$0		$0		$0		$0	0	$0
Total other direct costs			$0		$53		$0		$0		$53
Grand Totals			$808	$24	$2,476	$28	$2,543	$24	$2,423	$84	$8,249

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Resurrection Creek Landscape Analysis **Heritage Resources and Cultural Landscapes Management**

Option 1 Custodial Management

		Task 1		**Task 2**		**Task 3**		**Task 4**		**Task 5**		**Total**	
		Complete Inventory of Heritage Resources		**Assess and Maintain Historic Cabins**		**Maintain Management Partnerships**							
Staff/Item	***Rate***	***Person-hours***	***Cost***	***Person-hours***	***Cost***	***Person-hours***	***Cost***	***Person-hours***	***Cost***	***Person-hours***	***Cost***	***Person-hours***	***Cost***
Fisheries Biologist	30.0		$0		$0		$0		$0		$0	0	$0
Geomorphologist/Hydrologist[2]	101.0		$0		$0		$0		$0		$0	0	$0
Hydraulic Engineer	101.0		$0		$0		$0		$0		$0	0	$0
Wildlife Biologist	27.4		$0		$0		$0		$0		$0	0	$0
Landscape Architect	30.0		$0		$0		$0		$0		$0	0	$0
GIS analyst	26.0	50	$1,300		$0		$0		$0		$0	50	$1,300
Staff technician	18.0	300	$5,400	40	$720		$0		$0		$0	340	$6,120
Project Manager	28.0		$0		$0		$0		$0		$0	0	$0
Cultural Resources Specialist	27.4	450	$12,330	40	$1,096	35	$959		$0		$0	525	$14,385
Historic Architect	28.0		$0	16	$448		$0		$0		$0	16	$448
			$0		$0		$0		$0		$0	0	$0
			$0		$0		$0		$0		$0	0	$0
		800	$19,030	96	$2,264	35	$959	0	$0	0	$0	931	$22,253
Other costs													
Lodging + meals	$25		$0		$0		$0		$0		$0	0	$0
Field supplies	$50		$0		$0		$0		$0		$0	0	$0
Employee mileage	$0.350		$0		$0		$0		$0		$0	0	$0
Copies	$100		$0		$0		$0		$0		$0	0	$0
Other	$10		$0	700	$7,000		$0		$0		$0	700	$7,000
Other	$10		$0		$0		$0		$0		$0	0	$0
Total other direct costs			$0		$7,000		$0		$0		$0		$7,000
Grand totals			$19,030	$96	$9,264	$35	$959	$0	$0	$0	$0	$931	$29,253

Assumptions:

Cost is per year except as noted, for 40 years

Resurrection Creek Landscape Analysis

Heritage Resources and Cultural Landscapes Management

Option 2 Comprehensive Management

		Task 1		**Task 2**		**Task 3**		**Task 4**		**Task 5**		**Total**	
		Complete Inventory of Heritage Resources		**Assess, Rehabilitate**, and Maintain Historic Cabins**		**Maintain Management Partnerships**		**Develop Interpretive Signage and Walking Tour***					
Staff/Item	***Rate***	***Person-hours***	***Cost***	***Person-hours***	***Cost***	***Person-hours***	***Cost***	***Person-hours***	***Cost***	***Person-hours***	***Cost***	***Person-hours***	***Cost***
Fisheries Biologist	30.0		$0		$0		$0		$0		$0	0	$0
Geomorphologist/Hydrologist[2]	101.0		$0		$0		$0		$0		$0	0	$0
Hydraulic Engineer	101.0		$0		$0		$0		$0		$0	0	$0
Wildlife Biologist	27.4		$0		$0		$0		$0		$0	0	$0
Landscape Architect	30.0		$0		$0		$0		$0		$0	0	$0
GIS analyst	26.0	80	$2,080		$0		$0		$0		$0	80	$2,080
Staff technician	18.0	600	$10,800	60	$1,080		$0	80	$1,440		$0	740	$13,320
Project Manager	28.0		$0		$0		$0		$0		$0	0	$0
Cultural Resources Specialist	27.4	900	$24,660	80	$2,192	100	$2,740	200	$5,480		$0	1,280	$35,072
Historic Architect	28.0		$0	50	$1,400		$0		$0		$0	50	$1,400
			$0		$0		$0		$0		$0	0	$0
			$0		$0		$0		$0		$0	0	$0
		1,580	$37,540	190	$4,672	100	$2,740	280	$6,920	0	$0	2,150	$51,872
Other costs													
Lodging + meals	$25		$0		$0		$0		$0		$0	0	$0
Field supplies	$50		$0		$0		$0		$0		$0	0	$0
Employee mileage	$0.350		$0		$0		$0		$0		$0	0	$0
Copies	$100		$0		$0		$0		$0		$0	0	$0
Other	$10		$0	700	$7,000		$0	3,000	$30,000		$0	3,700	$37,000
Other	$10		$0		$0		$0		$0		$0	0	$0
Total other direct costs			$0		$7,000		$0		$30,000		$0		$37,000
Grand totals			$37,540	$190	$11,672	$100	$2,740	$280	$36,920	$0	$0	$2,150	$88,872

Assumptions:

Cost is per year except as noted, for 20 years

*One-time expenses

**costs unknown until actual assessment conducted

APPENDIX C

LAWS, EXECUTIVE ORDERS, AND PROGRAMMATIC AGREEMENTS THAT APPLY TO MANAGEMENT OF HERITAGE RESOURCES IN THE RESURRECTION CREEK WATERSHED ASSOCIATION

Management of heritage resources is governed by Federal legislation, primarily the National Historic Preservation Act (NHPA) of 1966 as amended in 2000, Executive Order 11593 of 1971, and the Archaeological Resources Protection Act (ARPA) of 1979. As allowed under the regulations for NHPA, Region 10 of the Forest Service has operated since 1995 under a Programmatic Agreement with the Alaska State Historic Preservation Officer (SHPO) and the National Advisory Council on Historic Preservation (ACHP), regarding compliance with NHPA section 106.

NHPA regulates survey for and inventory of heritage resources, under sections 110 and 106. Section 106 stipulates that "prior to the approval of the expenditure of any Federal funds on the [proposed Federal or federally assisted] undertaking, or prior to the issuance of any license…take into account the effect of the undertaking on any district, site, building, structure, or object that is included in or eligible for inclusion in the National Register" (16 U.S.C. 470f). Section 110 stipulates that Federal agencies "use, to the maximum extent feasible, historic properties available to the agency," "establish a program to locate, inventory, and nominate…all properties…that appear to qualify for inclusion on the National Register," "undertake…any preservation, as may be necessary to carry out this section," "exercise caution to assure that any such property that might qualify for inclusion [for the National Register of Historic Places] is not inadvertently transferred, sold, demolished, substantially altered, or allowed to deteriorate significantly" (16 U.S.C. 470h-2).

Executive Order 11593 was created to further "the purposes and policies of the National Environmental Policy Act of 1969 (83 Stat. 852, 42 U.S.C. 4321 et seq.), the NHPA of 1966 (80 Stat. 915, 16 U.S.C. 470 et seq.), the Historic Sites Act of 1935 (49 Stat. 666, 16 U.S.C. 461 et seq.), and the Antiquities Act of 1906 (34 Stat. 225, 16 U.S.C. 431 et seq.)" (36 FR 8971). It reiterates the requirements of the above laws to (1) administer the cultural properties under their control in a spirit of stewardship and trusteeship for future generations; (2) initiate measures necessary to direct their policies, plans, and programs in such a way that federally owned sites, structures, and objects of historical, architectural, or archaeological significance are preserved, restored, and maintained for the inspiration and benefit of the people; and (3) in consultation with the ACHP (16 U.S.C. 470i), institute procedures to assure that Federal plans and programs contribute to the preservation and enhancement of non-federally owned sites, structures, and objects of historical, architectural, or archaeological significance.

ARPA's purpose "is to secure, for the present and future benefit of the American people, the protection of archaeological resources and sites which are on public lands and Indian lands" (16 U.S.C. 1b 470aa). This law provides for criminal prosecution of people who undertake "unauthorized excavation, removal, damage, alteration, or defacement of archaeological resources" or traffic "in archaeological resources the excavation or removal of which was wrongful under Federal [State or local] law" (16 U.S.C. 1b 470ee).

The "Region 10 Programmatic Agreement with the SHPO and the ACHP, regarding compliance with NHPA section 106" addresses the 36 CFR 800 review process, and allows some modifications which slightly streamline the process of inventory, documentation, evaluation, and reporting (ultimately to Congress). It deals only with NHPA section 106, and does not address any of the USFS's responsibilities under other sections of this law, especially Section 110, which deals with inventories, historic building and property preservation and maintenance, among other things. Although the 1995 Programmatic Agreement expired at the end of September 1999, the Region is still using the agreement, by tacit agreement with the SHPO, until the new draft agreement is signed. The Programmatic Agreement <u>does not eliminate the need for the USFS to conduct surveys to identify heritage resources in project areas</u>, *unless* the area in question meets one of eight technically defined undertakings that are identified as having "little potential to affect historic properties."