East Copper River Delta Landscape Assessment
Cordova Ranger District
Chugach National Forest

07/28/2004

Looking north across the Martin River valley and the confluence of the Martin and Copper Rivers towards Goat Mountain and Childs Glacier. August 2003.

Team:
Susan Kesti - Team Leader, writer-editor, vegetation, socio-economic
Milo Burcham – Wildlife resources, Subsistence
Bruce Campbell – Lands, Special Uses
Rob DeVelice – Succession, Ecology
Carol Huber – Minerals, Geology, Mining
Tim Joyce – Fish subsistence
Dirk Lang – Fisheries
Bill MacFarlane – Hydrology, Water Quality
Dixon Sherman – Recreation
Ricardo Velarde – Soils, Geology
Linda Yarborough – Heritage Resources

Table of Contents

List of Figures

List of Tables

Executive Summary

The East Copper River Delta Landscape Assessment is an ecosystem analysis at the landscape scale that involves both information gathering and analysis. The purpose is to document and develop an understanding of the processes and interactions occurring in the area east of the Copper River, from the Wernicke River drainage south to Kayak Island drainage. The analysis covers 1,008,020 acres of land and fresh water. This acreage does not include 749,290 acres of saltwater within the analysis boundary.

Figure 1 – Looking up Martin River Valley

This report focuses on the issues and key questions identified for this area and describes it in terms of its biological, physical, and social features. Information includes disturbance regimes, soils, hydrology, geology, minerals, vegetative patterns and distribution, fish and wildlife species and their habitats, and human use patterns including cultural resources, subsistence, and recreation. Individual resource reports are available for more information.

Landscape analyses are a step between a forest plan and project implementation. They provide a means of refining desired condition of the landscape given the goals and objectives, management prescriptions, and standards and guidelines from the Forest Plan, current policy, and other applicable State and Federal regulations. They provide an opportunity to brainstorm monitoring and inventory needs and projects to help us reach the desired future condition. The end result is not a decision document but a report that can be used in future site-specific analyses and planning.

A team of resource specialists from the Chugach National Forest Cordova Ranger District and Supervisor's Office prepared this assessment. During the analysis, input from other Federal and State Agencies, City of Cordova, local Tribal Governments and landowners was solicited.

Chapter 1 – Introduction

Purpose

The purpose of this landscape scale ecosystem analysis is to develop and document an understanding of the processes and interactions occurring in the analysis area and determine how we can achieve our desired future condition described in the revised Chugach Forest Land and Resource Management Plan (Forest Plan) and Record of Decision (ROD) signed in May 2002. The East Copper River Delta (East Delta) analysis area includes the watershed associations that comprise the easternmost portion of the Cordova Ranger District of the Chugach National Forest. It includes the Wernicke River watershed south to Kayak Island (Figure 1.1).

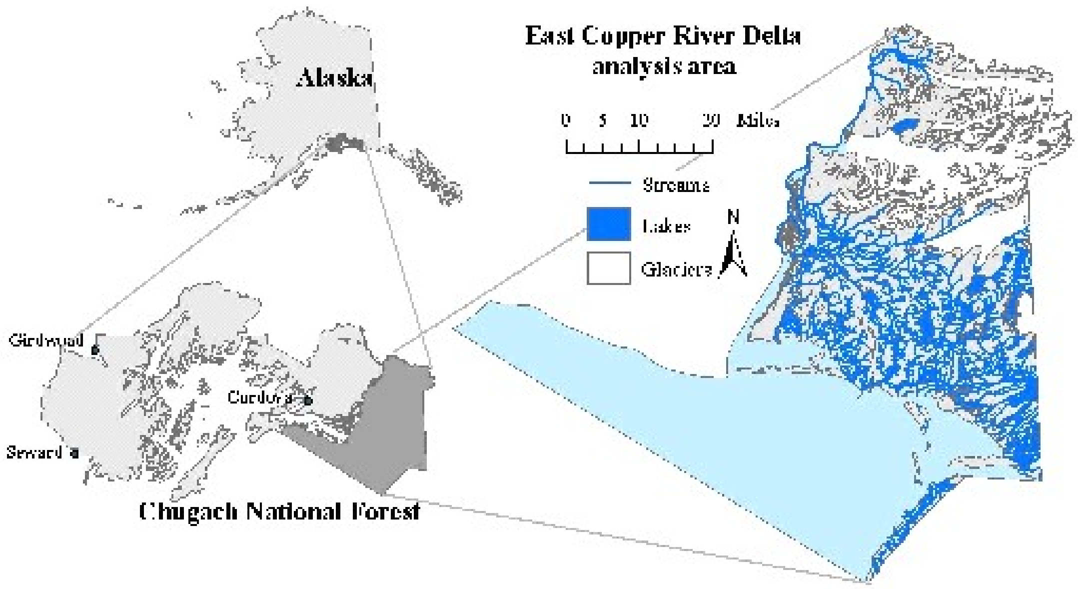


Figure 1.1-Location of the East Copper River Delta analysis area.

The Analysis Area

The 1,757,311 acre analysis area covers a large undeveloped area located 30 miles east of Cordova Alaska of which 1,008,020 acres (1,575 square miles) is land and fresh water. The analysis area is bounded by the Copper River on the west, Wrangell St. Elias National Park and Wilderness on the north, Bering Glacier and Bureau of Land Management lands on the east, the Suckling Hills and State of Alaska lands on the southeast, and the Gulf of Alaska on the south. The area is characterized by wide expanses of deltaic deposits from the glacially influenced Copper, Bering, and Martin Rivers, as well as offshore islands, coastal foothills, high peaks, and heavily glaciated valleys of the Chugach Range. Glaciers cover about 275,000 acres or 27% of the analysis area (Fig 1.2). Abundant precipitation and large glaciers are the driving forces behind the geomorphic and hydrologic processes in this area. Several large glacial and non-glacial lakes cover about 3.3% or 33,400 acres of the analysis area. The Copper River drains the heavily glaciated Copper River basin of Interior Alaska.

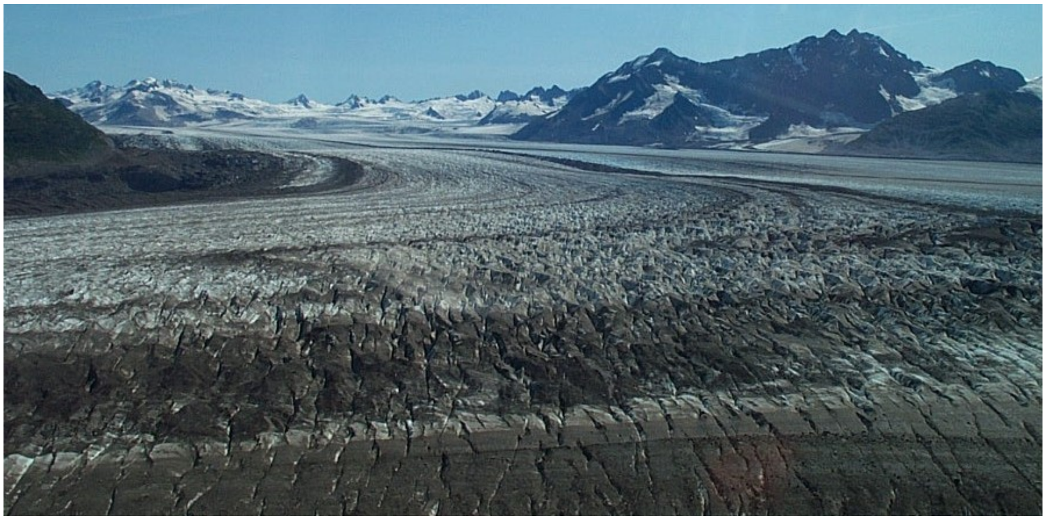


Figure 1.2- Looking east up Miles Glacier

The majority of the East Delta analysis area is relatively inaccessible except by boat or aircraft. However, people use the area to hunt, fish, trap, snowmachine, crosscountry ski, beachcomb, camp, kayak, canoe, raft, boat, pick berries, view wildlife and glaciers, picnic, sightsee, hike, explore, and stay at the remote cabins. There are private inholdings and active oil and gas leases. The Copper River Delta has abundant wildlife, such as bears, moose, goats, beavers, waterfowl, trumpeter swans, songbirds, eagles, and shorebirds. The Copper River bisects the Chugach Mountains and carries very high sediment loads, draining an immense area of interior Alaska including portions of the Wrangell Mountains, the Alaska Range, the Talkeetna Range, and the Saint Elias Range. The Miles Glacier and the Martin, Katalla, and Bering rivers also shape the analysis area.

The Copper River supports the largest salmon fishery in central Alaska. Five salmon species and two species of char use the river. The world famous Copper River sockeye salmon have a global market. Fresh water fish are also abundant and include Dolly Varden, rainbow trout, arctic grayling, eulachon, burbot, lake trout, and cutthroat trout (Christensen and Mastrantonio 1999).

Figure 1.3 displays the various landowners of the area and Table 1.1 summarizes the acreage for each. Approximately 90% of the analysis area is National Forest System land, including the Katalla exchange area and lands selected but not conveyed. There are a number of small private inholdings in the analysis area. Information about current owners is limited and not current. The East Delta Minerals Resource Report provides information compiled by the Chugach National Forest lands department about these inholdings

Table 1.1-Summary of land ownership

Ownership	Acres	% of land area
National Forest (USFS)	455,950	46.4
National Forest – ANILCA Addition	358,187	36.4
State of Alaska	3,681	0.3
Selected by the State	1,386	0.1
Eyak Native Corporation	21322	2.2
Selected by Eyak Corp.	5118	0.5
Chugach Alaska Corporation (CAC)	47,038	4.8
USFS Surface, CAC - Subsurface	13,340	1.4
Chugach Alaska Corporation – Oil & Gas	10,634	1.1
Selected by CAC	7,775	0.8
Katalla Exchange Area	56,405	5.7
Private	2,004	0.2
Total (land only)	**982,820**	100
Fresh Water	25,182	~
Salt Water	749,292	~

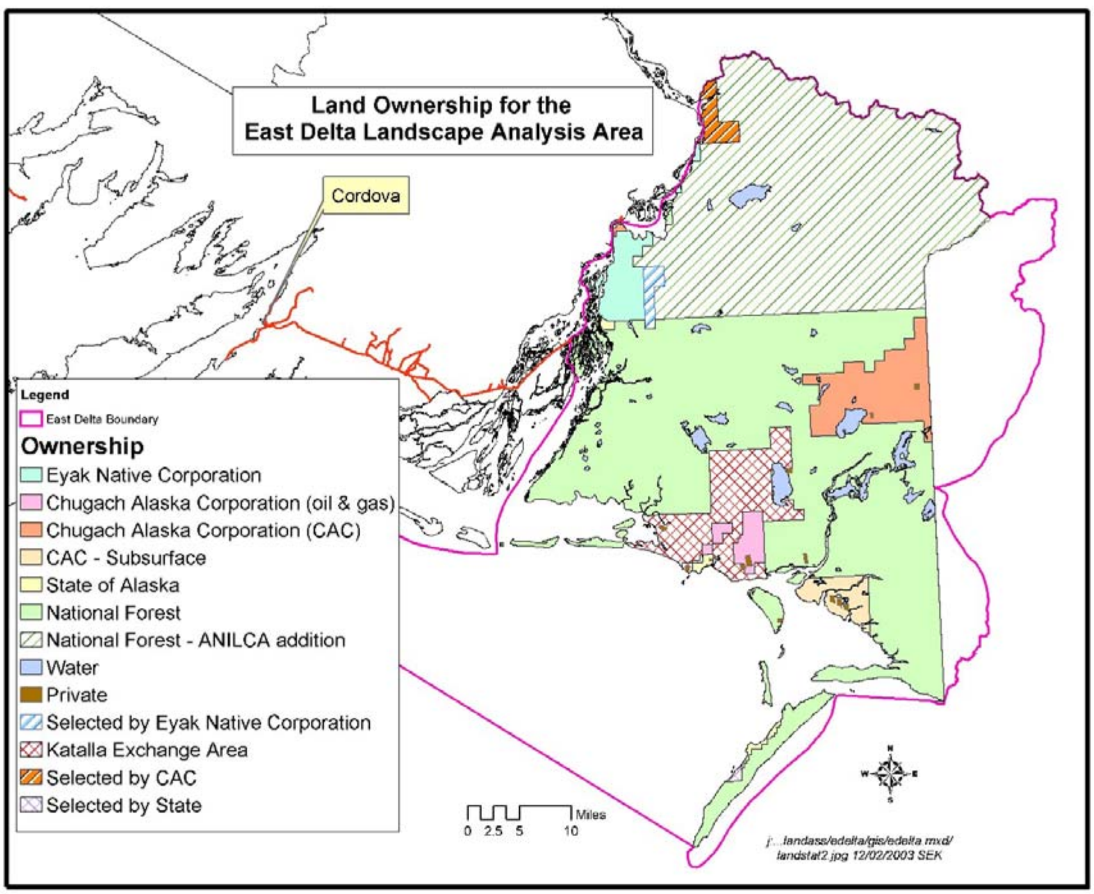


Figure 1.3- Landownership patterns for the East Delta analysis area

The Copper River Highway provides access along the northeastern edge of the analysis area. The portion of the highway from Mile 37 to the Million Dollar Bridge at Mile 48 lies within the analysis area. Future road access may be provided into the upper Martin River valley if Chugach Alaska Corporation builds the Carbon Mountain road.

Legislative History

The Alaska National Interest Lands Conservation Act of 1980 (ANILCA) includes specific language in Section 501(b) pertaining to the management of the Copper River Delta. It states:

> "...That the conservation of fish and wildlife and their habitat shall be the primary purpose for the management of the Copper/Rude River Addition and the Copper-Bering River portions of the existing Chugach National Forest ... Provided, that the taking of fish and wildlife shall be permitted within the zones established by this subsection pursuant to the provisions of this Act and other applicable State and Federal law. Multiple use activities shall be permitted in a manner consistent with the conservation of fish and wildlife and their habitat..."

Due to its exceptional nature in terms of wildlife and fisheries habitat, the Copper River Delta has continued to hold people's interest at the local, state and national level. The State designated the Delta as a Critical Habitat Area ((AS16.20.230 (11)). In 1990, the Copper River Delta was included in the Western Hemisphere Shorebird Reserve Network by a Memorandum of Understanding (MOU) signed by the Forest Service, US Fish and Wildlife Service, Chugach Alaska Corporation, Eyak Native Corporation, and the City of Cordova. All parties recognized the international importance of the Copper River Delta to migratory shorebirds. In 1991, final rule 36 CFR 241 was issued pertaining to the conservation of fish and wildlife and their habitat. It reemphasized that the federally – owned lands were to be managed for multiple use in a manner consistent with the primary management goal of conserving fish and wildlife and their habitats.

Desired Future Condition

Chugach Land and Resource Management Plan direction

The Chugach Forest Land and Resource Management Plan (Forest Plan) was revised and the Record of Decision (ROD) signed in May 2002. It outlines Forest-wide direction, goals and objectives, and standards and guidelines in Chapter 3. Chapter 4 describes each prescription's theme and management intent with regards to the desired future condition for ecological and social systems and displays allowed activities, standards, and guidelines for each prescription.

The management prescriptions for this analysis area include ANILCA 501(b)-1, 2, and 3 which are described on pages 4-25 through 29, 4-37 through 39, and 4-75 through 78 of the revised Forest Plan. All of these prescriptions emphasize fish and wildlife habitat conservation, but differ in the extent to which other activities, primarily recreation, resource development, and access, are allowed. As shown in Figure 1.4, the area north of the Martin River valley and the Carbon Mountain road easement has the 501(b)-2 prescription. The Carbon Mountain road easement and ¼ mile either side has been assigned the 501(b)-3 prescription to provide for uses associated with road access. The

501(b) – 1 prescription is applied to the majority of the area south of the Carbon Mountain Road easement. The 501(b)-1 prescription is slightly more restrictive than the 501(b)-2 prescription in that it limits new developed recreation facilities and prohibits commercial forest product uses. As described on page 12 of the ROD, under 501(b)-1 prescription, reasonable access to private lands as defined in ANILCA, sec 1323(a) will be allowed. Reasonable access, for conducting mineral operations, including roads, will be approved under a plan of operations (USDA 2002a). With regards to minerals resources, all three prescriptions allow salable and locatable activities consistent with the management intent, standards, and guidelines. The activities tables do not mention leasable activities (Forest Plan, pg 4-26, 38, 75).

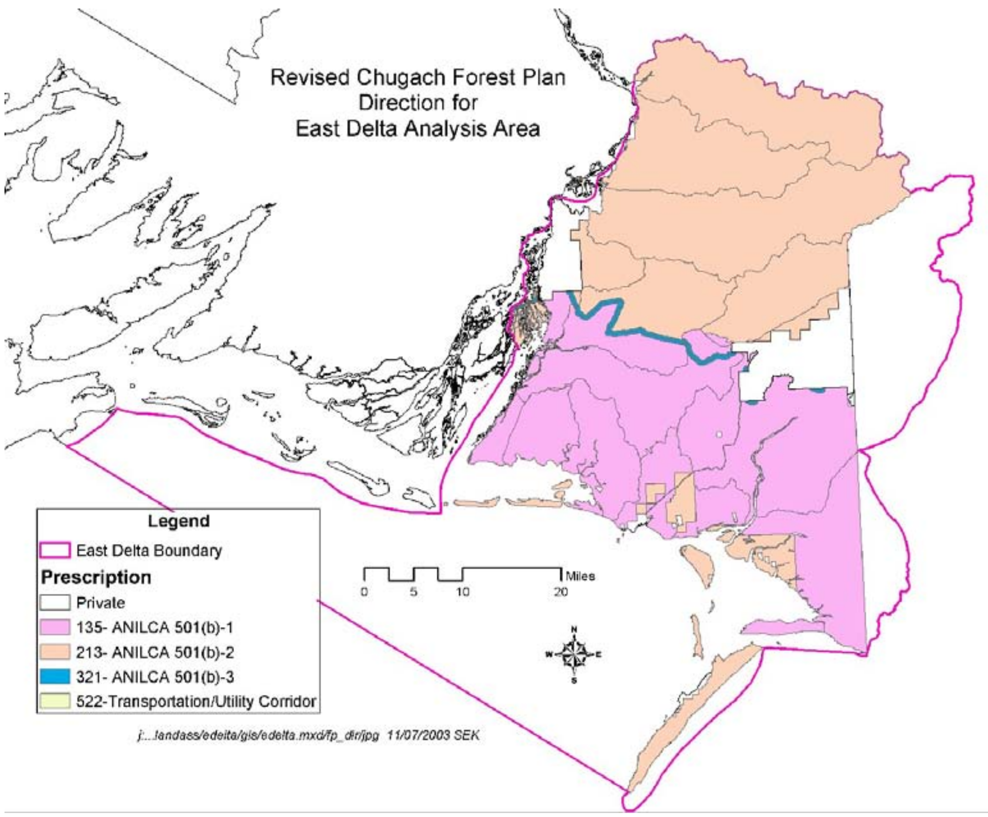


Figure 1.4-Forest Plan Direction for the East Delta Analysis Area

The management prescriptions for the area are consistent with the terms and conditions of the 1982 Chugach Settlement Agreement (also known as the 1982 CNI[1] Settlement Agreement) and allow Chugach Alaska Corporation to exercise their rights to manage their lands, access their landholdings, conduct exploration, and develop their oil and gas rights (ROD pg 13)**.** A road from Carbon Mountain to Katalla is identified in the Forest Plan to reflect this agreement. As stated on page 10 of the ROD, once the routes are identified as described in paragraph 8(A)(2) of the Settlement Agreement, the 501(b)-3 prescription shall be applied to the proposed routes and to ¼ mile on either side of the

[1] Chugach Natives Incorporate is now known as Chugach Alaska Corporation.

routes. Once an easement is granted, the selected route and ¼ mile either side will be assigned the 501(b)-3 prescription. The routes not selected for use will revert back to the original prescription. Also, if an oil or gas well capable of producing in paying quantities is completed as per paragraph 6 of the Settlement Agreement, then the 521 Minerals Prescription will immediately be applied to the Katalla Exchange Preference Area as identified in paragraph 7 of the Settlement Agreement (ROD page 12).

The types of allowed summer and winter motorized use vary by area and are displayed in Figures 1.5 and 1.6. In the summer, most of the analysis area is closed to motorized use except for subsistence. The barrier islands and Softuk Bar are open for summer motorized use on nonvegetated areas only. The area north of the Carbon Mountain Road easement is open in the winter to all motorized use, which includes snow machines, helicopters, and other craft. Winter is defined as December 1 through April 30. The area south of the Carbon Mountain Road Easement has a variety of restrictions. Portions are open to snow machines only, some areas are closed except for subsistence and others are open to all. Refer to Figure 1.5 for details.

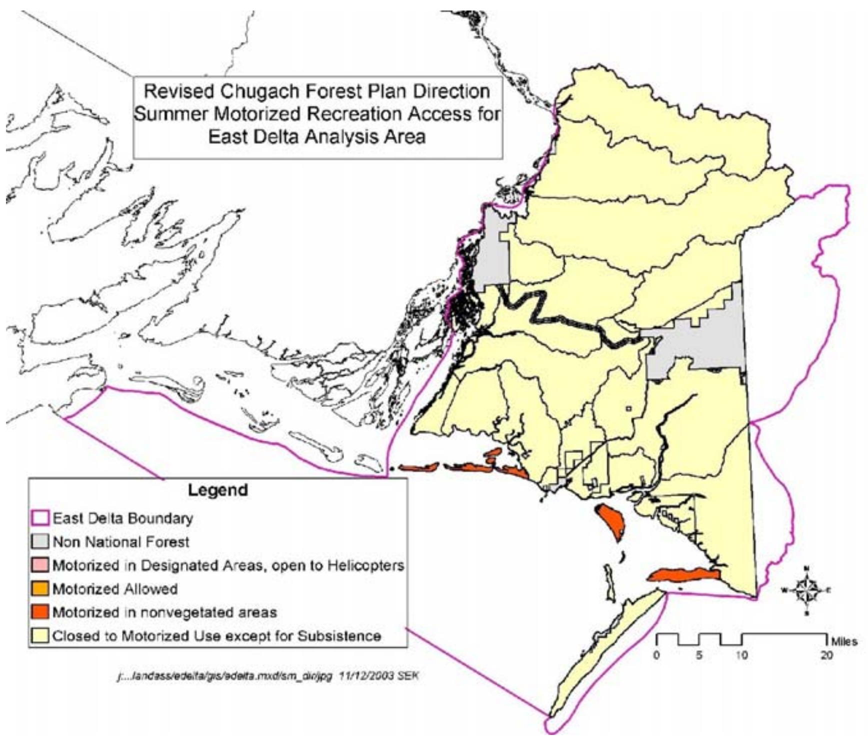


Figure 1.5-Summer motorized recreation access

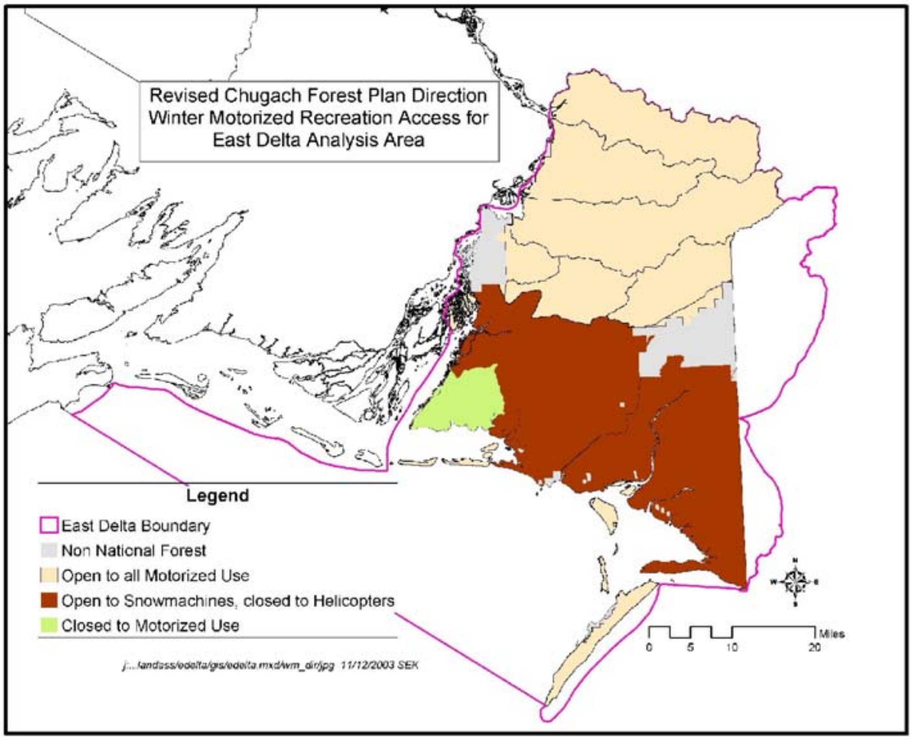


Figure 1.6-Winter motorized recreation access

Figure 1.7-Winter in the Martin River Valley, looking towards Martin Glacier (Feb 2004)

The desired future condition for fisheries and wildlife resources is that stream and wildlife habitat conditions remain in a natural, un-altered state, and ecosystem health is sustained across the entire analysis area. It is desired that keystone species in this ecosystem, such as Pacific salmon, (Willson and Halupka 1995; Willson et al. 1998; Cederholm et al. 1999), be maintained at or above the levels documented in this analysis.

Human harvest of fish and wildlife populations and human disturbance of these resources and their habitat should be managed to ensure the continued viability of all species.

It is desired that the road, timber, oil, and gas developments in the analysis area be done in a manner that minimizes impacts to fisheries and wildlife resources. It is desired that commercial fishing and hatchery production not compromise the long term sustainability of salmon populations. Human induced impacts can reduce the potential full range of habitat variability of streams (Ebersole et. al. 1999). Recent management objectives at the landscape scale have stressed the importance of maintaining a historical range of natural variability (Swanson et al. 1994; Kaufmann et al. 1994). Increased visitation of the area for fishing, hunting, hiking, wildlife viewing, solitude, or other reasons, is likely in the future and impacts of these human uses will need to be monitored and mitigated if necessary.

Under the current Chugach Forest land management plan, there is little reason to believe human related impacts will inhibit fisheries or wildlife resources from expressing their full range of variability. Most of the analysis area will remain as a large, pristine roadless area. The primary management goals for this area are for the conservation of fish and wildlife and their habitats as required by Section 501(b) of ANILCA (USDA Forest Service 2002b). The area has a high degree of natural integrity with most long-term ecological processes intact. The area has high scenic value and provides the opportunity for recreation in a primitive and remote setting with plenty of solitude (USDA Forest Service 2002b).

It is desired that Atlantic salmon will not establish breeding populations in the freshwaters of the analysis area. An aggressive approach will be taken toward the prevention and extirpation of exotic Atlantic salmon.

Large-scale natural processes (earthquake, uplift and subsidence, glacial lake outburst flooding, etc) will continue to influence fish and wildlife resources in the analysis area. The Bering and Martin Lakes may shrink due to sedimentation from periodic outburst floods and subsequent down cutting of the outlet streams. As a result, lake rearing habitat may decrease. However, the same natural process and others such as floods, channel migration, and glacial retreat will also create new habitat for fish to exploit. The current management prescription strives to maintain these natural processes that benefit the diversity of fish and wildlife habitat currently present.

Chapter 2 – Analysis Area Description

Physical Characteristics

The analysis area includes a variety of glacial and non-glacial watersheds draining west into the Copper River and south into the Gulf of Alaska (Fig 2.1). Watersheds were delineated to the 5th and 6th-levels following national standards (Federal Geographic Data Committee 2002). Much of the northern half of the analysis area lies within the heavily glaciated Wernicke (Fig 2.2), Miles, Copper River, and Central Copper River watersheds, rising to a maximum elevation of about 11,100 feet. The Copper River Delta watershed drains the Copper River as well as many glacial and nonglacial watersheds surrounding the Delta. The Martin River and North Bering River watersheds drain high peaks of the Chugach Range, as well as the foothills. The expansive Bering Glacier, just east of the National Forest boundary, drains west into the South Bering River watershed and south into numerous channels in the Bering Glacier Drainage watershed. The Controller Bay watershed includes Kayak, Wingham, and Kanak Islands, Okalee Spit, and tidal areas and the low foothills of the Katalla River subwatershed (Fig 2.3). The Copper River Islands watershed includes the barrier islands at the mouth of the Copper River.

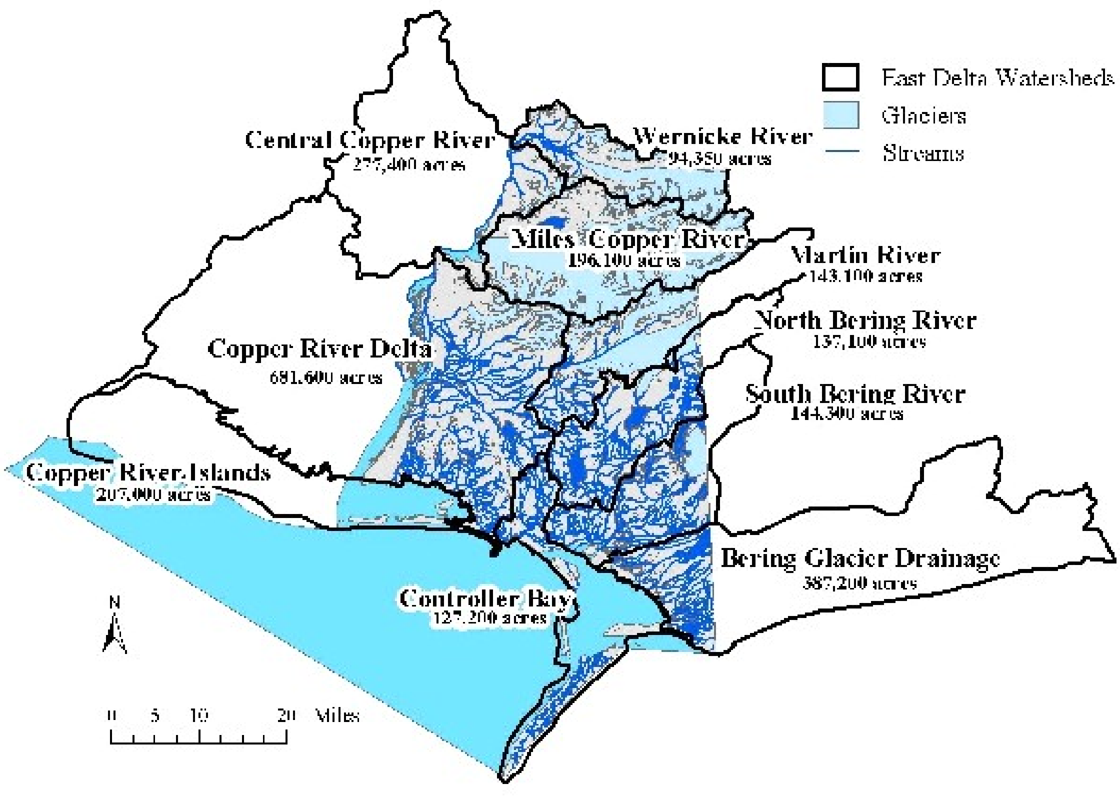


Figure 2.1-Watersheds of the East Delta analysis area.

Figure 2.2 Wernecke River Drainage August 2003

Figure 2.3 – Kwintala and Campbell Rivers Area of Bering Glacier Drainage. August 2003

Climate

The East Delta analysis area has a maritime climate with mild temperatures and heavy precipitation. Conditions vary considerably with elevation and location. Weather records are available for the Cordova Airport (about 18 miles west of the analysis area), Cape Yakataga (about 50 miles east of the analysis area), and Cape Saint Elias on the southern tip of Kayak Island (Western Regional Climate Center 2003) (Table 2.1). Weather data are not available for the high elevations of the analysis area.

Average annual daily temperatures are about 42^{o} F on the southern point of Kayak Island, decreasing to about 39^{o} F at the Cordova Airport. The Gulf of Alaska moderates temperatures along the coast, resulting in warmer minimum winter temperatures and cooler maximum summer temperatures than inland areas. Temperatures decrease dramatically with increasing elevation.

Low pressure storms generally circulate counterclockwise in the Gulf of Alaska, and weather and winds in the East Copper River Delta generally come from the southeast. Precipitation increases dramatically with elevation, as the Chugach Mountains capture moisture from these storms. Mean annual precipitation ranges from about 80 to 90 inches along the coast and up the Copper River to over 200 inches at the highest elevations on the glaciers (Fig 2.4). The heaviest rainfall generally occurs in the late summer and fall, and the lowest precipitation occurs in the spring and summer.

Snow falls at all elevations between mid-October and mid-May, although rain can occur at any time of the year. The low elevation areas of the analysis area receive about 85 to 120 inches of snow annually, with maximum snowpacks generally less than 1 foot deep. Snowfall and snowpack increase dramatically with elevation; the percentage of precipitation falling as snow increases from about 15% on the lowlands to about 60% at elevations above 4000 feet.

The Chugach Range provides a barrier between the Copper River Basin of interior Alaska and the Gulf of Alaska. The Copper River Canyon is the only gap in this barrier. Because of the strong pressure gradient that commonly forms in the winter between the low pressure in the Gulf of Alaska and high pressure in the interior, strong downriver winds are common, often reaching sustained velocities of 60 miles per hour and gusts of over 120 miles per hour (Thilenius 1990). These cold winds create a microclimate along the Copper River affecting temperatures, snowpacks, and vegetation, and causing sand dunes to form. Strong winds from the Gulf of Alaska are also common in this area.

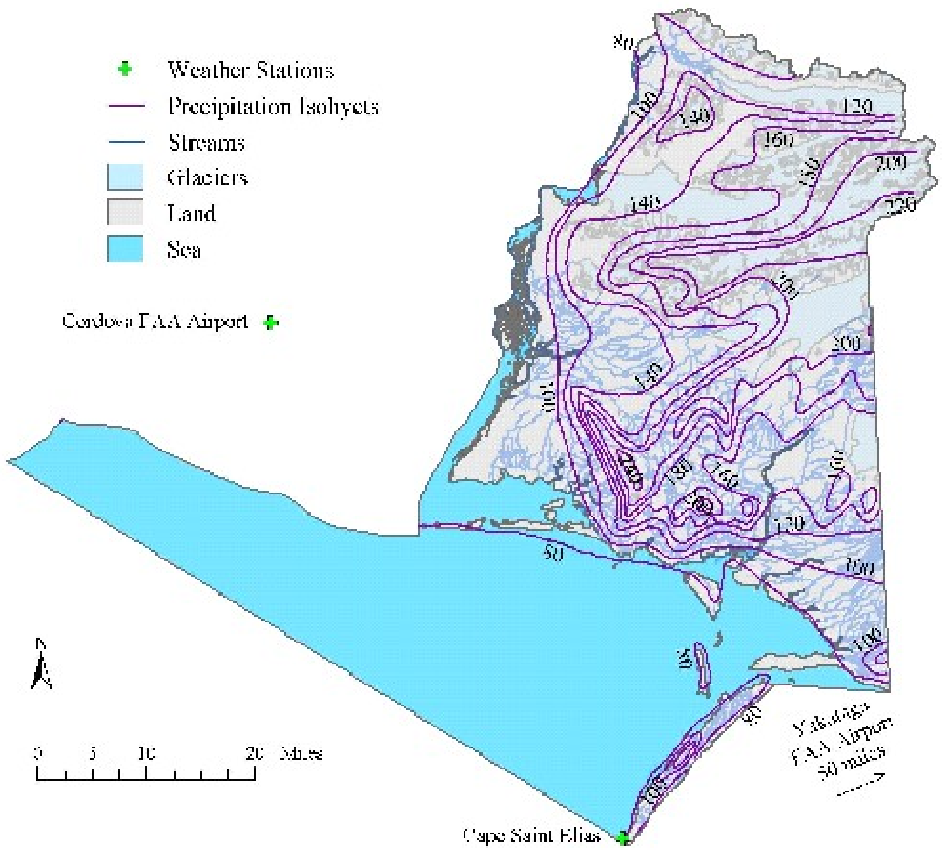


Figure 2.4-Weather stations and mean annual precipitation, in inches, for the analysis area. Data from USDA FS (1997).

Table 2.1-Climate statistics for weather stations in and near the East Delta analysis area. Data from Western Regional Climate Center (2003).

		Cordova FAA Airport, AK	Cape Saint Elias, AK	Yakataga FAA Airport, AK
Location	Station Number	502177	501321	509930
	Elevation (ft)	40	50	30
	Latitude	60º 30'	59º 48'	60º 05'
	Longitude	145º 30'	144º 36'	142º 30'
	Number of years of data	51	25	34
Temp	Average daily temperature (ºF)	38.5	41.8	39.8
	Average max July temperature (ºF)	61.4	57.7	58.3
	Average min January temperature (ºF)	15.2	27.4	21.1
Precip	Average annual precipitation (inches)	92.9	97.9	99.3
	Average annual snowfall (inches)	118.8	86.8	95.7
	Average March snow depth (inches)	11	4	8

Ecological Classification

Using the National Hierarchy of Ecological Units (ECOMAP 1993), the majority of the analysis area that is not icefields lies within the Northern Gulf Forelands Ecological

Section as described and mapped by Davidson (1996). The analysis area includes the Tasnuna River, St. Elias Icefields, Copper River, Copper River Delta, and Prince William Sound Islands Ecological Subsections (Fig 2.5). The salt water beyond the barrier islands is coded as Prince William Sound Islands. The Copper River Delta subsection consists of recent, relatively flat, outwash alluvial sediments associated with periodic flooding from outburst lakes and periods of heavy precipitation. Many spits, barrier islands, sand bars, and tidal flats are present and constantly changing due to isostatic rebound, wave action, floods, and tectonic uplift. The seaward portion of the area consists of tidal marshes and uplifted marine tidal sediments and ponds (which were raised above tidal influence by the 1964 Great Alaska Earthquake). The landward portion of the area consists of alluvial outwash deposits. The numerous sand bars and barrier islands seaward protect the mainland.

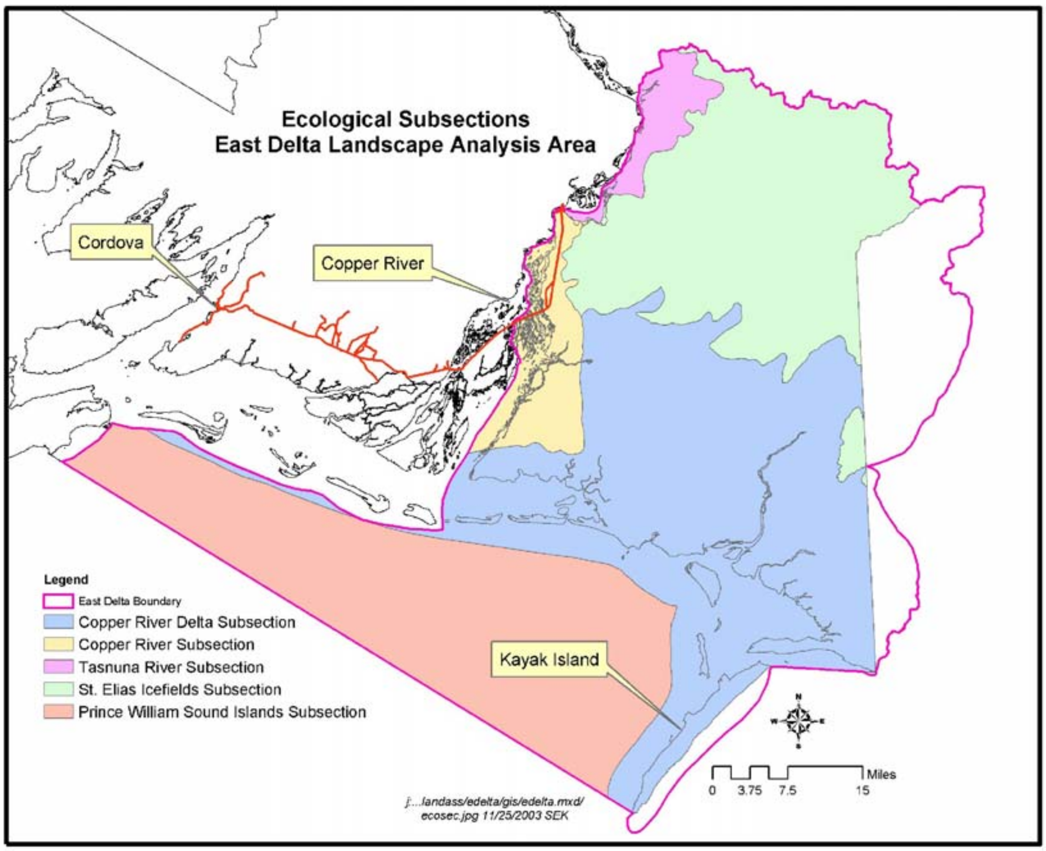


Figure 2.5-Ecological subsections present in the East Delta analysis area

The Copper River Subsection of the Northern Gulf Forelands Section is directly east of the Copper River Delta Subsection and includes the lowlands and sideslopes of the Copper River floodplain. The climate is transitional between maritime and continental. The abrupt line separating these subsections is partially the result of the Copper River Canyon influences on climatic factors. The Copper River Subsection features islands, sand dunes, and lowlands directly affected by the river. The landscape is very dynamic with changing river courses and strong winds flowing out of the interior of Alaska (driven by the atmospheric pressure gradient from the interior to the Gulf of Alaska). The water and wind erosion and deposition are continuously changing the landscape.

The St Elias Icefields Subsection and the Tasnuna Subsection of the Kenai Mountains Section include the icefields, glaciers, and rugged mountains of the northern portion of the analysis area and is characterized by high precipitation and deep winter snowpacks.

Geomorphology

The Copper River Delta (the Delta) began forming about 9000 years ago, when a catastrophic flood drained the 2000 square mile glacially dammed Lake Atna in interior Alaska (Ferrians 1989). The sediment transported to the Gulf of Alaska began forming a large delta, which emerged above sea level about 2500 years later (Reimnitz 1966). With a current annual suspended sediment load of 69 million tons, the Delta continues to aggrade. Periodic tectonic uplift also causes it to enlarge. Although high rates of subsidence compensate for these high uplift and sedimentation rates, the net result is a seaward expansion of the Delta.

Much of the analysis area consists of large outwash plains from the large glacial rivers draining the Chugach Mountains. Aggradation of these outwash plains has also contributed to expansion of the Delta. Martin, Little Martin, Tokun, and Bering Lakes were formed as the outwash from the Martin and Bering Rivers dammed the mouths of these non-glacial tributary valleys. Strong winds and the abundance of sand and silt from these glacial sources allow for the creation of linear sand dunes at the mouth of the Copper River from Long Island to the Gulf of Alaska.

Counterclockwise tidal currents in the Gulf of Alaska push sediment from the outlets of the Bering and Copper Rivers to the west along the coastline. Longshore currents transport this sand and silt. Softuk Bar and Okalee Spit are located down current from the area where bedrock ridges protrude into the coast. Kanak Island, Strawberry Reef, and several barrier islands lie off the coast. Consisting of mostly sand, these landforms can change their configuration easily with currents, waves, and wind, although vegetation, where it persists, helps stabilize them. These features protect the coast of the Delta from wave action in the Gulf of Alaska. Extensive tidal flats exist north of the islands.

Landforms

Boggs (2000) recognized six major landscapes across the Copper River Delta: outwash plain, floodplain, linear dune, uplifted marsh, tidal marsh (or new marsh), and barrier island-spit-coastal dune. Floodplains occupy a relatively small portion of the Copper River Delta (Boggs 2000). Floodplains are areas where outwash deposits have been reworked by fluvial processes. The generalized geographic relationship of these landscapes (except for floodplain) and their general soil characteristics are depicted in Figure 2.6. As shown in this figure, prior to the 1964 earthquake, the area presently recognized as uplifted marsh was tidal marsh and the area presently recognized as tidal marsh was below the intertidal zone.

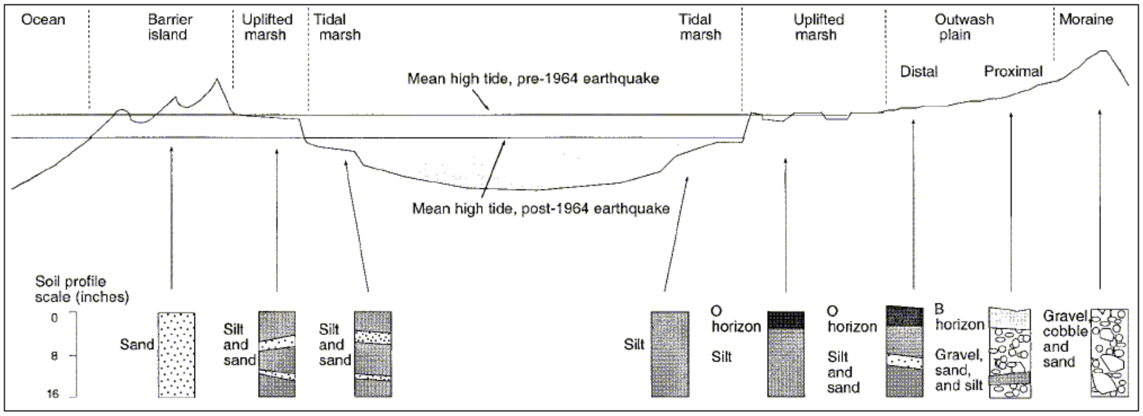


Figure 2.6-Idealized cross section of major landscapes and soil characteristics on the Copper River Delta (from Boggs 2000).

Landtype Associations

The Landtype Association (LTA) is a part of the National Hierarchal Framework that is used to delineate landscapes. Ecological units at this level are defined by the "geomorphic process and how it affects the topography, surficial geology, local climate, soils, and potential natural plants community patterns" (Davidson 1997). Forest watershed analysis or landscape analysis planning are typically done at this level of classification. They provide a simple method to delineate the landscape and provide guidance of limitations for implementing management activities or projects. Figure 2.7 displays the landtype associations present in the analysis area and Table 2.2 displays the acreages for each.

Table 2.2-Acres of each Landtype Association in the East Delta Analysis Area.

Landtype Association (Map Unit)	Acreage	Percent
Glaciers (00)	350,978	32.7
Mountain Summits (10)	106,578	9.9
Mountain Sideslopes (30)	126,156	11.8
Depositional Slopes (40)	3,662	0.3
Moraines (60)	19,672	1.8
Coastal (70)	143,360	13.4
Outwash (80)	234,770	21.9
Hills (90)	87,675	8.2
Totals	**1,072851**	**100**

The original version of the landtypes for the Copper River Delta are found in the *Copper River Delta Integrated Inventory, Map Units, Soils Descriptions, and Selected Tables* (compiled in June, 1992, presently unpublished). Descriptions of the characteristics and processes defining the landtype associations follow.

Glaciers - The glacier unit covers 350,978 acres of the analysis area and consists primarily of active glaciers, ice fields, and inclusions of rock. Soils development is minimal because of the relatively young age of any exposed surface.

Mountain Summits – This unit covers 106,578 acres of the analysis area. It is characterized by rocky terrain with intermittent ice and snow. The soil that does occur tends to be stony, weakly developed and shallow. Subtle changes in the soil profile and depth will occur as you move from concave to convex positions on the landscape.

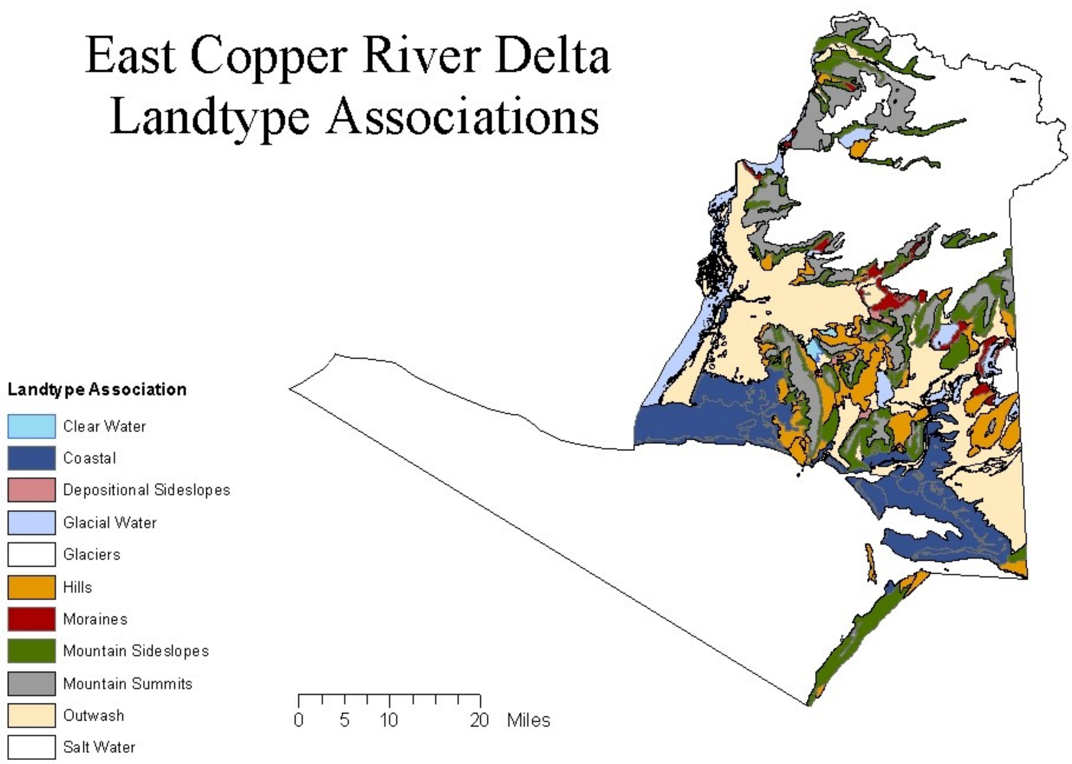


Figure 2.7-Landtype Associations in the East Delta analysis area. Information from Chugach National Forest Corporate GIS database

Mountain Sideslopes - The Mountain Sideslopes unit covers 126,156 acres of the analysis area. It is characterized by disturbance in the form of mass wasting and slope erosion. These soils formed from compact glacial till and the extent of pedogenesis is typically determined by slope position. The soils get deeper and more developed as you move from the higher, steeper, convex positions to the lower, gentler, concave positions down slope. Soils are typically medium textured and well drained. Areas that are not subject to continual erosion or deposition from material above will usually exhibit greater soil development and will support mature conifer forests.

Coastal - This unit covers 143,360 acres of the analysis area and consists of uplifted marshes, tidal flats, beaches and dunes. These landscapes are the result of marine processes such as tide fluctuations, wave action, and aeolian deposits.

The uplifted marshes which include pond fringes and slough levee complexes have been mapped as the Softuk-Alaganik soils association. The soils are deep and generally level with a few inclusions on steep slopes. They have silt loam textures throughout the profile and have up to 2-inches of organic materials on the surface consisting of litter and live roots.

The tidal flats are mapped as Eyak soils. These soils are deep, very poorly drained, and created from marine sediments of very fine sand, silt, and clay. They are nearly level, frequently flooded, deep and very poorly drained, with silt loam throughout the profile.

The beaches, both active and abandoned (or uplifted) are mapped as the Kokinhenik-cryopsamments-Katalla complex. The Kokinhenik soils are frequently flooded, have a texture of fine sand, and are deep and somewhat poorly to well-drained. The Cryopsamments are also frequently flooded, deep, and very poorly drained. They have a fine to coarse sand texture. The Katalla soils are deep and well-drained, but unlike the other two soils, they are rarely flooded and covered with a 2-inch layer of organic matter consisting of litter, moss, and roots.

The dunes are mapped as a variant of the Kokinhenik soils found on the beaches. The soils on these dunes tend to be on steeper slopes made up of wind-blown silt and fine sand. They are rarely flooded, deep, excessively drained, and have a 1-inch organic layer on the surface consisting of litter and moss. The soil profile has silt loam or fine loamy sand near the surface and turning into coarse sand with depth.

Depositional Slopes – This unit covers 3,662 acres of the analysis area. These soils are forming at the base of long sideslopes where sediments from higher slopes accumulate. Soils are usually, deep, coarse textured, and well drained, except where there is accumulation of subsurface runoff. Some of these soils consist of compact glacial till which produces more poorly drained soils because of a water-restricting layer. These more poorly drained soils are less productive for forests than other soils in the association. Slope gradient is usually less than 35%. Vegetation can range from lush grasses and herbaceous plants to old growth forests. The vegetation is strongly dependent on disturbance by avalanches.

Moraines - This unit covers 19,672 acres of the analysis area. It includes glacial depositional features such as esters, kettles, kames and moraines. In general, the soils tend to be poorly to well drained and are a mix of non sorted gravel, cobbles, and stones in a moderate to fine textured matrix. Drainage often depends on slope rather than soil permeability. Trees are normally found on the sideslopes and tops of moraines. Wetter vegetation is commonly found in the lower basins in between the moraines.

Outwash - This unit covers 234,770 acres of the analysis area. These soils are forming on active floodplains and on glacial outwash sediments that were laid down under high water energy. The Saddlebag-Tiedeman soil association is mapped on these units. These soils are somewhat well drained to excessively drained. They are usually gentle sloping with a 2 to 3 inch organic layer on the surface. The Saddlebag soils are rarely flooded and are deep and well drained. The upper 11 inches of the mineral soil are loamy fine sand or very fine sandy loam turning into gravelly coarse sand with depth. The Tiedeman soils are occasionally flooded, deep, and somewhat well drained. The upper 16 inches of mineral soil are typically very gravelly fine to coarse sand turning into extremely gravelly coarse sand with depth.

Further out into distal outwash plains the sediments on which the soils are forming have been laid down under lower water energy and tend to be finer. The soils that have been mapped in these areas are the Ashman-Pete Dahl-Cryaquents soil complex and the Deadwood consociation. The complex is deep and poorly to very poorly drained, with the water table normally within 12 inches of surface. Ashman soils are frequently flooded and have mineral layers that are composed of silts, and fine to medium sand. The Pete Dahl soils are also frequently flooded with a 2-inch organic layer on the surface consisting of decomposed litter and live roots, intermixed with some silt. The mineral soil beneath is typically silt. The Cryaquents are occasionally flooded, covered with a 3-inch organic layer composed of litter, moss, and live roots intermixed with silt. Soil profile has fine sand or sandy loam near the surface and a subsurface of very gravelly coarse sand. Deadwood soils are deep, poorly to very poorly drained. The poor drainage impedes decomposition of organic material as a result these soils have layers of organic material well into subsurface.

The vegetation on the poorly drained, fine textured soils will be indicative of wetlands where the surface is level, and low productive forests on gentle slopes. Coarse textured soils will produce highly productive forests.

Hills - The Hills unit covers 87,675 acres of the analysis area. Soils are formed from glacial till or ice-scoured bedrock knobs. Soil type is highly dependent on landscape position. Soils on knobs and shoulder slopes will be shallower and less developed than those on sideslopes. Those in toe slope positions and basins that receive and pond water will tend to develop organic soils and may support wetland vegetation. The vegetation usually consists of forested communities on the slopes and hilltops where soils are well drained, and in the small basins or valleys in-between the hills, it will commonly be associated with wet soils or wetlands.

Geology

The geology of the northern region is dominated by three geologically distinct units; the Cretaceous-age Valdez Group, Tertiary-age Orca Group, and Quaternary unconsolidated, surficial deposits (Fig 2.8). Quaternary units are limited to mostly undifferentiated deposits and supraglacial moraine. A more detailed map of the geology of the northern region is in Appendix A (Fig A.1).

Quaternary unconsolidated, surficial deposits occupy much of the southern part (Fig 2.9) of the analysis area. There are two distinct bedrock units: Orca Group units occur west of the Ragged Mountain fault and the younger Tertiary-age units occur east of the fault. The Orca Group has no known potential for oil and gas, or coal. However, the younger Tertiary-age units which are a part of the “Gulf of Alaska Tertiary Province” have substantiated potential for oil and gas and coal resources (Miller 1959).

On Kayak and Wingham Islands, strata younger than the Orca Group are imbricated along at least five up-to-the northwest reverse faults (Plafker, 1974). Net displacement on the faults is estimated to be nearly 3 miles on the major faults such as the Kayak fault. The inferred Tenfathom fault off the southeast coast of the island is suggested by a submarine topographic break and by the pronounced steepening of seismic reflectors shown in offshore geophysical records. Refer to Figure 2.10. Most of the bedrock exposed on Kayak Island consists of Yakataga Formation and an undivided sedimentary rock unit. Minor amounts of unconsolidated deposits are present.

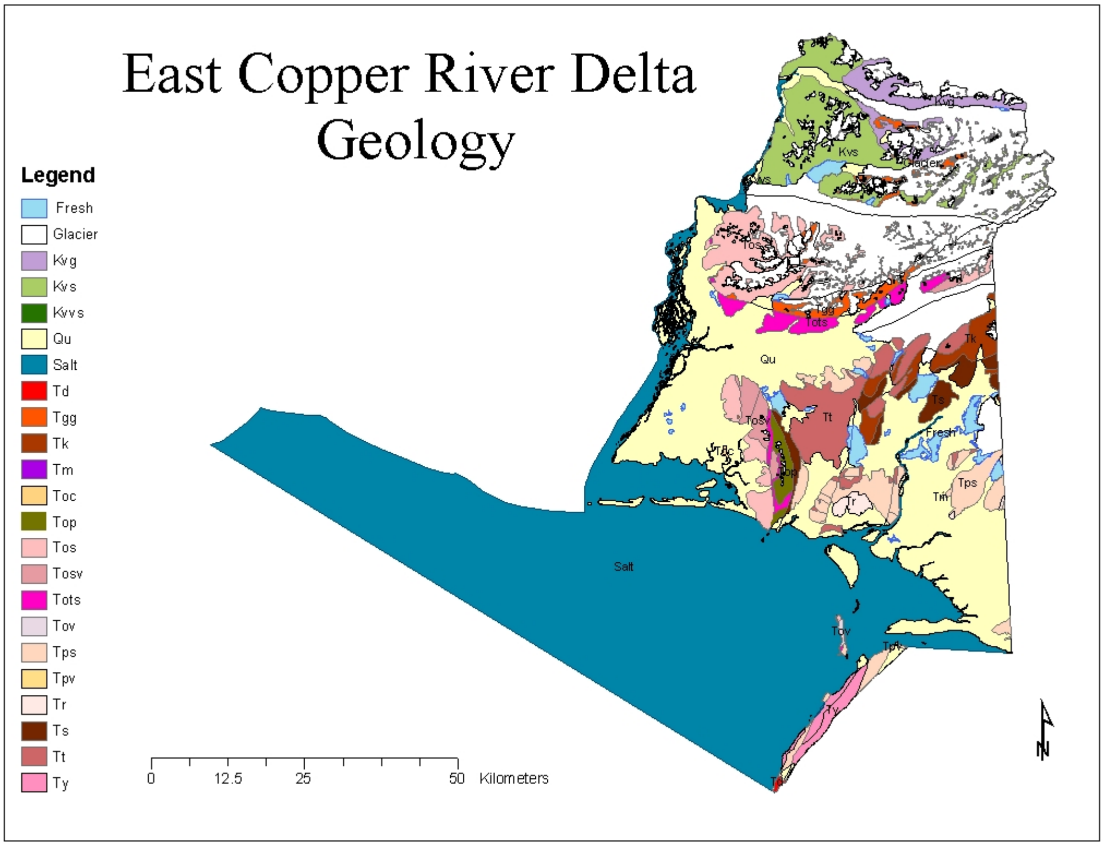


Figure 2.8- Bedrock Geology of the East Delta analysis area. Information from Chugach NF Corporate GIS data layer.

Cretaceous Valdez Group - This is a thick sequence of complex, deformed interbedded metasedimentary and metavolcanic rocks that form an accretionary wedge nearly a mile thick. It is part of a belt of Cretaceous marine rocks 1000 miles long and as much as 60 miles wide that extends along the Gulf of Alaska margin from Chatham Strait (to the east) to Sanak Islands (to the south west). The Valdez Group is part of the Chugach Terrane as defined by Berg and others (1972). The metamorphic grade of the Valdez Group increases eastward, where the rocks are transitional into a belt of schist, gneiss, and migmatite, which extends across the adjacent Bering Glacier quadrangle to the Canadian border.

Kvs, Kvvs, Kvm and Kvg units of the Valdez Group

These Late Cretaceous units occur in the northernmost portion of the analysis area (Fig 2.8 and A.1). Kvs is a thick sequence of metasedimentary rock consisting of sandstone, siltstone, argillite, slate and phyllite, and rare beds of pebbly argillite. Kvvs occurs on the northeast side of Miles Lake. It consists of approximately equal proportions of interbedded metavolcanic and metasedimentary rocks. Kvm is chiefly homogeneous schist. Common banding probably represents the original layering. It is transitional into gneissose rock to the east and into greenschist facies, metasedimentary rocks to the west. Kvg is a metamorphosized granodiorite and granite, referred to as gneiss. Some schist is present and this unit is transitional into schistose rocks to the north, and west.

Tg

This unit consists of Tertiary-age granodiorite, granite and minor diorite. These plutons[2] are generally not deformed or metamorphosed. They occur as small, scattered exposures north of Miles Glacier, and along the north side of the east-west trending Martin fault.

Orca Group - The Eocene to Paleocene age Orca Group was named by Schrader (1900) for a widespread, thick, and complexly deformed sequence of flysch and mafic volcanic rocks in fault contact with the southern margin of the Valdez Group. The Contact fault system forms the landward boundary of the belt (Plafker et al 1977). The Orca Group is considered to be an accretionary sequence and part of the geologic belt (Prince William Terrane) that extends through Prince William Sound to the Kodiak Islands to the west and that probably underlies much of the contiguous continental shelf (Plafker 1969, 1971; Tysdal and Case 1979). The estimated thickness of the Orca Group is as many as thousands of feet, possibly 19,000 to 32,000 feet (Winkler and Plafker 1993).

Tos (Orca Group)

Tos is a sedimentary unit forming a monotonous sequence of thin- to thick-bedded sandstone, siltstone, and mudstone showing structures indicative of deposition from turbidity currents. Sandstone is more abundant than finer-grained rocks. Minor amounts of hemipelagic[3] mudstone occur throughout the Orca Group. Limestone lenses or concretions are found locally, and these, along with conglomerates, are characteristic of sedimentary rocks belonging to the Orca Group. This unit occurs throughout the area between Miles Glacier and the Martin fault, as well as west of the Ragged Mountain fault.

Tovs (Orca Group)

This interbedded sedimentary and volcanic rock unit has variable proportions of interbedded turbidites and basalt. A tuffaceous sandstone unit extends along the Ragged Mountain fault.

[2] A body of igneous rock that has formed beneath the surface of the earth.
[3] Sharing deep sea and shallow sea characteristics.

Tps – Sedimentary rocks, undivided

The Poul Creek Formation is divided into a unit consisting of undivided concretionary, pyritic, glaucontic[4], reddish-weathering, dark-gray to greenish-gray siltstone, claystone, and sandstone; subordinate dark-brown, laminated shale rich in organic material, silty shale, and gray calcareous sandstone. It locally includes thin interbeds of basalitic tuff.

Tt - Tokun Formation (Eocene)

This formation consists mostly of concretionary siltstone and lesser, variable amount of interbedded sandstone, chiefly in lower part of formation. Thick sandstone beds are exposed on Kayak Island. Siltstone is generally medium to dark gray and nearly massive; locally, thin beds and lenses of lighter gray, brown-weathering calcareous siltstone and silty limestone are found within darker siltstone. Spheroidal calcareous concretions as much as 3 feet across are distributed randomly or along bedding surfaces in the siltstone. Near Bering Lake, outcrops of the upper Tokun Formation have thin beds of glauconitic sandstone. The interbedded sandstone is generally lighter gray than the siltstone, and is micaceous, feldspathic and brown-weathering. This formation has organic contents of around 1% but has a low pryrolytic hydrocarbon to organic carbon ratio suggestive of a very weak source horizon for petroleum. The entire horizon is probably thermally mature.

Ts – Stillwater Formation (Eocene)

This formation primarily consists of dense hard dark-gray siltstone. Where siltstone is carbonaceous, it has a coal-like appearance; where it is calcareous, it may be variegated from reddish brown to pale green and usually contains foraminifer fossils. Represented by only one United States Geological Survey (USGS) sample, it has a low pyrolytic hydrocarbon to organic carbon ratio and is within the post-mature zone of high temperature methane production. Therefore, it is a non-source horizon for petroleum.

Tk – Kulthieth Formation (Eocene)

The Kulthieth Formation includes at least 5000 feet of interbedded, massive to thin-bedded, coal-bearing arkosic sandstone, dark-gray to black carbonaceous siltstone and shale, and minor coal. Bituminous to semi-anthracite coal in beds as much as 10 feet thick is a conspicuous, but minor part of the sequence. The coal beds are commonly intensely deformed and display shearing and structural thinning and thickening of the beds. The Kulthieth Formation underlies the Bering River Coal fields. Figure 2.32 displays this formation and coalfield.

In the Katalla area, the Kulthieth Formation can be considered to be a non-source horizon for petroleum for the following reasons:

- Beds in the Kulthieth Formation have greater than 1 percent organic content. However, the formation is low in amorphous kerogen and has a generally higher content of woody and inert organic material than other rock units in the area.
- In addition, it has a low organic hydrocarbon to organic carbon ratio.
- In outcrop, the formation is thermally mature to post-mature.

[4] Contains the mineral glaucolite which is a hydrous silicate of iron and potassium.

Tr – Redwood Formation (Pliocene to Oligocene?)

The lower sandstone member consists of about two-thirds thick-bedded sandstone and one-third silty sandstone and siltstone. The Upper Puffy Member is more diverse and consists of about 50% siltstone, mudstone, and claystone, 30% conglomeratic mudstone and conglomerate, and 20% sandstone. The siltstone, mudstone and claystone are similar in appearance to parts of the underlying Poul Creek Formation but contain few or no concretions, no glauconitic or volcanic beds and are sandier and more erosion resistant. This formation is a weak source horizon for petroleum, with substantially less than 1% organic content. Additionally the formation is probably thermally immature.

Tps - Poul Creek (aka Katalla) Formation (Miocene to Eocene)

The Poul Creek Formation contains some rich source beds with organic content ranging up to greater than 4%, but averaging about 1% (Winkler and Plafker, 1993). Thermal indicators suggest that the formation is approaching the zone of thermal maturity and some parts of the formation may be capable of generating gaseous hydrocarbons, particularly where more deeply buried. The horizon with the highest organic content also contains the greatest percentage of amorphous and herbaceous kerogen, and may thus be a source of oil generation where more deeply buried.

Tps - Katalla (aka Poul Creek) Formation

The Katalla Formation (correlates with the Poul Creek Formation) was first defined by Martin (1905) as a series of dark argillaceous and carbonaceous shales, with occasional thin beds of sandstone, limestone, conglomerate, and volcanic ash, typically exposed in the region to the northeast of the townsite of Katalla, along the banks of the Katalla River and in the range of hills to the southeast. Later, Martin (1908) described the sequence in greater detail as including five lithologic units with a total thickness of 6,500 feet. Miller (1959) identified three units of the Katalla Formation. Wells of the Katalla field produced oil from the carbonaceous shaly middle part of the Katalla Formation.

Tm – Mafic dikes, sills, and plugs (Oligocene)

This formation includes strongly altered intrusions of diabase, basalt and lamprophyre and is probably related genetically to extrusive volcanic rocks (Tpv) in the Poul Creek Formation. Small exposures are located east of the Ragged Mountain fault, along the Nichawak River, and on the south and north ends of Kayak Island.

Quaternary deposits - These deposits consist of undifferentiated deposits, dunes, supraglacial moraine, landslide deposits, and talus, as well as terminal, lateral, and ground moraine (Winkler and Plafker 1993). They occur across the entire analysis area, but are more prevalent in the south (Fig. 2.8, 2.9, 2.10, A-1).

Qs - Surficial deposit, undifferentiated (Holocene)

Undifferentiated unconsolidated, surficial deposits are predominately outwash deposited by glacial melt water and alluvium deposited by non-glacial streams. Locally it includes minor deposits that formed on marine terraces and in wetlands. The material is primarily well-sorted, stratified gravel and sand. Terrace deposits are less well sorted. Wetlands deposits generally consist of peat, muck and silt. The thickness of these deposits is not well known but the sediment load of the coastal rivers is very high and sedimentation rates seaward of their mouths are rapid. Near shore deposits on the Copper River Delta area are much as 590 feet thick.

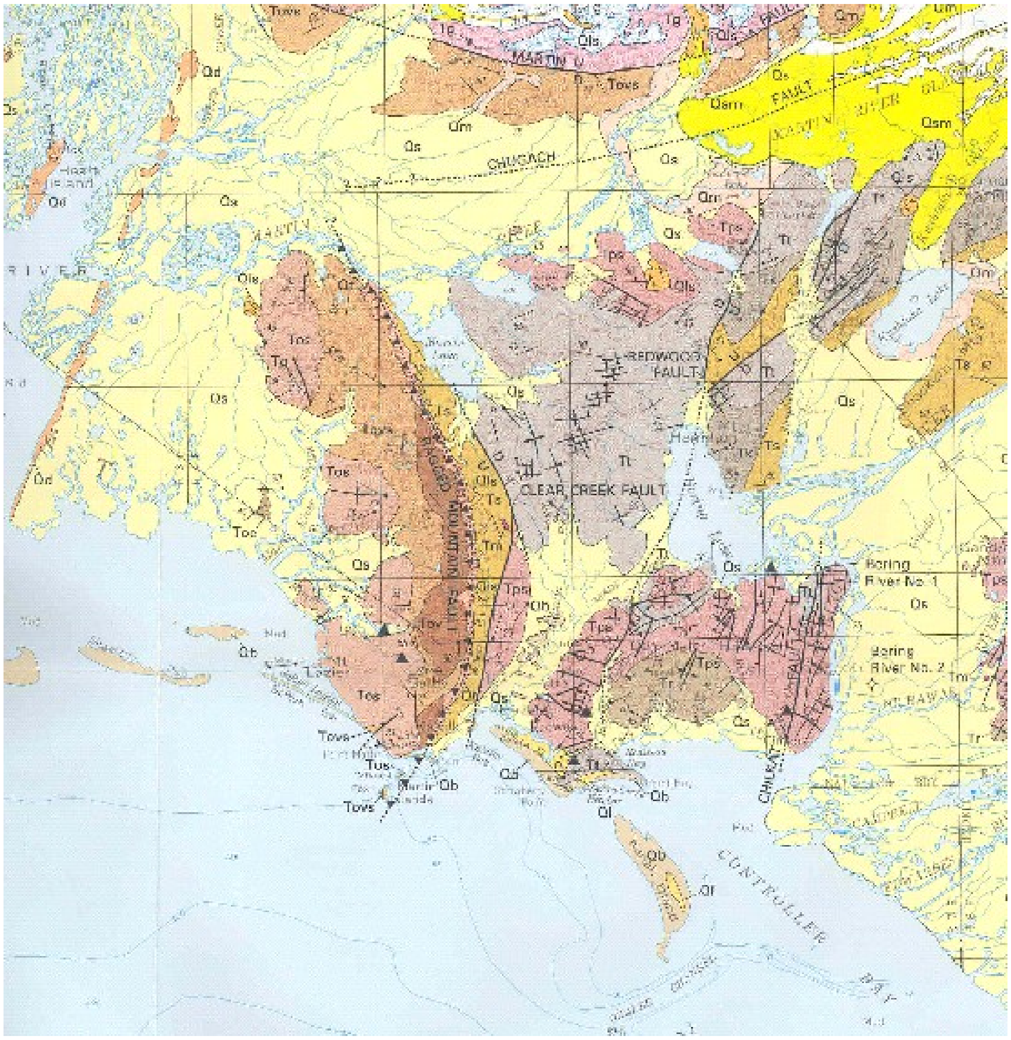


Figure 2.9-Geology of the southern East Copper River Delta. From Winkler and Plafker, 1993.

Outwash deposits occur west of Martin River Glacier, west of Bering River Glacier, north and south of Kushtaka Lake, and along the west flank of the Chugach Mountains. Well-drained areas offer good road foundation material. Poorly drained areas will also offer good road foundation if adequately drained. This unit is generally a source of small quantities of good borrow material. Large wetland deposits occur in the Katalla valley, north and west of Ragged Mountain, south of Bering River and south of Kushtaka Lake. Extensive muskeg deposits occur in the Katalla valley. Both of these deposits are generally poor sources of borrow material.

Qb – Beaches, spits and offshore bars (Holocene)

Constructional shoreline deposits of well-sorted gravel and sand form as; offshore bars on submerged parts of Bering and Copper River deltas, spits extending westward or northwestward from headlands, and beaches consisting of successive sequences of runnels and ridges extending landward from present shoreline. Nine elevated beach ridges, which appear to be related to intermittent tectonic emergence, are found near Katalla (Plafker 1969). Because of progradation, spits near Katalla Bay are now nearly 3 miles inland (Kachadoorian 1960).

The thickness of the deposit is unknown but may be 25 to 75 feet. This material is considered excellent as road foundation, but the deposit has insufficient fine material for road surfacing.

Ql – Lagoonal deposits (Holocene)

These deposits are fine-grained silt that is rich in organic material, mud and peat, deposited in calm water landward of beaches or spits. They occur at Katalla Bay, Kanak Island, and the south end of Kayak Island.

Qd – Dunes (Holocene)

Holocene sand dunes (Qd) occur at the mouth of the Copper River. The material consists of well-sorted, fine-grained sand and silt aligned in longitudinal ridges as much as 150 feet high. Dunes are nourished by sustained, unidirectional, high-velocity winds that blow down the Copper River canyon, especially during spring and fall (Winkler and Plafker 1993).

Qsm – Supraglacial moraine (Holocene)

Supraglacial moraine (Qsm) occurs primarily along and at the mouth of Martin and Kushtaka Glaciers and to a lesser extent on the lower reaches of the Werneke, Van Cleve, Miles, and Johnson Glaciers. These deposits consist of unweathered, poorly sorted, generally pebble- to boulder-sized rock debris on the surface of the glacier and form conspicuous medial and lateral moraines.

Well-drained moraines are generally good as road foundations. It is a poor to good source for borrow material. Excessive boulder on Kushtaka moraine would require crushing of material from this moraine.

Qm – Terminal, lateral and ground moraine (Holocene)

These deposits consist of unsorted boulders, cobbles, gravel and sand deposited during glacier retreat. Terminal moraines of the Kushtaka and Martin River Glaciers are at least 1000 years old. This deposit may be both unvegetated and vegetated, locally sustaining dense brush and forest, but retaining its morainal morphology.

Qt – Talus (Holocene)

Talus consists of boulder to pebble-sized angular rock debris derived from adjacent bedrock. Talus occurs along the entire eastern flank of Ragged Mountain.

Qls – Landslides (Holocene)

Landslide material is unsorted, angular rock debris derived by failure of bedrock slopes that in many places were oversteepened by glaciers and left unsupported when the ice retreated. Many landslides deposited over glaciers or snowfields were triggered by the 1964 earthquake (Plafker 1968). Large slides have developed along the east flank of Ragged Mountain, north of Martin River and on the east flank of Charlotte Ridge.

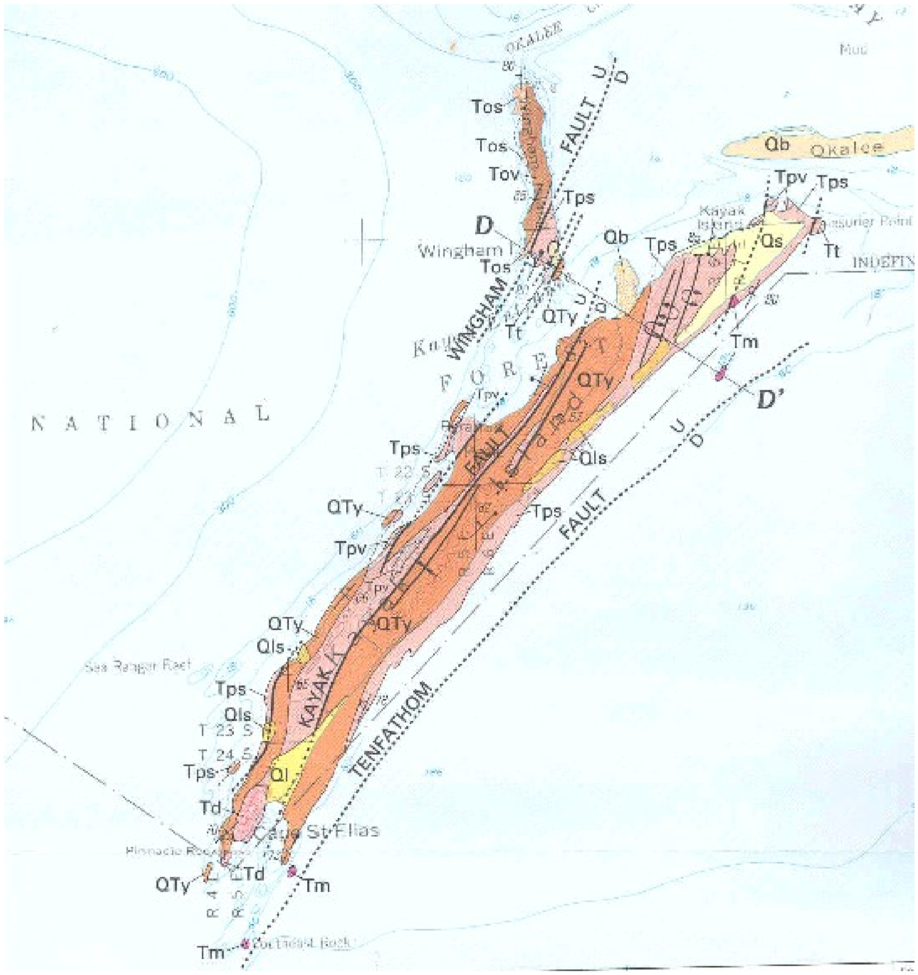


Figure 2.10 - Geology of Kayak and Wingham Islands. From Winkler and Plafker 1993.

Qty – Yakataga Formation (Pleistocene to Miocene)

This formation consists of diverse marine and glaciomarine clastic rocks more than a mile thick on Kayak and Wingham Islands. Yakataga is not exposed on the mainland in the analysis area. Much of the continental shelf between Kayak and Middleton Island is underlain by the Yakataga. Interbedded gray to dark-gray and greenish-gray siltstone, mudstone, and sandstone dominate the lower third of the formation. In the upper two-thirds, till-like diamicite interbedded with siltsone and sandstone predominates. Conglomerate is a minor lithology throughout the formation. Sandstone and conglomerate combined constitute about 10% of the section exposed on Kayak Island.

Td – Dacite of Cape Saint Elias (Pliocene or Miocene)

A prominent, very pale gray dacite plug complex forms Cape Saint Elias and Pinnacle Rock at the southwestern end of Kayak Island (Plafker 1974). The dacite is very dense and hard, and is conspicuously jointed. This unit has sharp, nearly vertical contacts with adjacent dark-gray argillaceous rocks of the Yakataga and Poul Creek Formations, which are metamorphosed to dark hornfels for at least 320 feet around the intrusion.

Soils

The soils of the analysis area are the product of a continually changing landscape that breaks apart, transports, and reworks the parent material upon which they are forming. Some of these changes are brought about by the erosive effect of glaciers, the transport and deposition of sediments by alluvial and glacial outwash, the accumulation of wind-blown materials, wave and tidal action, and tectonic uplift. Soils were briefly discussed in the landtype association section because of the strong correlation between landscape position and soil formation. Additional information is presented here. On-site soil investigations have for the most part been limited to the delta itself and to a lesser degree further into the uplands. As a consequence, soils information for the uplands is less detailed than what is presented for the lower lying areas on or near the delta.

Soils in the analysis area are not so much influenced by the nature of the bedrock underneath as they are by the surficial geology. For the most part, these soils are forming from material that has been altered physically and/or chemically from the original bedrock. An exception to this is some of the soils found in areas that have recently been deglaciated or that occur at higher elevations such as on Goat and Ragged Mountains. The bedrock in these areas has been exposed by scouring from glacier advancement or by the continual erosive effects of freeze-thaw action, rainfall, and wind. The soils forming on these sites are on recently exposed bedrock that has not been overlain by glacial, colluvial, eolian, alluvial or marine deposits and can take on both the physical and chemical characteristics of the bedrock. For example, soils forming on metasedimentary bedrock (Fig. 2.8) such as slate or greywacke (Kvs) will tend to be finer and richer in iron-oxides than soils forming from granodiorite (Tgg). These characteristics will continue to dominate until it has been exposed to the elements long enough to have its inherited bedrock properties altered physically and chemically by climatic factors (primarily rainfall) or be buried by another material such as glacial or alluvial outwash, landslide debris, or wind-deposited sand.

Soil development also depends on the geographic setting. The rugged glaciated terrain of the Chugach Mountains to the north provides freshly exposed bedrock material that is regularly sloughing off due to freezing and thawing cycles. The material that breaks away and collects at depositional positions on the landscape provides colluvial parent material for soil formation. As glaciers advance and retreat over time, they destroy and create new landscapes. Glaciers not only expose fresh bedrock but provide an extraordinary amount of depositional material throughout extensive outwash plains, as well as leaving behind moraines as they retreat. Glacial streams deposit sediment as massive outwash plains across the delta.

Along the coast, the uplifted marshes are underlain by marine deltaic deposits and support a variety of organic soils. The tidal flats develop soils regularly inundated and composed of silt and fine sand. Lastly, the dunes and barrier islands along the southern coast are created by winds, waves, and alongshore transport of sediment (Boggs, 2000) and are composed of a variety of sandy and gravelly soils.

As summarized by Boggs (2000), the Copper River supplies the primary sediment load necessary for the development of the delta, carrying about 69 million tons of sediment per year (Brabets 1997). This sediment consists of fine sands and coarse silts. Nearshore transport of sediments maintains the barrier islands and spits of fine to medium sands extending from Softuk Bar to Point Whitshed. These islands shelter the estuaries from offshore ocean currents and allow finer sands and silts to deposit enabling tidal marshes to form.

Davidson (1992) separates the soils of the area into aeolian sand deposits, relatively high-energy alluvial deposits of sands and gravels, and low energy marine deposits of glacial silts and very fine sands. High winds blow fine sandy loess down the Copper River canyon and form sand dunes hundreds of feet long and up to 100 feet high at the mouth of the Copper River. The sand dunes consist of well-drained, permeable, fine to coarse sands. Some minor deposits of sand are found in thin layers on sand bars in active river channels. Landforms from soils deposited in a higher energy environment consist of alluvial fans and river terraces immediately downriver from the glaciers and beaches and shorelines exposed to the ocean surf. The alluvial fans and river terraces below the glaciers consist of well-drained, permeable, coarse textured sands and gravels. The beach deposits consist of clean, well drained, permeable, fine to medium sands.

Landforms where soils are deposited in a low energy environment consist of the transitional zones between the alluvial fans and the raised delta and between the raised delta and the active tidal flats. Virtually all of these soils consist of poorly drained, slowly permeable, variable mixtures of glacial silts and very fine sands. These units are distinguished by ponds of fresh water on the soil surface or saturated soils. The slough levees have the best drained soils and the deepest water table due to the raised cutbanks. Texture analyses indicate the slough levees have a higher percentage of coarse silt and very fine sand relative to fine silt compared to other deltaic soils.

Wetlands

The Copper River Delta as a whole is considered the largest coastal wetlands complex on the Pacific Coast of North America (Thilenius 1990). The data used to characterize the wetland types within the analysis area are from the National Wetlands Inventory (NWI) of the United States Fish and Wildlife Service (USFWS). Although the NWI does not cover the entire analysis area, it is a good representation of the wetland type and pattern of distribution (Fig 2.11). The majority of the area lacking NWI coverage is in the upland areas and presumed to have few wetlands. Wetlands cover 411,500 acres in the analysis area. They are classified into systems which represent “a complex of wetlands and deepwater habitats that share the influence of similar hydrologic, geomorphologic, chemical, or biological factors” (Cowardin et al 1979).

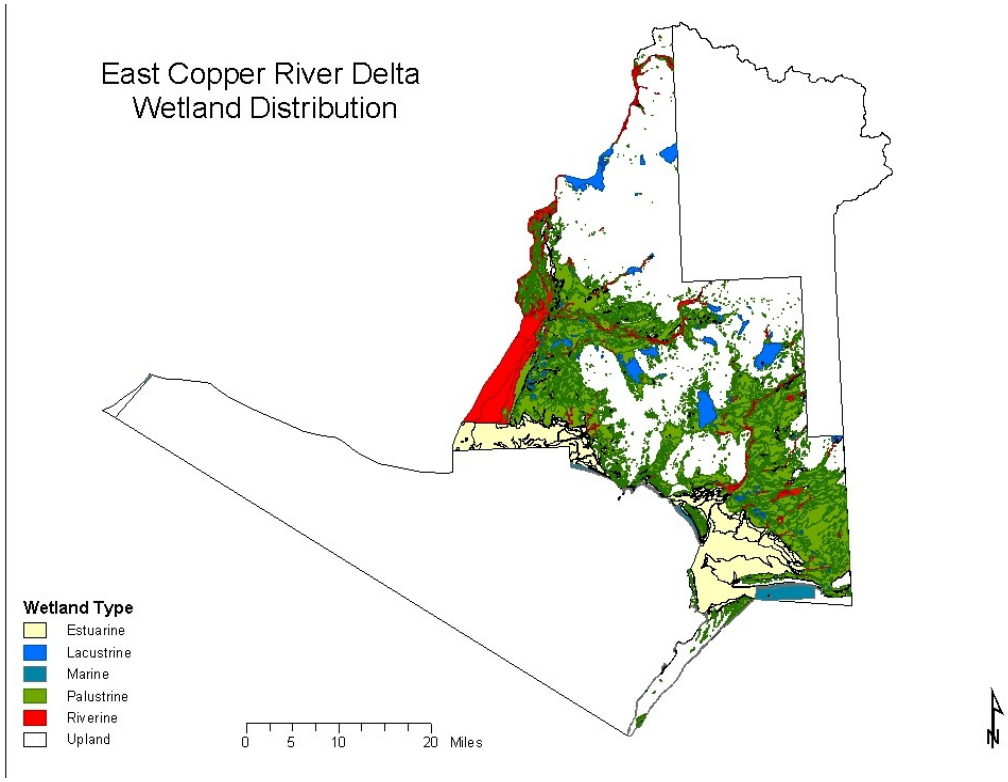


Figure 2.11-Wetland classification for the East Delta analysis area Data from USDA FS, updated 1997.

Original wetland data from US Fish & Wildlife Service, delineated from 1:60,000 aerial photography with field verification & 1 - 3 ac. minimum cell size.

The most dominant wetland type is the palustrine system at 236,340 acres. These non-tidal and tidal wetlands are dominated by trees and shrubs and have low ocean-derived salinities (Cowardin 1979). This complex includes the uplifted marshes, wet meadows, fens, and small shallow ponds. The estuarine is the next most abundant type at 90,270 acres. This complex includes the tidal flats, tidal marshes, coastal rivers and embayments found in the southern portion of the analysis area. The riverine wetlands system is the third most common and consists of 52,580 acres. These wetlands are located within river and stream channels but do not include those wetlands that are dominated by trees, shrubs, or have a high concentration of ocean-derived salts. Approximately 26,580 acres are classified as lacustrine wetlands which are located in landform depressions and dammed river channels. The 5,760 acres of marine wetlands are found along the coastline on Okalee Spit, Kanak Island, and Softuk Bar.

Hydrology

Glaciers - Extensive glaciation occurred in the late Pleistocene (12,000 to 25,000 years ago), and glaciers in the Copper River area at one time advanced as far as 60 miles south of the Chugach Mountains to the edge of the continental shelf (Hampton et al. 1987).

Rapid melting accompanied by numerous episodes of small advances and retreats occurred in the Holocene, beginning 12,000 years ago.

The Miles and Wernicke Glaciers, flowing west out of the Chugach Mountains into the Copper River, cover much of the northern half of the analysis area. The 32-mile long Miles Glacier was once part of a large glacier that filled the Copper River Canyon, and glacial advances scoured the deep basin now occupied by Miles Lake after the glaciers receded (Miles Lake depth extends below sea level). The McPherson, Johnson, and Martin River Glaciers flow west out of the Chugach Mountains toward the Copper River Delta. McPherson and Johnson Glaciers are both small hanging glaciers. The Martin River Glacier is about 40 miles long, covering about 56 square miles (Reid 1970). Two small lobes spill off the glacier to the south to Kushtaka Lake and Lake Charlotte. These lakes are created by the terminal moraines from these lobes. The Bering Glacier is the largest glacier in North America (Roush 1994) with a length of 120 miles, an area of about 2000 square miles, and a 21 mile wide piedmont lobe. Only a small portion of this piedmont lobe lies within the Chugach National Forest.

Outburst floods are common on nearly all of the glacial systems in this area. Dynamic glaciers and steep topography provide the conditions that allow glacial ice to dam tributary valley outlets, creating reservoirs. These reservoirs eventually erode the ice dams, resulting in catastrophic floods. The recurrence of these events varies depending on the time required to fill the reservoir and can occur at any time of the year. Changes in glacial dynamics can also alter the timing and magnitude of these events.

Streams and Rivers - A total of 1,758 miles of mapped streams and rivers lie within the analysis area. They were classified using a system developed by the Tongass National Forest (USDA Forest Service 1992) (Figure 2.12). Because field verification has not been done for much of this area, many assigned channel types may be inaccurate and some important salmon streams not mapped. Streams in the northern portion of the analysis area are mostly from glacial sources, and subglacial drainages exist, although they are not generally depicted. The larger rivers draining onto the Copper River Delta, including the Martin River, Johnson River, and Sheep Creek, are also from glacial sources.

Many non-glacial, clear water streams emerge from groundwater and non-glacial lakes in the area. Streams draining the foothills of the Chugach Range in the southcentral portion of the analysis area are predominantly short, non-glacial, high gradient channels draining steep hillslopes. Palustrine channels and wetland areas exist in much of the low gradient delta area and on the outwash plain of the Bering River. Most of these channels are strongly influenced by beaver dams. Estuarine channels are present along the coast of the Copper River Delta and the Bering outwash plain. Very few streams exist on the barrier islands, Kanak Island, and Okalee Spit. Streams on Kayak Island are all very short, high gradient channels.

With a length of 290 miles and a drainage area of 24,200 square miles, the Copper River drains the sixth largest basin in Alaska (Brabets 1997). Because 18% of the Copper River watershed is glaciated, the river carries very high sediment loads to the delta, where it spreads into numerous sloughs and side channels with large vegetated islands and bars before entering the Gulf of Alaska. The river is 9 miles wide at Flag Point. The lower Copper River has a gradient of 0.1% from the Million Dollar Bridge to Flag Point Bridge, decreasing toward the Gulf of Alaska. Bed material is coarse to very coarse gravel upstream of the Flag Point Bridge (Brabets 1997). Channel migration, scour, and aggradation regularly occur, resulting in highway and bridge maintenance issues.

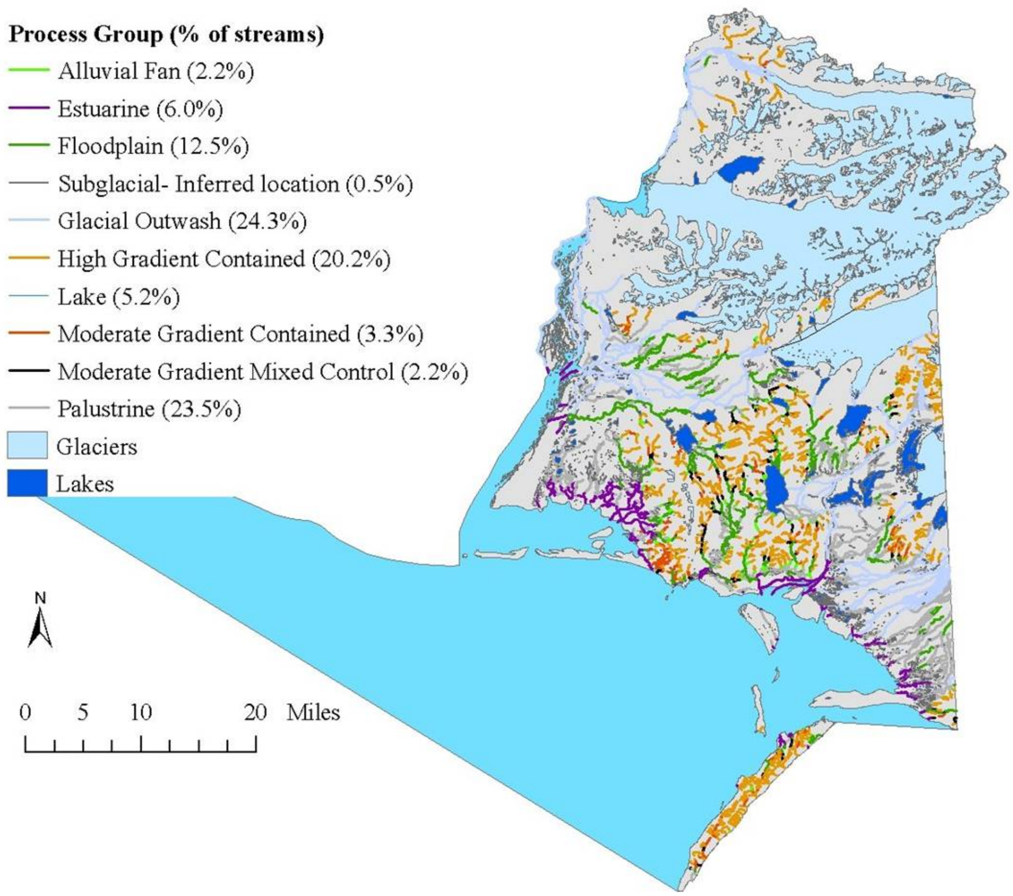


Figure 2.12-Stream channel process groups in the analysis area. Data from USDA FS, (2002).

Streamflows

Streamflow data for the East Copper River Delta are limited, and no gauging stations are in operation. Historic data are available for the Copper River at the Million Dollar Bridge and Dick Creek north of Bering Lake, but they do not characterize flow regimes in many of the glacial systems in the area. The Copper River is controlled by its large watershed mostly north of the Chugach Range, and the Dick Creek watershed represents a small, non-glacial, rainfall-dominated system in the foothills of the Chugach Range.

The flow regime on the Copper River is largely influenced by glaciers and weather patterns of the Copper River Basin. Flows increase dramatically in late May and early June during snowmelt runoff (Table 2.3, Fig 2.13). At the Million Dollar Bridge, peak flows of 150,000 to 200,000 cubic feet per second (cfs) typically occur in July and early

August, during the peak of glacial melting. The 1981 flood, with an estimated flow of 470,000 cfs, exceeded the 100 year flood event (Brabets 1997). Flows gradually decrease from early August to October, and winter flows generally remain at a constant 8000 to 13,000 cfs from early December to mid-April.

Flows on Dick Creek, with a drainage area of 7.95 square miles, are controlled by rainfall and snowmelt runoff, and its hydrograph is typical of the non-glaciated, low elevation foothills of the Chugach Range. Flows gradually rise in late April, and peak flows during snowmelt runoff average about 300 cfs (Table 2.3, Fig 2.13). Rainstorms in August through November cause high magnitude, short duration, flashy flows. The highest recorded flow of 2140 cfs occurred in August, 1981 (USGS 2003). Winter flows from early December to late March average 50 to 100 cfs, although winter rainstorms often cause high magnitude, short duration flow events. During cold and dry winters, minimum winter flows can be less than 5 cfs.

Table 2.3- Streamflow statistics for the Copper River (Brabets 1997) and Dick Creek (USGS 2003).

	Copper River at Million Dollar Bridge near Cordova, AK [2]	Dick Creek near Cordova, AK
USGS Station Number	15214000	15195000
Latitude	60°40'18"	60°20'32"
Longitude	144°44'41"	144°18'10"
# of years data	46 (1950-1995)	11 (1970-1981)
Drainage area (sq miles)	24,200	7.95
Average daily flow (cfs)	57,400	136
Extreme minimum daily flow (cfs)	4100	3.5
Extreme instantaneous peak flow (cfs)	470,000	2140
Average June flow (cfs)	135,370 [3]	204
Average March flow (cfs)	8,882 [3]	36
2-year flood (Q_2) (cfs) [1]	220,000	1960
cfs/square mile	9	247
10-year flood (Q_{10}) (cfs) [1]	300,000	2320
cfs/square mile	12	292

[1] Flood frequency statistics from Curran et al. (2003), weighted skew.
[2] Includes synthesized data based on flows from Copper River at Chitina (Station # 15212000) (from Brabets, 1997)
[3] Based on data from 1988 to 1995 only (Station #15214000)

Glacial outburst floods are often larger than peak flows from non-outburst events, although most outburst floods in this area are not measured. The Van Cleve outburst flood of August 1992 caused the Copper River at the Million Dollar Bridge to increase from 150,000 to 300,000 cfs in 5 days, falling back to 150,000 cfs over the next 3 days (Brabets 1997). This increase is typical of other Van Cleve outburst floods. Post and Mayo (1971) predicted peak flows from the Bering Glacier/ Berg Lake glacial outburst system exceeding 1 million cfs. The 1994 outburst flood from Berg Lake into the Bering River delivered an estimated 194 billion cubic feet of water over a period of 72 hours (Noserale 1998).

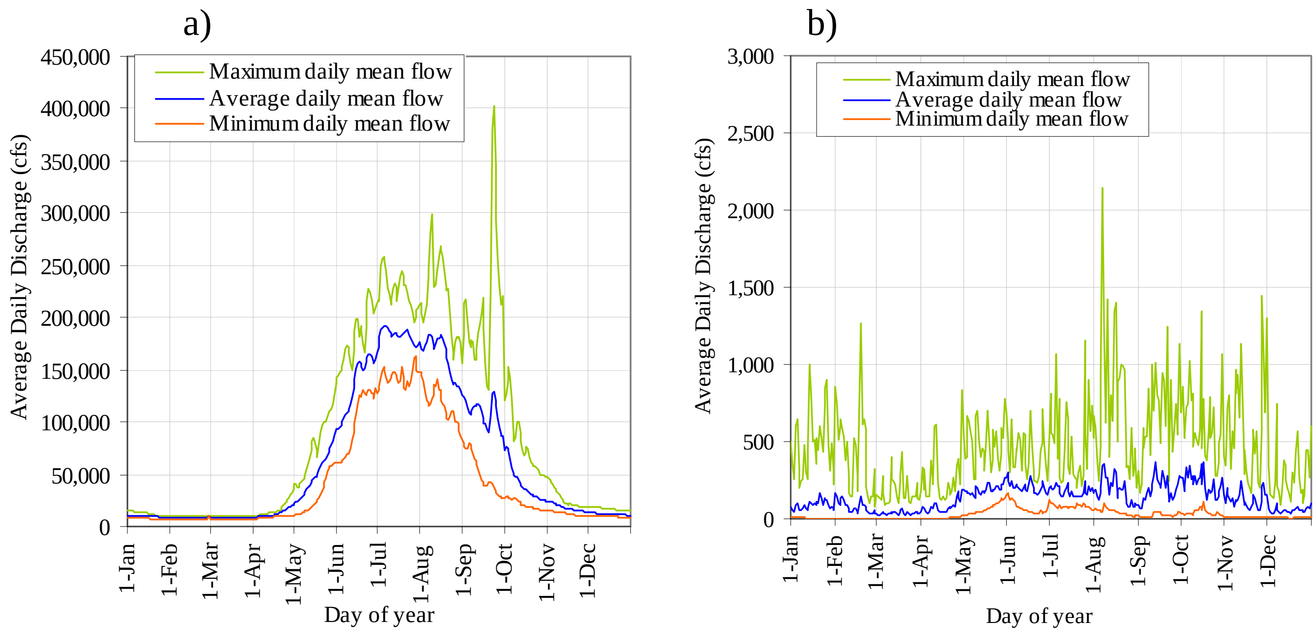


Figure 2.13 - Average daily streamflows for a) Copper River at Million Dollar Bridge (1988-1995), and b) Dick Creek (1970-1981) (USGS 2003).

The flow regimes of the Martin River, Johnson River, and Sheep Creek are mainly controlled by large glaciers, with peak flows occurring in late July to early August, and low flows from November to April. Rainfall creates large peak flows in these systems, but they are generally not as large as the flows during the peak of glacial melting. Late summer and fall rain events on glacial ice can result in very flashy flows, and rainfall that occurs during glacial runoff can greatly enhance peak flows. Flow volumes per square mile are considerably larger than those of Dick Creek because of the additional runoff from glacial melt. Non-glacial streams in the analysis area have flow regimes similar to that of Dick Creek. Coastal rivers such as the Katalla River have lower flow volumes because of lower precipitation.

Water Quality and Sedimentation

Water quality is generally pristine because of the scarcity of development and human activities in the analysis area. Several agencies collected baseline water quality data in the Bering River Coalfields area in the 1960s and 1970s (Blanchet 1984, Balto 1982) (Table 2.4), and the US Geological Survey monitored water quality on Dick Creek from 1970 to 1979 (USGS 2003). These data show conditions of clear, cold, well oxygenated water. Levels of pH in some samples were lower than the minimum Alaska state standard of 6.5 (Alaska Department of Environmental Conservation 2003), possibly because of acidification from forest and wetland organics. Suspended sediment concentrations and turbidities were generally low, increasing with discharge. Naturally elevated levels of iron were measured in some locations, with high levels measured in Kushtaka Lake in 1981.

Table 2.4 - Summary of water quality parameters from the Bering River Coalfields region. Values presented as ranges from low to high.

Location and Source *	Dates	Temp. (deg C)		pH (units)		Dis. Oxygen (mg/L)		Susp. Sed. (mg/L)		Dis. Solids (mg/L)		Alkalinity (mg/L CaCO3)		Sp. Cond. (umhos)	
Shepard Cr (EPA) [1]	1968									40	90				
Lakes (EPA) [1]	1968									40	106				
Streams (EPA) [2]	1969-71	4.8	11.0	7.0	8.1	7.8	12.6					17	68	29	158
Streams (USGS) [3]	1972	2.5	8.5	6.5	8.1	10.4	13.5	1.0	25.0	42	68			54	110
Lakes (ADF&G) [4]	1981			5.4	6.8							5	32	17	75
Streams (USFS) [5]	1982	6.0	8.6	6.1	8.2	9.4	12.0	1.6	53.0	19	62	4	14	72	134
Dick Cr. (USGS) [6]	1970-79	1.0	7.5	6.0	7.4	5.6	13.3	1.0	17.0					35	84

Location and Source *	Dates	K (mg/L)		Na (mg/L)		Mg (mg/L)		Ca (mg/L)		Fe (mg/L)		Sulfate (mg/L)		Phosphate (mg/L)	
Shepard Cr (EPA) [1]	1968									0.10	0.20	23.6	35.4	0.17	0.3
Lakes (EPA) [1]	1968									0.10	0.58	29.3	59.2	0.06	0.35
Streams (EPA) [2]	1969-71	0.12	0.95	0.87	6.60	0.35	3.60	7.4	28.1	<0.1	3.63	5.1	37.3	<.01	0.02
Streams (USGS) [3]	1972	0.20	0.80	1.40	7.90	0.50	1.70	8.0	15.0	0.03	0.28	4.0	12.0		
Lakes (ADF&G) [4]	1981					<0.3	2.90	1.6	15.8	0.02	26.0 [#]				
Streams (USFS) [5]	1982	0.18	0.68	1.13	3.32	0.60	1.86	8.5	16.5	<0.01	0.03	2.4	5.6		
Dick Cr. (USGS) [6]	1970-79	<0.10	0.30	1.50	2.90	0.30	1.30	5.6	12.0	<0.01	0.32	6.0	17.0		

* See Blanchet (1984) for complete tabulation of data and sampling locations.
[1] Lakes include Bering, Charlotte, and Kushtaka Lakes.
[2] Streams include Shepard, Carbon, Dick, Unnamed (Kushtaka Ridge), Stillwater, Clear, and Trout Creeks.
[3] Streams include Trout, Clear (Tributary), Clear, Stillwater, Shepard, Carbon, and Dick Creeks.
[4] From Balto (1982). Lakes include Bering Lake, Kushtaka Lake, Martin Lake, and Lake Tokum.
[5] Streams include Maxwell, Shepard, Railroad, Iron, and Stillwater Creeks.
[6] From US Geological Survey (2003).
[#] Kushtaka Lake had Fe concentrations ranging from 10.7 to 26.0. All other ranged from 0.02 to 0.55.

Water in streams, sloughs, and ponds in the low elevation wetland areas has high concentrations of organic compounds (Wissmar et al. 1991). High levels of carbon dioxide from decomposed plant material lead to high alkalinities and higher concentrations of calcium and magnesium. Because water is retained a long time in these wetlands, nutrients are recycled in these environments.

Glacial streams are considerably more turbid than non-glacial streams. Suspended sediment and bedload sediment concentrations in the Martin River, Bering River, Johnson River, Sheep Creek, and the Wernicke River are generally very high. These glacial systems transport large quantities of glacial silt. Many of these systems do not have proglacial lakes to capture bedload sediment, resulting in high bedload transport rates and active channel migration on their outwash plains.

The Copper River carries more suspended sediment per square mile of watershed than any other Alaskan river, averaging 69 million tons per year (Brabets 1997). This is the result of high discharges, numerous glacial sources in the Copper River Basin, and the presence of erodible late-Pleistocene lacustrine deposits in the Copper River Basin. During peak flows from 1991 to 1993, suspended sediment loads at the highway bridges ranged from 1000 to 2500 mg/L, increasing with discharge (Brabets 1997). Because Miles Lake acts as a settling basin, the outlet is well armored and little bedload sediment transport occurs just downstream of the lake. However, the Copper River picks up considerable bedload from its bed and banks, as well as Childs Glacier and other glacial tributaries downstream of Miles Lake. Chemical water quality parameters measured at the Million Dollar Bridge show a lack of toxic pollutants, reflecting the low levels of human activity in this area, but extremely high turbidities, ranging from 100 to 800 NTU (US Geological Survey 2003). Temperatures were low, dissolved oxygen levels were high, and pH levels were slightly basic but within an acceptable range.

Hydrocarbons are naturally present in streams in the Katalla Oil Field area from oil and gas seeps. A recent 3-year study of hydrocarbon concentrations in streams feeding into Katalla Slough indicated low levels of hydrocarbons in all areas except those immediately adjacent to active oil seeps, where concentrations of heavy hydrocarbons are able to accumulate. Hydrocarbons were rarely detected downstream of the oil field in Katalla Slough (MacFarlane 2003).

Ground Water

Groundwater-fed streams are common in parts of the Delta at the bases of steep sideslopes and in the upper portions of glacial outwash fans, where course material allows for subsurface flow. The multiple groundwater-fed streams flowing southwest between the Martin River and Johnson River are important clear water fish habitat. Clear Creek is also a groundwater-fed stream that flows south from near Miles Lake, along the Copper River Highway, into Sheep Creek.

Biological Characteristics

Fish

The complex aquatic habitats in the analysis area support a rich diversity of fishes. Anadromous salmonids present include coho salmon (*Oncorhynchus kisutch*), sockeye salmon (*O. nerka*), pink salmon (*O. gorbuscha)*, chinook salmon (*O. tshawytscha*), Dolly Varden (*Salvelinus malma*), coastal cutthroat trout (*O. clarkii clarkii*), chum salmon (*O. keta*), and steelhead (*O. mykiss*) (ADF&G 1998). Some resident forms of Dolly Varden and coastal cutthroat trout are also believed to occur in the analysis area (Trotter 1997). Other anadromous fishes present are eulachon (*Thaleichthys pacificus*), pacific lamprey (*Lampetra tridenttata*), green sturgeon (*Acipenser medirostris*), and white sturgeon (*A. transmontanus*) (Page and Burr 1991). Additional freshwater fishes that may be present are round whitefish (*Prosopium cylindraceum*), humpback whitefish (*Coregonus pidschian)*,arctic grayling (*Thymallus arcticus*), rainbowtrout (*O.mykiss*), lake trout (*Salvelinus namaycush*), three-spine stickleback (*Gasterosteus aculeatus*), slimy sculpin (*Cottus cognathus*), prickly sculpin (*C. aster*), and burbot (*Lota lota*).

No federally listed threatened or endangered fish species are present in the analysis area. Coho salmon and Dolly Varden are Management Indicator Species (MIS) and cutthroat trout is listed as a Species of Special Interest in the revised Forest Plan (USDA Forest Service 2002b).

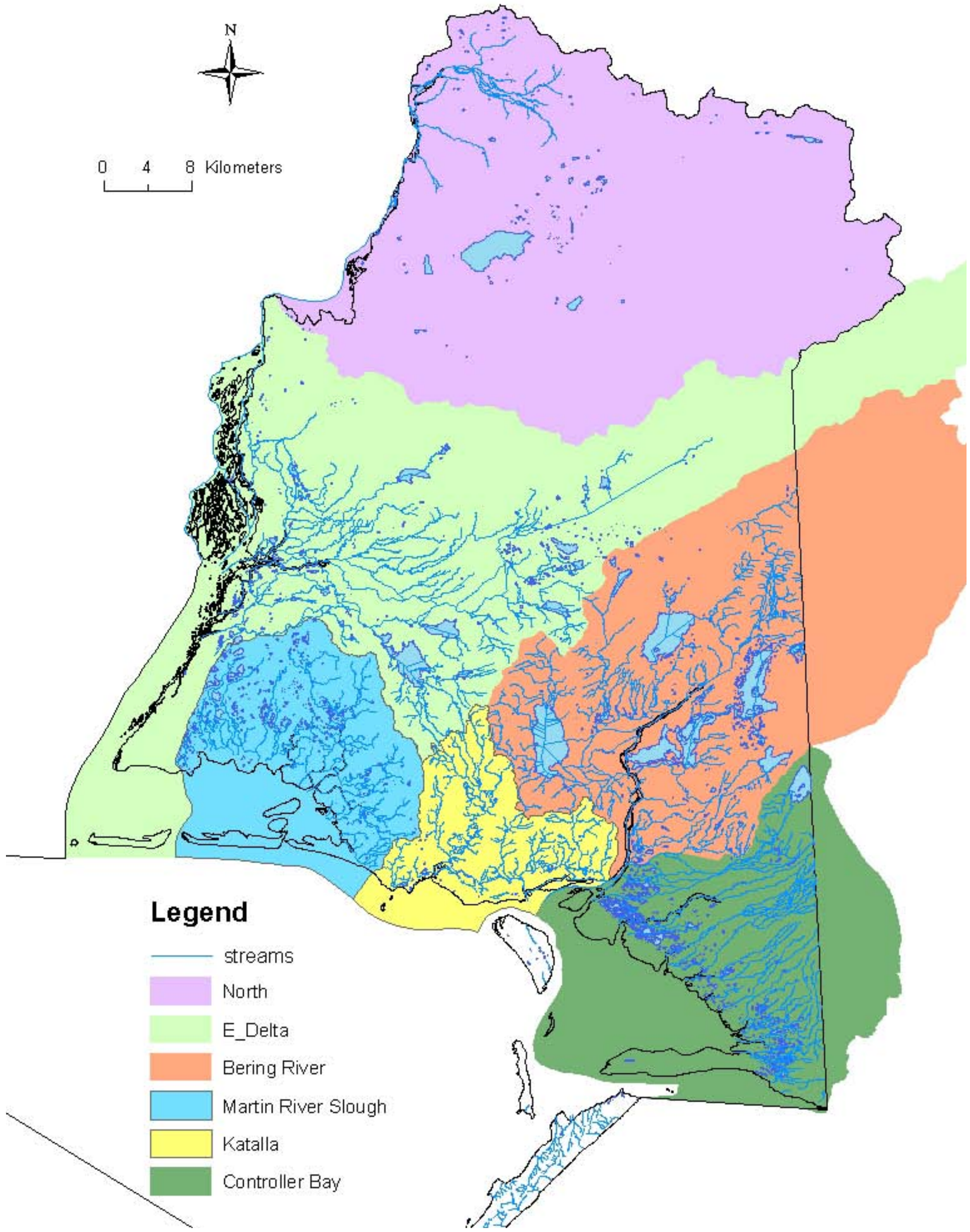


Figure 2.14 - The fisheries watershed regions for the analysis area. The Islands (Kanak, Wingham, and Kayak) are not shown in the legend.

Habitat Characteristics - Fisheries habitat conditions are controlled by the dynamic geomorphic and tectonic activity on the Copper River Delta. Twelve thousand years ago, during the last major glacial period, freshwater fish were probably not present in the analysis area because it was covered under a thick layer of ice. Since then, fish have invaded the many streams and lakes produced by the receding glaciers, however, the historic range of natural variability of the fisheries resource is unknown.

Over the past 2000 years, a persistent subsidence of land interrupted by punctuated intervals of uplift due to earthquakes has occurred at 600 – 1000 year intervals (Christensen and Mastrantonio 1999). Subsidence likely increased proportions of salt water and tidally influenced slough habitats in the analysis area. These habitats do not provide spawning habitat, and may limit freshwater rearing habitat for coho and sockeye salmon. On the other hand, uplift and the resultant morphological channel changes likely increased the amount of spawning and rearing habitat available to these species. Additionally, alder and spruce can become more prevalent in the riparian zones following uplift, influencing fish habitat and populations. Populations may have naturally fluctuated around periods of subsidence and uplift. The relative amounts of spawning and freshwater rearing habitat are believed to have increased since the uplift of the 1964 earthquake. However, documented information on historic distributions, abundances, and aquatic habitat conditions in the analysis area is limited. Fish population and habitat characteristics for salmonid species are discussed by watershed region from north to south as displayed in Figure 2.14 on the previous page.

North

Glaciers and steep terrain of the Chugach Mountains are the dominant influence on fish habitat in the northernmost region of the analysis area. Large glaciers in this region include the Miles, Wernicke, and Van Cleve. Miles Lake lies at the terminus of Miles Glacier and is a part of the Copper River. This lake and the rest of the Copper River are important to salmonids that migrate into the upper portion of the Copper River watershed in interior southcentral Alaska. Most of the major rivers in the northern region are glacial in origin and are characterized by braided channels and cold, turbid waters that are relatively unproductive fish rearing habitats (Allan 1995). Fish use these channels primarily as migration corridors to access spawning and rearing habitats. In this region, the upper reaches of the major river valleys appear to be steep and remain glacial. These streams appear to provide little spawning or rearing habitat for salmonids.

East Delta and Bering River

These two regions comprise a diverse and dynamic landscape ranging from large glaciers to wetland sloughs. They have the greatest fishery value in the analysis area because of the diversity and amount of productive spawning and rearing habitats present. Large lakes include the Kustaka, Bering, Charlotte, Tokun, and Martin. Although some of these lakes are glacially fed, clear water streams also enter these lakes. These clear water streams provide excellent spawning and rearing habitat for salmonids. Several large glacial rivers occur, including the Martin, Bering, Gandil, and Sheep. Clear-water stream systems originate in non-glacial drainages of the Ragged, Don Miller, Kushtaka, and Cunningham Ridge mountain ranges. Clear water streams are also formed by groundwater fed side channels and tributaries found in the large glacial outwash floodplains.

Small clear water streams fed by rain and snowmelt often flow into the major glacial rivers or lakes before reaching the coast. The headwaters of these systems are typically steep, high gradient contained channels that mainly function to transport sediment (USDA Forest Service 1992). Gravels used by anadromous salmonids for spawning are transported from these areas and deposited into downstream habitats where channels are lower gradient and less contained. Coniferous forests dominate the riparian zones in these headwater stream channels. Large wood from the riparian zone is recruited into stream channels and transported downstream where it creates complex habitats beneficial to stream rearing salmonids. The headwater tributaries typically contain minimal fish spawning or rearing habitat due to steep gradients and large substrates.

Transitional stream reaches, between headwater tributaries and glacial outwash channels, provide much of the spawning and rearing habitat for salmonids. The floodplain process group comprises many of the channels in these stream reaches. Floodplain channels have high Indicator Species Rating (ISR) values with regard to both spawning and rearing habitat for coho and sockeye salmon, and Dolly Varden (USDA Forest Service 1992). Pools and beaver ponds are prevalent habitats in these channels and they provide depth and complexity necessary for overwintering survival of salmonids (Bustard and Narver 1975; Smith and Griffith 1994). Riparian zones composed of mixed deciduous and coniferous forests offer overhanging stream bank cover and in-stream habitat through recruitment of large wood.

Periods of heavy rain and steep, flashy, headwater streams can result in frequent flooding of stream channels. Floods can dislodge and transport aquatic and terrestrial invertebrates downstream, making them more vulnerable to predation by juvenile salmonids (Pearson and Franklin 1968; Irvine 1985). Flooding can also make previously inaccessible food resources available to stream rearing salmonids through the inundation of water on flood plains and pond margins (Junk et al. 1989; Wissmar et al. 1991).

Groundwater-fed systems also provide important spawning and rearing habitat for anadromous salmonids in the East Delta watershed region. These systems typically originate from subsurface groundwater flow from an adjacent large glacial river or glacial moraines. In these channels, coho and sockeye salmon tend to spawn in upwellings where suitable gravels exist. These upwelling zones supply oxygenated water, which is critical to egg and embryo survival (Bjornn and Reiser 1991). Groundwater fed systems can also provide important overwinter habitat for stream rearing fishes because they may offer consistent flows and relatively warm temperatures during the winter months (Cunjak 1996).

Martin River Slough, Katalla, and Controller Bay

These coastal regions of the analysis area are comprised of complex aquatic habitats including ocean beaches, mudflats, sloughs, estuaries, ponds, and marsh (Benda et al. 1991). Ocean beaches in the region include Strawberry Reef, Okalee Spit, and Softuk Bar. Some of the major sloughs and rivers include Martin River Slough and the Katalla, Nichawak, Campbell, Okalee, and Edwardes Rivers.

The lowest stream reaches in this area are tidally influenced; therefore the highest diversity of fish species can likely be found here because both salt and freshwater fish species may be present. Little is known about fish use of the intertidal habitats. Adult coastal cutthroat trout are closely associated with the coastal streams and estuaries of the

Northwest Pacific Ocean (Williams and Nehlsen 1997). Juvenile cutthroat trout and salmon can tolerate a wide range of salinities and may be able to migrate through or even rear in these inter-tidal areas (Otto 1971; Yeoh 1991). Salmon smolts migrate through the lower Delta area and may forage in the estuaries prior to migrating to the open ocean. The freshwater inter-basin sloughs and ponds provide summer rearing habitat for juvenile coho and sockeye salmon (Bryant et al. 1991). However, low oxygen levels and prolonged ice cover may render these same habitats unsuitable during the winter. Clear flowing tidal rivers such as the Katalla provide spawning for pink and chum salmon.

Islands

Kanak, Wingham, and Kayak Islands make up this region of the analysis area. Wingham and Kayak islands are characterized by high gradient streams and rocky beaches. On these two islands most of the freshwater streams are probably too steep to support fish. Juvenile coho salmon have been observed by Forest Service personnel in a few low gradient coastal streams on the northwest side of Kayak Island. Anadromous salmonids have not been documented on Kanak or Wingham Islands.

Fish distribution - The current GIS corporate stream layer for the Chugach National Forest may not include all salmonid stream systems. The current layer may also not include all documented data on fish species presence. For instance, coho salmon are known to be present in streams on Kayak Island but the GIS database does not show coho presence in these streams. The data presented here likely underestimates the true presence and distribution of the key species, especially cutthroat trout and Dolly Varden.

Coho salmon are the most widely distributed species in the analysis area (Figs 2.15A and 2.16A). Based on the current GIS corporate stream layer, they can be present at some life stage in all but the northern region covering approximately 332 miles of streams (USDA Forest Service GIS 1998). Coho are present in the Islands region (several Kayak Island streams) as well but the extent of their distribution in these streams is unknown (K. Hodges, USFS, personal communication).

Dolly Varden are the next most widely distributed species (Figs 2.15C and 2.16A). They are found in approximately 278 miles of streams in the analysis area (USDA Forest Service GIS 1998).

Sockeye salmon are found in 258 miles of streams in the analysis area **(**Figs 2.15A and 2.16A). These fish are generally associated with lakes because juveniles often rear in lakes for 1 – 3 years before migrating to the ocean as smolts (Groot and Margolis 1991). Thus, the Martin, Little Martin, Bering, Kushtaka, and Tokun Lakes are considered important sockeye salmon rearing habitats.

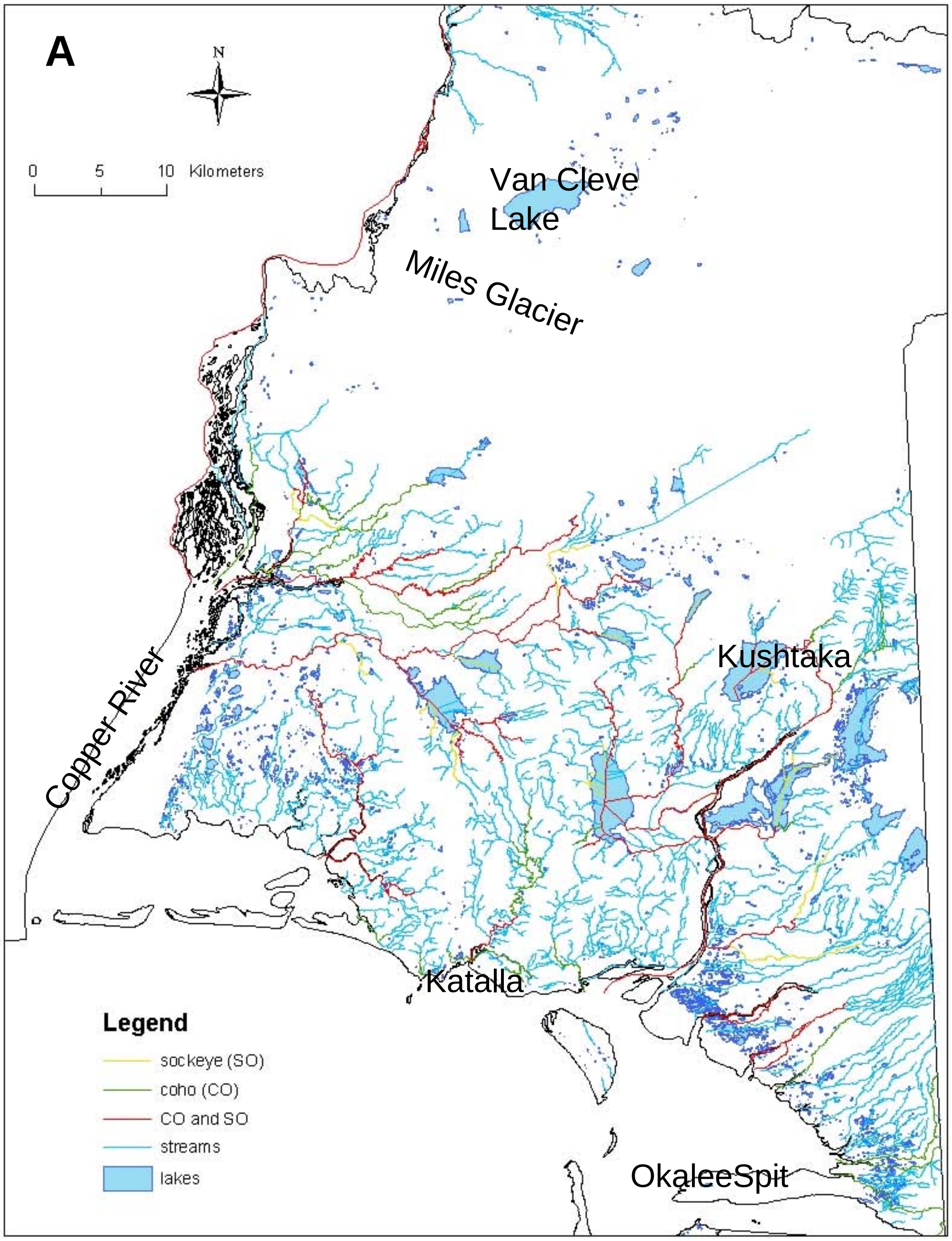


Figure 2.15A - Distribution of sockeye and coho salmon in the analysis area based on current GIS corporate stream layer (USDA Forest Service GIS 2002).

Pink salmon occur in 73 miles of streams and chum salmon occur 67 miles of streams in the analysis area. These species are closely linked to the major clear flowing streams in the coastal region (Figs 2.15B and 2.16A).

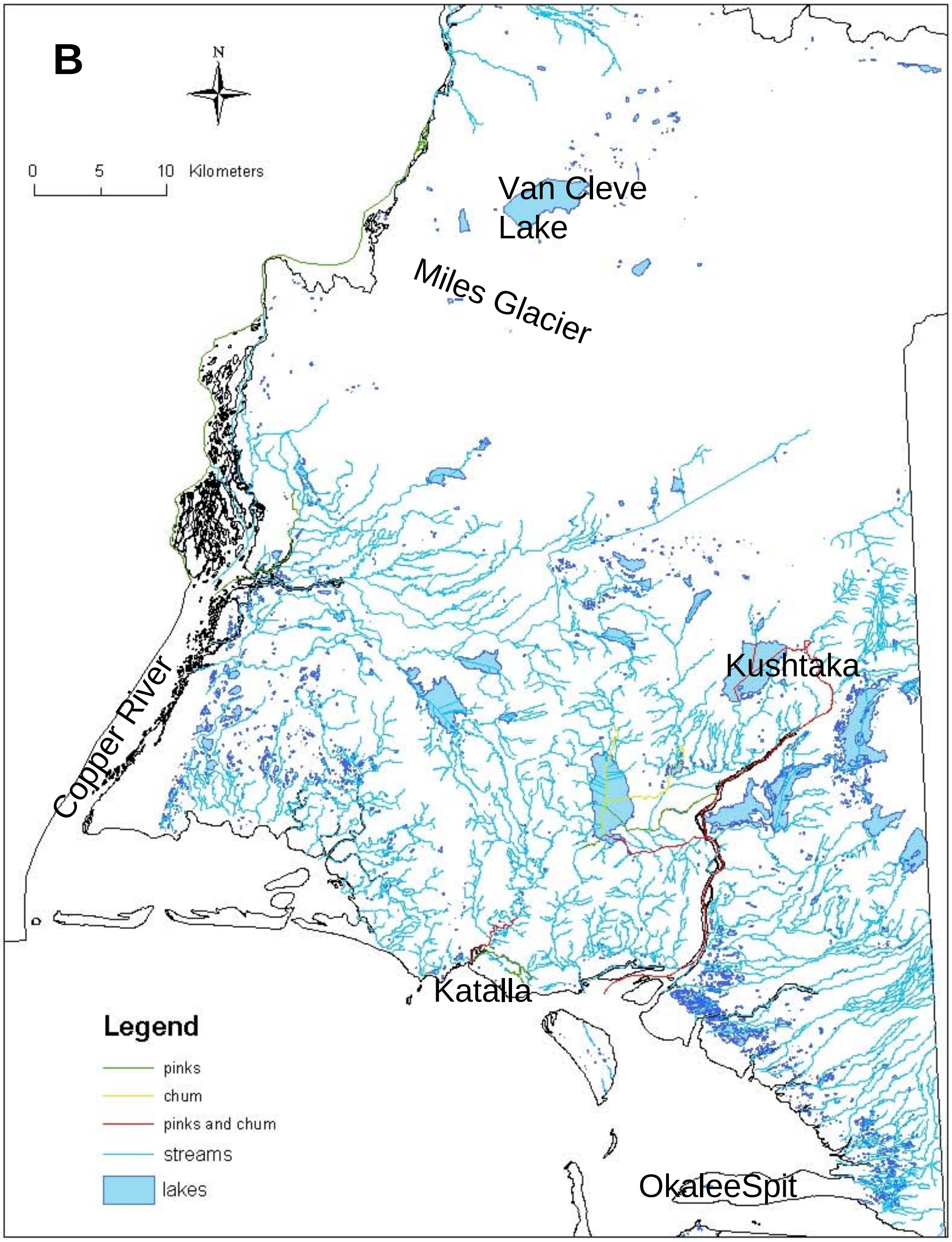


Figure 2.15B - Distribution of pink and chum salmon in the analysis area based on current GIS corporate stream layer (USDA Forest Service GIS 2002).

Coastal cutthroat trout can be found in 155 miles of streams in the analysis area (Figs 2.15C and 2.16A) (USDA Forest Service GIS 2002). This species may be more widely distributed and current studies by the Alaska Department of Fish and Game (ADF&G) will provide important information on the range and distribution of these fish in the analysis area (B. Marston, ADF&G Sportfish Biologist, personal communication).

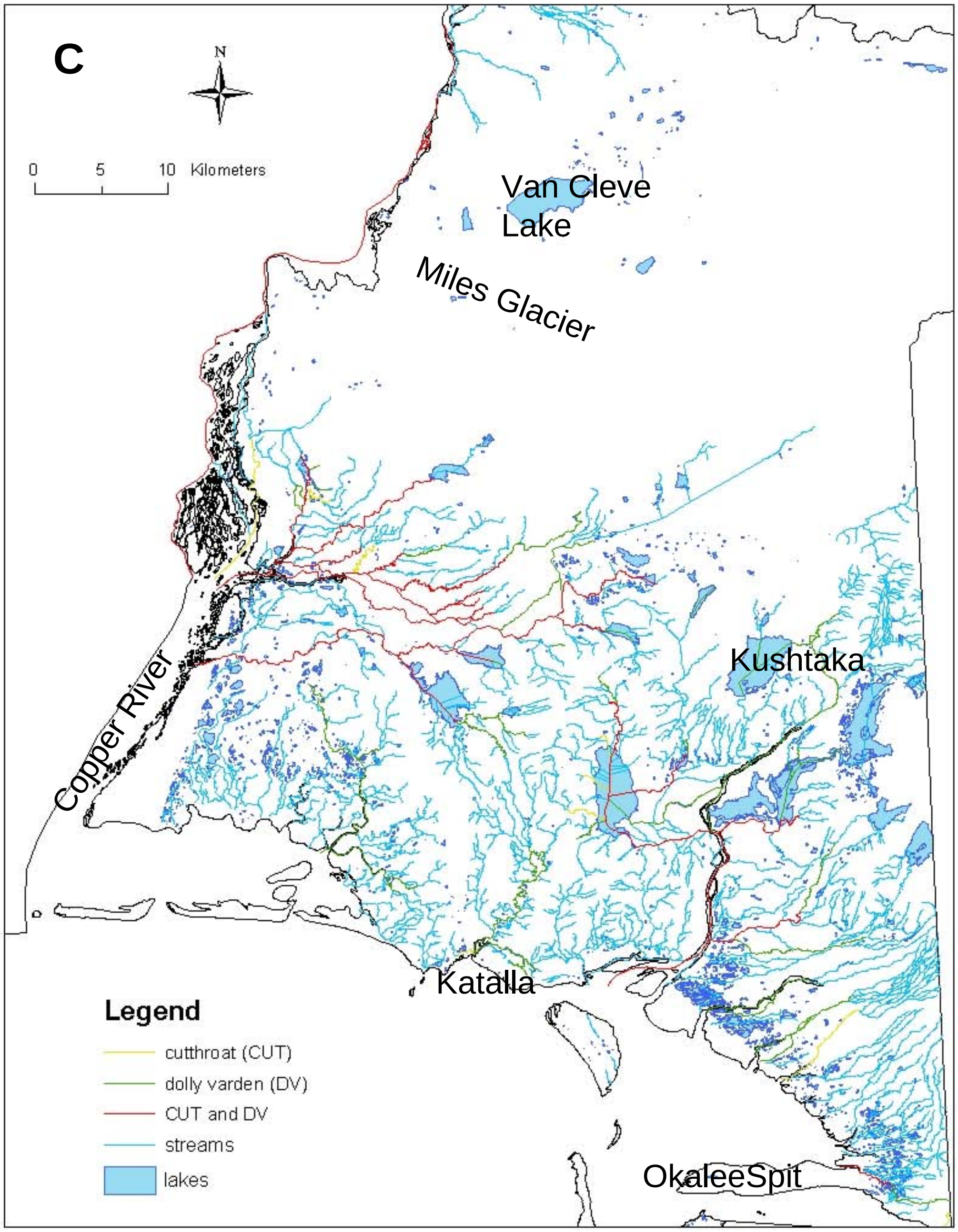
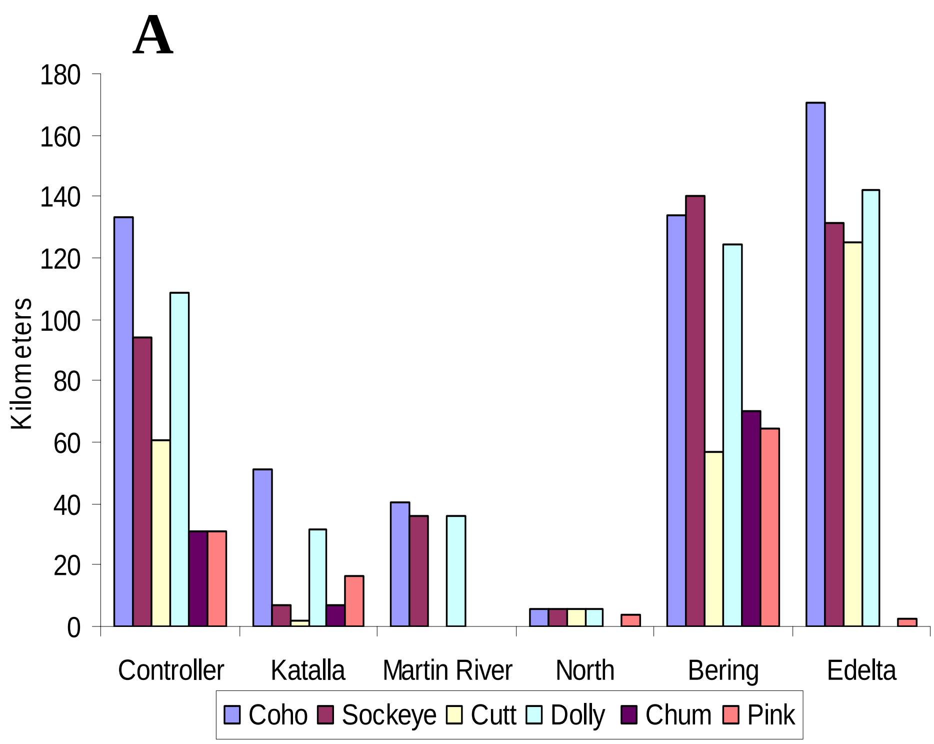


Figure 2.15C - Distribution of cutthroat trout and dolly Varden in the analysis area based on current GIS corporate stream layer (USDA Forest Service GIS 2002).



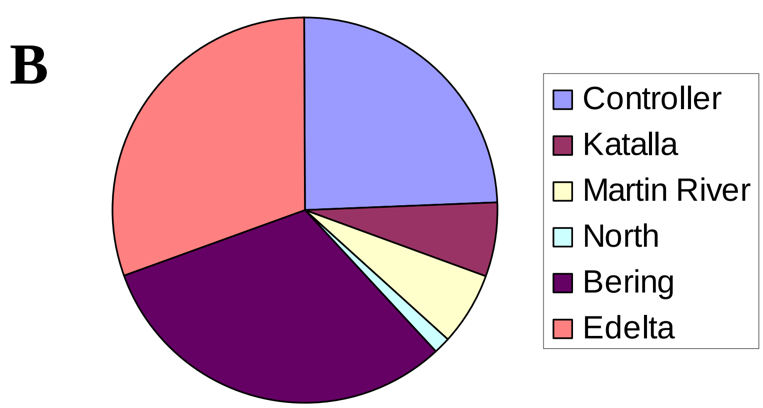


Figure 2.16 - Presence and distribution of selected salmonid species in the analysis area based on the GIS corporate stream layer. A) shows the species presence in kilometers of stream for each of the watershed regions. B) shows the salmonid presence in each region as the percentage of total amount of streams with these species.

The East Delta, Controller Bay, and Bering River regions comprise a large percentage of the total documented salmonid stream habitat in the analysis area (Fig 2.16B). The streams in these regions appear to support extensive coho and sockeye salmon and Dolly

Varden populations (Figure 2.16A). The North region contains a small percentage of the stream habitat (Figure 2.16B), and no salmonid presence is recorded in the corporate GIS data base for the Islands region (USDA Forest Service GIS 1998).

The Martin River system contains a robust and unique population of steelhead/rainbow and cutthroat trout. The adult sea-run trout can be as long as 25.5 inches**.** There appears to be a high degree of hybridization between the two species. In a recent genetics study not yet published, 60% of the sampled fish from the Martin Lake system were cutthroat-rainbow hybrids (Gordon Reeves, PNW research station, personal communication). In the same study, hybridization between the two species was also documented in other streams on the Delta including the Mile 18 and Bering River although the proportion of hybridized fish sampled was less.

The origin of the steelhead/rainbow trout in the analysis area is unknown. Rainbow trout do not naturally exist in Prince William Sound but populations do travel up the Copper River to the interior basin. Anecdotal information suggests that steelhead and rainbow trout occurred in small populations in a few streams of the East Delta analysis area. These rainbow trout may be an extension of the upriver population. However, rainbow trout were stocked in some streams along the Copper River Highway near Cordova from 1966 – 1991, and stockings occurred in open systems where fish were free to move in or out of the stocked watersheds (Miller and Stratton 2001). These rainbow and cut-bow trout hybrids may be ancestors from these past stocking efforts.

Many biological factors contribute to the aquatic productivity of the lower gradient, clear-water stream systems, which appear to be the most productive for anadromous salmonids. Clear water allows light penetration, the energy source for primary production in streams (Allan 1995). Much of the riparian vegetation along these streams is deciduous, thus annual inputs from leaf litter to streams can be a substantial source of nutrients. Two dominant species of riparian vegetation, Sitka alder (*Alnus crispa var sinuata*) and sweet gale (*Myrica gale*), are nitrogen fixers. Leaf drop in the fall can make this nitrogen available to aquatic systems. When nitrogen is limited, these species may provide an important source of new nitrogen for stream habitats (Wissmar et al. 1991).

Beaver (*Castor Canadensis*) play a significant role in creating large, deep ponds that can be especially productive rearing habitats for juvenile coho salmon (Peterson 1982, Bryant 1984). Beaver ponds are also depositional areas where nutrients can be trapped and stored (Bilby and Likens 1980, Cedarholm et al. 1989). Stream habitats adjacent to spawning gravels may be highly productive because spawning salmon provide food and nutrients to stream rearing resident and juvenile salmonids (Bilby et al. 1998, Lang 2003). High recruitment of young-of-the-year cohorts from nearby spawning habitats may also influence stream rearing productivity of salmonids in these stream reaches (Bryant et al. 1991, Lang 2003).

Vegetation[5]

Around 14,000 years ago, the glaciers covering the area began to recede and plants began steadily moving in from the south and from glacial refuges in Alaska. Extrapolating from paleoecological evidence (Heusser 1983, Peteet 1986), Sitka spruce[6] and western hemlock forests became established about 3000 years ago. The vegetation of the Copper River Delta is very dynamic since it is highly dependent on the tectonic uplifting and slow subsidence of the land, the constant channel changes of the glacial rivers, and the drainage characteristics of the soil. Strong historical evidence indicates that the vegetation development on the Delta has gone through a least two cycles from the low meadow/shrub stage to the spruce forest stage, meaning sufficient time between the submerged and uplifted cycles has occurred to allow the vegetation to progress to a forested stage.

Before 1964, much of the delta was covered by brackish marshes dominated by sedges and mixed grass/forb communities. By lifting these marshes above the tidal influence, the earthquake initiated dramatic changes in vegetation composition and structure. Some marsh communities described as common in early studies (1986 and 1975) are now rare or absent on the landscape. Many mudflats were elevated sufficiently that they are now developing brackish marshes (Boggs 2000). Prior to 1964, much of the outer portion of the delta was identified by a 4.6-foot high wave-cut terrace that averaged about 12 feet above the mean high tide line (Thilenius 1989). As evidenced by partially buried driftwood and other natural and man-made objects, this terrace and at least the adjacent inter-levee basins were periodically flooded by tides. Levees farther inland were probably influenced to lesser degrees.

Vegetation inventories by Crow (1968), Thilenius (1989), and Potyondy (1975b) indicate that before the earthquake, either no or only minor amounts of woody shrubs occurred on the foreshore levees with an increasingly greater number occurring farther inland. In other words, where the tidal influence was the greatest or the most recent, woody shrubs occurred less frequently. There is no evidence that this area is flooded by tides since it has been uplifted. Since the uplift, woody shrubs have grown to dominate the vegetation cover on the foreshore levee and other levees not previously covered with woody vegetation.

As described in the Vegetation Ecology Resource Report for East Delta prepared by Develice (2004), although the overall number of plant community types is less on the Copper River Delta than on the two other broad geographic areas of the Forest (i.e., Kenai Peninsula and Prince William Sound), the number of herbaceous communities is highest on the delta. Refer to *Classification of Community Types, Successional Sequences, and Landscapes of the Copper River Delta, Alaska* by Boggs (2000) for more detailed information. He describes 75 community types and 42 successional sequences.

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[5] Where appropriate, text in this document duplicates that presented in the West Copper River Delta Landscape Assessment (dated 03/18/2003).

[6] The scientific names for the species listed are provided in Appendix A Table A.1.

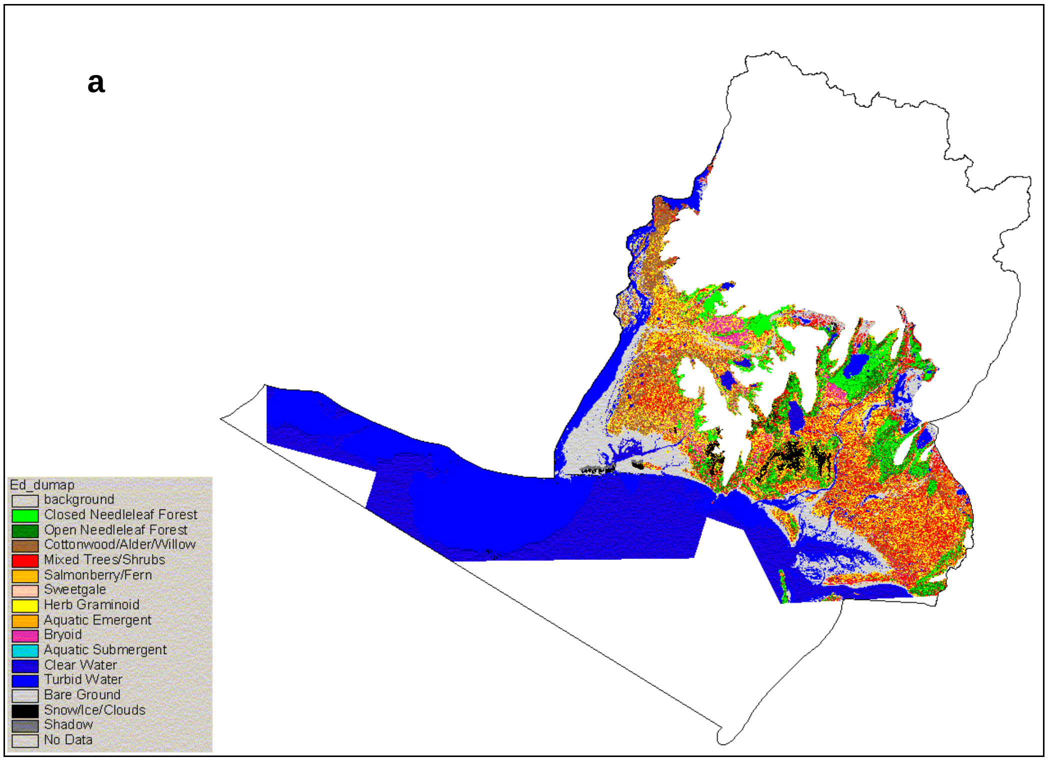
The vegetation cover type in the analysis area ranges from marsh, grass, willow, muskeg, needleleaf forests, broadleaf forest, alpine, rock, snow and ice. The characteristic needleleaf forest species include Sitka Spruce, mountain hemlock, and western hemlock. The forest understory is composed of salmonberry, devils club, early blueberry, Alaska blueberry, and skunk cabbage. Broadleaf forests are dominated by black cottonwood with devils club, salmonberry, alder, and willow and some spruce in the understory. Shrublands species include Sitka alder, Barclay and Sitka willow, and sweetgale. Herbland species include crowberry, bog blueberry, bog cranberry, Steller's cassiope, Aleutian mountain heath, luetkea, tall cottongrass, tufted bulrush, bluejoint reedgrass, beach rye, sedges, and mosses. Dominant wetland herbaceous communities include swamp horsetail, marsh fivefinger, buckbean, Lyngby's sedge, Sitka sedge, burreed, yellow pond lily, alkaligrass, Pacific silverweed, Nootka lupine, tall fireweed, tufted hairgrass and beach rye. Characteristic dominants of the shrublands include sweetgale, Sitka alder, Barclay willow and Sitka willow (DeVelice et al. 2001).

Figure 2.17a and Table 2.5 display the land cover type and acreages for each for the analysis area using multispectral imagery. Figure 2.17a and information in Table 2.5a, is from work done by Kempka et al.(1994) and Figure 2.17b and Table 2.5b is from Markon and Williams (1996). The classifications used in both land cover maps approximate level 3 of the Alaska Vegetation Classification (Viereck et al 1992.)

The work by Kempka et al. (1994) covers about 48% of the analysis area. The primary areas excluded are Kayak Island and mountainous terrain. The Markon and Williams (1996) work covers about 83% of the analysis area. The primary area excluded is along the eastern boundary of the analysis area.

Tall woody land cover dominates the vegetation in both images, with herbaceous vegetation second in abundance and low woody vegetation third. Since the Markon and Williams (1996) image includes an extensive area of mountainous terrain in the northeastern part of the analysis area, it includes much more non-vegetated terrain than the Kempka et al. (1994) image. Clouds and shadow are also more abundant in the Markon and Williams (1996) image and obscure landcover in portions of the southern half of the analysis area.

Table A.2 in Appendix A summarize the known cover type by acres from the corporate database and Figures A-2 andA-3 display this information on a map. This information is based on 1976 timber type data and aerial photo interpretation and has not been updated. No information is available for the north half of the analysis area.



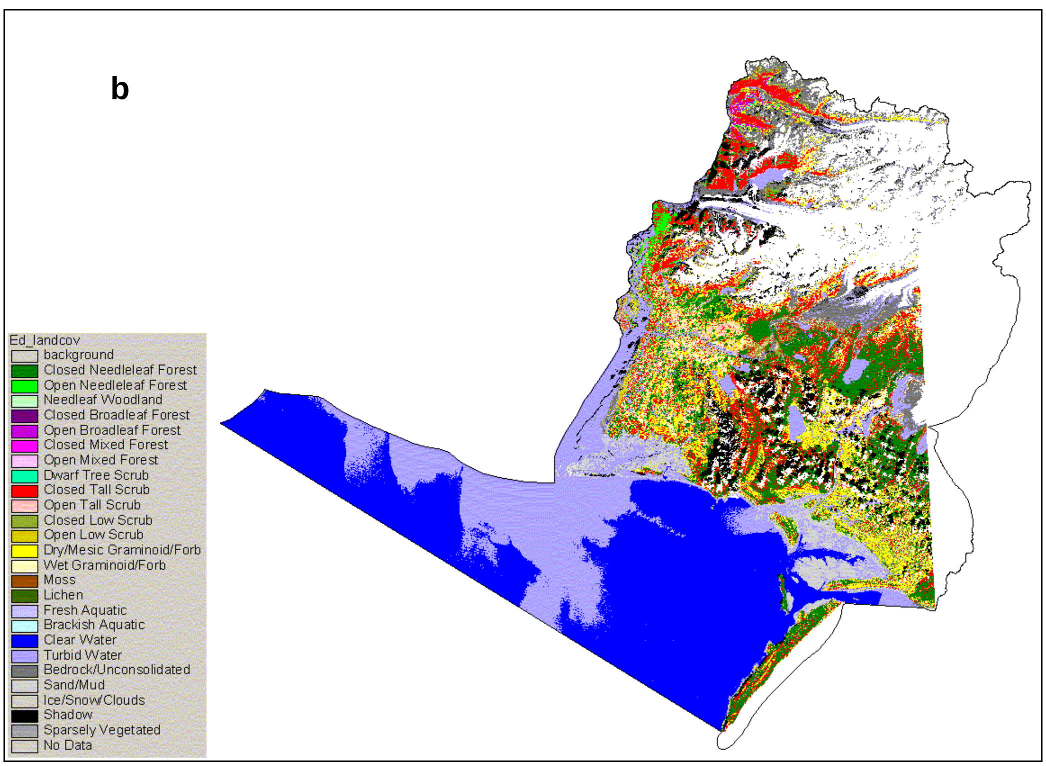


Figure 2.17 – Land cover types of the East Delta Analysis Area from a)Kempka et al. (1994) and b) Markon and Williams (1996).

Table 2.5- Acreage of land cover types within the analysis area from a) Kempka et al (1994) and b) Markon and Williams (1996).

A) Land Cover Type - Kempka et al. (1994)	Acres	Percent of Nonwater Area	Subtotal Percent
Closed Needleleaf forest	50,910	9.63	
Open Needleleaf forest	33,506	6,34	
Cottonwood/Alder/Willow	68,917	13,04	Tall Woody
Mixed Trees/Shrubs	98,758	18,89	47,71
Salmonberry/Fern	12,795	2,42	Low Woody
Sweetgale	14,858	2,81	5,23
Herb Graminoid	87,301	16.52	
Aquatic Emergent	18,961	3.59	
Bryoid	15,599	2.57	Herbaceaous
Aquatic submergent	274	0.05	22.74
Clear water	195,958	----	N/A
Turbid water	224,891	---	N/A
Bare Ground	110,553	20.92	Non-Vegetated
Snow/Ice/Clouds	16,393	3.10	24.02
Shadow	1,584	0.30	0.30

B) Land Cover Type – Markon and Williams (1996)	Acres	Percent of Nonwater Area	Subtotal Percent
Closed Needleleaf forest	138,072	13.87	
Open Needleleaf forest	15,198	1.53	
Open Broadleaf Forest	3,217	0.32	
Dwarf Tree Scrub	203	0.02	
Closed Tall Scrub	134,649	13.53	Tall Woody
Open Tall Scrub	7,971	0.80	30.07
Closed Low Scrub	33,277	3.34	Low Woody
Open Low Scrub	8,024	0.81	4.15
Dyr/Mesic Graminoid/forb	90,361	9.08	
Wet Graminoid/Forb	50,983	5.12	
Fresh Aquatic	215	0.02	
Brackish Aquatic	128	0.01	Herbaceous
Sparsely Vegetated	11,022	1.11	15.34
Clear water	448,682	----	N/A
Turbid water	312,903	---	N/A
Bedrock/Unconsolidated	95,513	9.60	
Sand/Mud	46,881	4.71	Non-Vegetated
Snow/Ice/Clouds	278,747	28.00	42.31
Shadow	80,917	8.13	8.13

Wildlife

The East Copper River Delta analysis area includes vast wetland habitats, uncommon elsewhere in coastal Alaska, as well as habitats that are representative of those found in coastal southcentral Alaska. Its diversity includes tidal marsh, uplifted marsh, and glacial outwash plains on the delta, as well as spruce and hemlock forests, muskeg, subalpine, and alpine habitats in the uplands (Boggs 2000). The fauna inhabiting this area include the compliment of species found elsewhere in coastal south-central Alaska with a few exceptions. Caribou (*Rangifer tarandus*) are not present and were not historically; while moose (*Alces alces*) although not present in historical times, were introduced west of the Copper River in the 1950s.

Glaciers and steep terrain of the Chugach Mountains are the dominant influence on wildlife habitat in the northernmost watersheds of the analysis area. Elevations range from 186 feet at Miles Lake to 11,210 feet on Mount Tom White in the northeast portion of the analysis area. The non-glaciated area is characterized by steep mountains, dense alder at lower elevations and alpine tundra and bare rock at higher elevations. The climate in the Copper River corridor, the most productive wildlife habitat in the northern portion of the analysis area, is especially severe, even for Alaska. Human use of this area is mainly within the Copper River corridor by river rafters and hunters.

The middle region of the analysis area is a diverse and dynamic landscape ranging from large glaciers to wetland sloughs. Correspondingly, there is a high diversity of wildlife habitats and vegetation. This area covers the transition between the same mountainous, glaciated peaks to the north and the delta wetlands to the south. The three island mountain ranges that are separated from those of the main Chugach Range to the north are the Ragged Mountains, Don Miller Hills, and Suckling Hills and they attain elevations up to 3,315 feet.

The Copper River Highway provides access to the northwest portion of this region near the Copper River. Some areas can be accessed by snowmobile in winter and by jet-boat or airboat in spring, summer, and fall. Several large lakes, including the Martin Lakes, Bering and Tokun Lakes are suitable for float plane access. Human use is light compared to the area west of the Copper River and is primarily by hunters and anglers. Unlike the West Copper River Delta, the East Copper River Delta is open to commercial guiding.

The Coastal region of the analysis area contains a complex of habitats including ocean beaches, mudflats, sloughs, tidal estuaries, ponds, and marsh. Elevations are mostly near sea level, although the isolated mountain ranges extend to the coast. The lower stream reaches in this area are tidally influenced. This portion of the analysis area is remote and accessible only by boat or airplane.

Wingham and Kayak Islands are characterized by mountainous terrain and rocky beaches. Elevations range from sea level to 1,620 feet at Cape Saint Elias. Vegetation on these islands is mostly coniferous forest. Extensive rocky tidal pools exist on the west side of Kayak Island. Generally people access Kayak Island with airplanes or helicopters. Fixed wing aircraft must land on eastern beaches at low tide. Cape Saint Elias lighthouse, at the southern tip of Kayak Island, is maintained by Cape Saint Elias Light Keepers Association and is available for rent. Presently, access to the lighthouse is restricted to helicopter landings or landing a fixed-wing airplane 2 miles to the northeast.

Following are the species or groups of species of special concern to the USFS, USFWS, ADF&G, or have other notable issues surrounding them (i.e. hunting, viewing, etc.). Sensitive Species are those plant and animal species the Regional Forester has identified as having a concern about population viability on National Forest System lands.

Federally listed threatened and endangered species are those species formally listed by the USFWS under authority of the Endangered Species Act of 1973, as amended. ADF&G lists Species of Special Concern as any species or subspecies of fish or wildlife or population of mammal or bird native to Alaska that has entered a long-term decline in abundance or is vulnerable to a significant decline due to low numbers, restricted distribution, dependence on limited habitat resources, or sensitivity to environmental disturbance.

Birds - Over 219 bird species have been documented within the North Gulf Coast-Prince William Sound Region of Alaska (Isleib and Kessel 1973). Between 1993 and 1995, 88 species of birds were documented on 2 breeding bird survey routes west of the Copper River and represent some of the more common breeders on the Delta (Appendix A, Table A.3). Table A.3 includes the scientific names for those species. Not represented in the survey data are several species of raptors that commonly breed within the analysis area including bald eagles, northern harriers, short-eared owls, and northern goshawks. Although much of the habitat and the associated avifauna in the area is in near pristine conditions, some bird-related issues exist and following are species or groups of birds meriting special attention.

The conservation of birds is complex due to the migratory nature of many species. Additionally, bird species fall under various management authorities depending on their population trends and game status. Table 2.6 lists the bird species found on the Copper River Delta that are of management concern by either the USFWS, USFS, ADF&G, or the National Audubon Society. The Forest Service addresses how each of these species is affected in site-specific project environmental analyses.

Table 2.6 - List of bird species occurring on the Copper River Delta considered to have special conservation concerns by either the USFWS, USFS, ADF&G, or the National Audubon Society.

Common name	Scientific Name	Comments
Alder flycatcher	*Empidonax alnorum*	Common Breeder
American golden plover	*Pluvialis dominica*	Common Migrant seen on mudflats and upland wetland areas
Bar-tailed godwit	*Limosa lapponica*	Casual Migrant
Black oystercatcher	*Haematopus bachmani*	Common Breeder, Winters near Montague and Green Islands
Black turnstone	*Arenaria melanocephala*	abundant in PWS near rocky areas rare on Copper River Delta, migrant
Brant	*Branta bernicla*	Common Spring Migrant mainly on the barrier islands
Bristle-thighed curlew	*Numenius tahitiensis*	Casual Migrant
Canada goose	*Branta canadensis*	Common Breeder and Migrant Dusky
Chestnut-backed chickadee	*Parus rufescens*	common all year
Common loon	*Gavia immer*	Migrant, & common local Breeder mainly on large upland lakes with fish
Dunlin	*Calidris alpina*	Abundant Migrant, most of world's population stops during spring migration
Golden-crowned sparrow	*Zonotrichia atricapilla*	abundant breeder and migrant, rare winter resident
Gray-cheeked thrush	*Catharus minimus*	Rare Breeder east of the Copper River
Hudsonian godwit	*Limosa haemastica*	Uncommon Migrant
Kittlitz' murrelet	*Brachyramphus brevirostris*	Breeder, Common PWS near glacial moraines Rare on Copper River Delta
Marbled godwit	*Limosa fedoa*	Common Migrant seen on mudflats and upland wetland areas
Marbled murrelet	*Brachyramphus marmoratus*	Breeder, winters, Common, Feeds in the nearshore and offshore regions, nests in Old Growth
Northern goshawk	*Accipiter gentilis*	Common Breeder and Winter Resident
Northern shrike	*Lanius excubitor*	uncommon in all seasons, may breed on the delta
Northwestern crow	*Corvus caurinus*	Breeder, abundant along coast in all seasons, decreases

Table 2.6 - List of bird species occurring on the Copper River Delta considered to have special conservation concerns by either the USFWS, USFS, ADF&G, or the National Audubon Society.

		dramatically inland
Olive-sided flycatcher	*Contopus cooperi*	Rare migrant, May breed on Copper River Delta and other areas around PWS
Osprey	*Pandion haliaetus*	Spring Migrant, Report of Breeding pair near Copper River
Pacific golden plover	*Pluvialis fulva*	Common Migrant seen on mudflats and upland wetland areas
Peregrine falcon	*Falco peregrinus*	Rare Migrant & Breeder, Cliff Nester, Reports of Nests Near Katalla, Hook Point, Boswell Bay, Possibly Flag Point
Red knot	*Calidris canutus*	Rare Migrant
Ruddy turnstone	*Arenaria interpres*	Abundant migrant in PWS near rocky areas rare on Copper River Delta
Rufous hummingbird	*Selasphorus rufus*	Common Breeder & migrant
Rusty blackbird	*Euphagus carolinus*	Rare winter resident. May breed inland.
Sanderling	*Calidrus alba*	Common Migrant, Rare Winter
Short-billed dowitcher	*Limnodromus griseus*	Seen on mudflats during migration, breeds in wetlands
Spectacled eider	*Somateria fischeri*	Rare winter Migrant
Steller's eider	*Polysticta stelleri*	Rare Migrant
Surfbird	*Aphriza virgata*	Seen mainly in PWS, Possible breeder
Townsend's warbler	*Dendroica townsendi*	Common, Breeds in Spruce Forests. Often seen and heard along SaddleBag Trail and Crater Lake Trail
Trumpeter swan	*Cygnus buccinator*	Common Breeder, Winter Resident--remains on open water during mild winters
Varied Thrush	*Ixoreus naevius*	abundant migrate and breeder, rare in winter
Western sandpiper	*Calidris mauri*	Abundant Migrant, up to 80% of World's Population stops during Spring Migration
Whimbrel	*Numenius phaeopus*	Common Migrant
Yellow-billed loon	*Gavia adamsii*	Winter Resident on Salt Water

The Copper River Delta is an important stopover and breeding ground for waterfowl including nine species of diving and sea ducks and four species of dabbling ducks. Most numerous of the waterfowl migrants are the trumpeter swan, Canada goose, white-fronted goose (*Anser albifrons*), northern pintail (*Anas acuta*), mallard, green-winged teal, and American widgeon. Sandhill cranes (*Grus canadensis*) also use the delta during migration. Most of these birds continue on to breeding grounds farther north, but several thousand pair of waterfowl remain to breed and raise their young on the marsh wetlands of the delta.

Seabirds

Several seabird colonies exist along the outer coast of the analysis area including nesting tufted puffins (*Fratercula cirrhata*), horned puffins (*Fratercula corniculata*), double-crested cormorants (*Phalacrocorax auritus*), pelagic cormorants (*Phalacrocorax pelagicus*), common murres (*Uria aalge*), black-legged kittiwakes (*Rissa tridactyla*), glaucous-winged gulls (*Larus glaucescens*), mew gulls (*L. canus*), arctic terns (*Sterna paradisaea*), and Aleutian terns (*S. aleutic)* (Table 2.7). Puffins, murres, cormorants, and kittiwakes use coastal cliff habitats for nesting while the other gull and tern species nest most commonly on barrier island dunes or on delta wetlands (Fig 2.18).

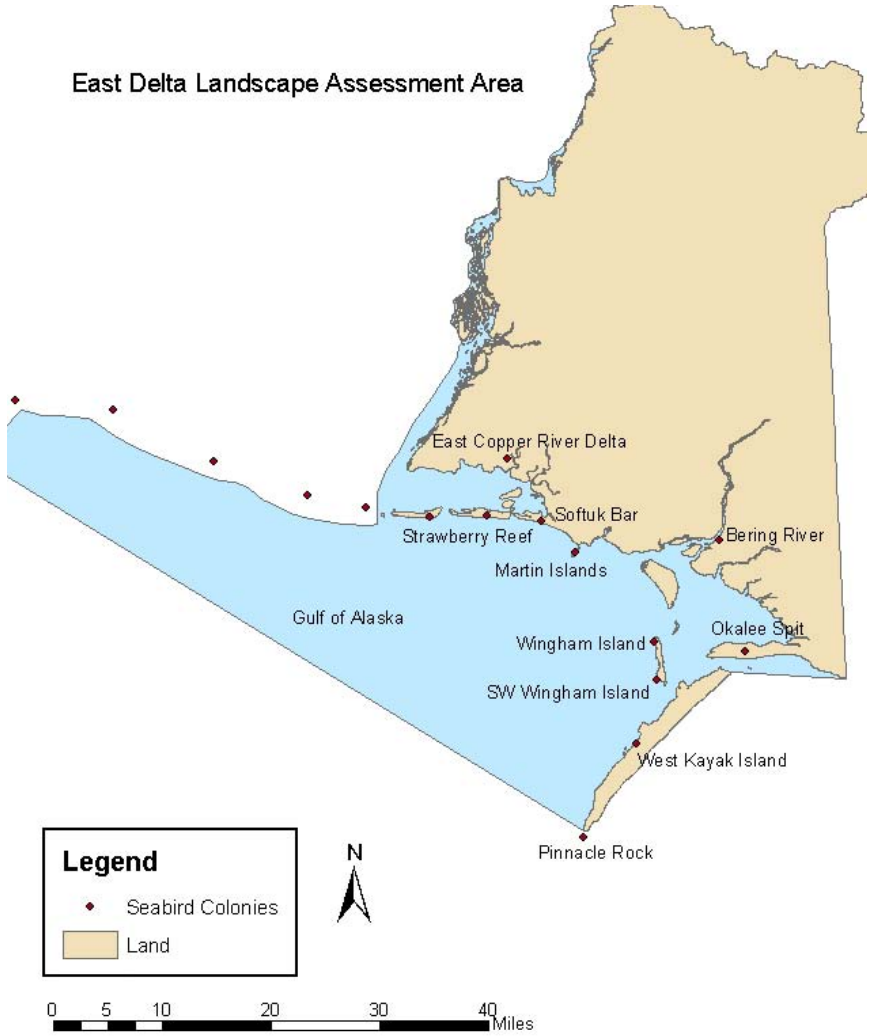


Figure 2.18 - Map of seabird nesting colonies in and near the analysis area

Table 2.7 - Seabird colonies within the Analysis Area (USFWS 2000).

	Puffins	*Murres*	*Gulls*	*Kittiwakes*	*Terns*	*Cormorants*	*Oystercatchers*	*Total*
Pinnacle Rock	6,000	2,460	220	0	0	232	0	8,912
West Kayak Island	108	0	50	0	0	78	0	236
SW Wingham Island	10	0	0	0	0	0	0	10
Wingham Island	200	4,620	190	14,256	0	330	0	19,596
Okalee Spit	0	0	0	0	200	0	0	200
Bering River	0	0	0	0	2,000	0	0	2,000
Martin Islands	2,200	4,240	400	13,420	0	12	4	20,276
Softuk Bar	0	0	1	0	1	0	0	2
East Copper River Delta	0	0	800	0	1,300	0	0	2,100

Shorebirds

Coastal areas of southcentral Alaska are important migration stopovers for migrating shorebirds. Every May, 4-6 million western sandpipers and Pacific dunlins use the Copper River Delta as a migration stopover (Bishop et al. 2000). Least sandpipers (*Calidris minutilla*), pectoral sandpipers (*C. melanotos*), lesser yellowlegs (*Tringa flavipes*), short and long-billed dowitchers (*L. scolopaceus*), marbled godwits, red knots, black-bellied plovers (*Pluvialis squatarola),* Pacific (*P. fulva*) and American golden plovers, and many other species also use this area during migration. These birds use the mudflats as critical feeding areas to replenish their fat reserves during their long migrations to breeding grounds.

Alder Flycatcher

The alder flycatcher is a species of management concern in Alaska. This species can be uncommon to fairly common in some years but rare in others. Isleib and Kessel (1973) reported alder flycatchers as fairly common in breeding territories along the Copper River Highway by the second week of June. Breeding Bird Survey data from 1993–1997 show alder flycatchers east of the 27-mile bridge in 1993, but absent in all other years. A partial survey in 2002 showed alder flycatchers to be fairly common east of Mile 17 of the highway. Alder flycatchers likely inhabit appropriate alder habitats in the analysis area.

Olive-sided flycatcher

The olive-sided flycatcher is a considered a Species of Special Concern by the State of Alaska. They breed in interior Alaska, and breeding pairs could occur in forested portions of the analysis area. They are listed as rare within the general area (Isleib and Kessel 1973), although they have been seen near Cordova during migration.

Rufous Hummingbird

The rufous hummingbird is a species of management concern in Alaska. They are common breeders and common migrants in the North Gulf Coast and Prince William Sound region, including Cordova (Islieb and Kessel 1973). They are common inhabitants west of the Copper River, so are likely common in the East Delta analysis area even though little data exists.

Bald eagle

The Bald eagle (*Haliaeetus leucocephalus)* is a species of special concern on the Chugach National Forest. The USFWS and USFS have an interagency agreement for its management in the Alaska Region that includes standards and guidelines for regulating human disturbance within identified bald eagle use areas. The bald eagle is an abundant and conspicuous resident of the North Gulf Coast and Prince William Sound region (Isleib and Kessel 1973). It is a year-round resident using large diameter spruce, hemlock, and cottonwood trees for nest sites and feeds in streams, lakes, and marine waters. Salmon in spawning streams can concentrate large numbers of eagles. Although the analysis area has not been intensively surveyed, several nests are known to occur and these nests represent only a fraction of all the nests in the area. Bald eagle nests are found wherever suitable nest trees are present (Figure 2.19).

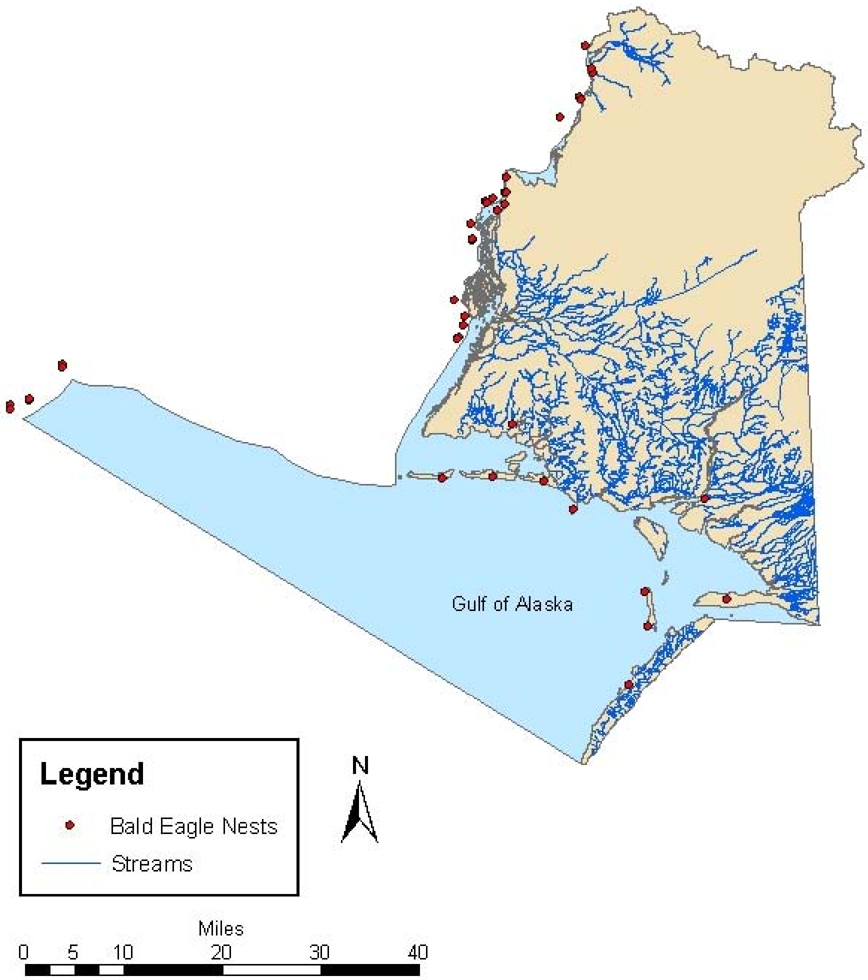


Figure 2.19-Distribution of bald eagle nests within the East Delta analysis area

Dusky Canada goose

The dusky Canada goose (*Branta canadensis occidentalis)* is a Region 10 sensitive species. Its breeding range is restricted to the Copper River Delta and wetlands east to Bering Glacier, Prince William Sound, and Middleton Island (Campbell 1990). It winters primarily in the Willamette Valley in Oregon, and along the Columbia River in Washington (Comely et al.1988, Bartonek et al. 1971).

Gray-cheeked Thrush

The gray-cheeked thrush is a considered a Species of Special Concern by the State of Alaska. Isleib and Kessel (1973) stated that the gray-cheeked thrush is a rare migrant and rare local breeder in the Prince William Sound-North Gulf Coast region. However, breeding bird survey data show this species to be fairly common east of Mile 30 of the Copper River Highway.

Northern Goshawk

The northern goshawk is the largest North American accipiter and a Region 10 sensitive species. Due to concerns over population declines, the northern goshawk is currently listed by the USFWS as a species of management concern. This means there is some evidence of vulnerability, but not enough data to consider a listing proposal under the Endangered Species Act of 1973. Declines in goshawk populations may be associated with forest harvest activities and habitat loss associated with roads (Bosakowski and Speiser 1994, Bright-Smith and Mannan 1994).

The northern goshawk is a forest habitat generalist, breeding in coniferous, deciduous, or mixed forests across its holarctic range (Reynolds et al. 1992). In Alaska, they are most often associated with old growth forests (McGowan 1975, Crocker-Bedford 1993, Titus 1996). It is considered a fairly common non-migratory resident in the Prince William Sound area (Isleib and Kessel 1973). While goshawks occur in a variety of forest successional stages, it is believed that nesting birds are most commonly associated with mature forests (Crocker-Bedford 1993, Titus et al. 1994, Titus 1996). Preferred habitat during the breeding season is mature and old growth forests with large trees for nesting and structural characteristics that allow goshawks to maneuver in and below the canopy while foraging (Reynolds et al. 1992). No goshawks nests are known in the analysis area, however, they likely occur in the appropriate forest habitats. A survey for goshawks was conducted in June of 2001 along the Katalla road, and no goshawks were detected.

Osprey

The osprey is a Region 10 sensitive species. It is an uncommon migrant and rare local breeder in the north Gulf Coast-Prince William Sound Region (Isleib and Kessel 1973). No osprey nests are known within the analysis area.

Peregrine falcon

The Peale's subspecies of peregrine falcon is a Region 10 sensitive species. It is a rare resident of the North Gulf Coast and Prince William Sound region. Most birds in the region appear to be *F. p. pealei*, but some migrants and one winter observation appeared to be the rare *F. p. anatum* (Isleib and Kessel 1973). During spring migration, peregrines appear most frequently between April 15 and May 5. Twelve to 20 pairs breed along the North Gulf Coast (Isleib and Kessel 1973). Eyries are on or in view of the coast and generally associated with nesting seabird colonies or waterfowl breeding areas. One active peregrine eyrie is known at Martin Point, and others likely exist within the analysis area, especially in the vicinity of the seabird colonies on Kayak and Wingham Islands.

Ptarmigan

All three species of ptarmigan, willow (*Lagopus lagopus*), rock (*L. mutus*), and white-tailed (*L. leucurus*), are found within the North Gulf Coast area of Alaska, and are likely found within the analysis area (Isleib and Kessel 1973). These birds largely use alpine habitats during the breeding season and some species, especially willow ptarmigan, descend to lower elevations in large numbers during winter. Isleib and Kessel (1973) noted reports of flocks of generally fewer than 100 birds in the Martin River Valley, however, during the 1950's flocks numbering several thousands were noted on the willow-alder flats in the area. Although no conservation concerns are known for any of these species in the region, they are popular bird for sport hunters and subsistence users during winter months. The ADF&G allows hunting of ptarmigan on the east Copper River Delta from 1 August through 15 May, with a bag limit of 20 per day.

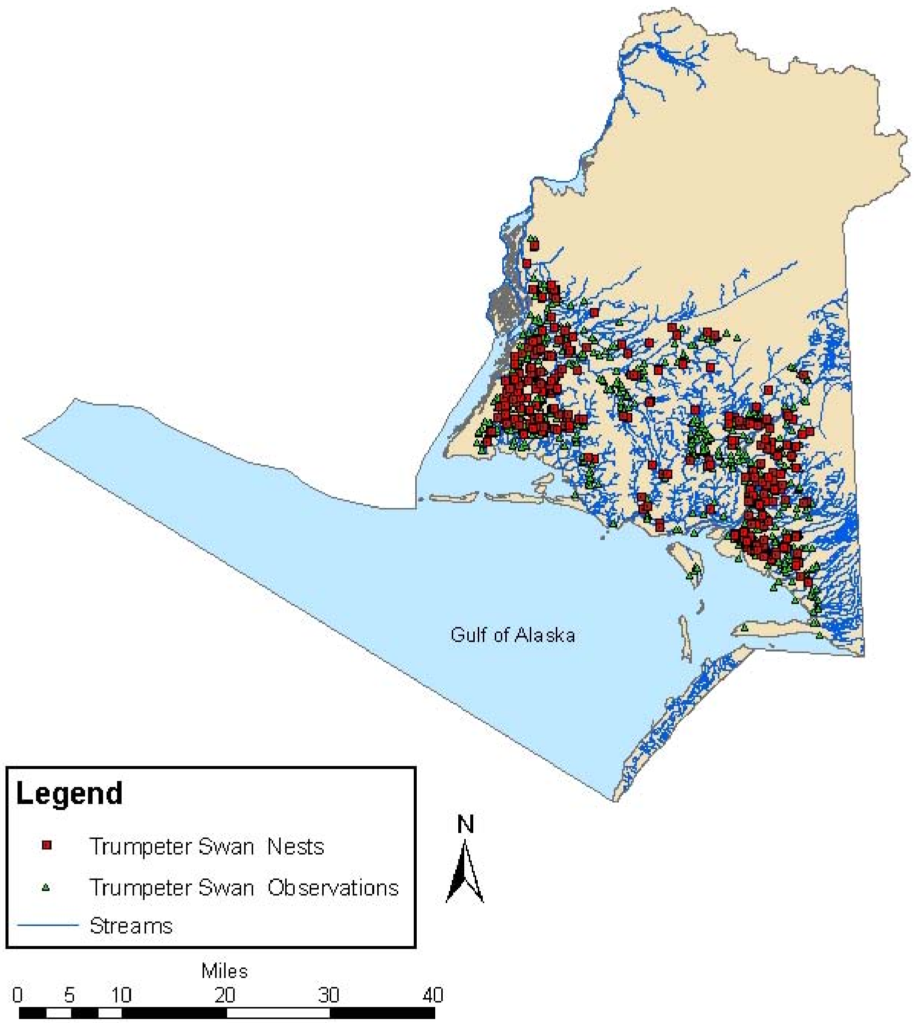


Figure 2.20-Distribution of trumpeter swan nests and observations in the East Delta analysis area

Trumpeter Swan

Trumpeter swans are a Region 10 sensitive species. They nest on the Copper River Delta and surrounding wetlands. Although some swans over-winter on ice-free waters in the area, most of the population winters in coastal British Columbia (Hansen et al. 1971). Swan nests, located through aerial surveys, are distributed throughout the analysis area (Figure 2.20).

Townsend's warbler

The Townsend's warbler is a considered a Species of Special Concern by the state of Alaska. It is a common, migratory breeder throughout south-central Alaska. They usually arrive from mid-May through early June and leave Alaska in August (Isleib and Kessel 1973). Townsend's warblers likely inhabit spruce-hemlock/alder forest, spruce-hemlock forest, and alder habitats within this analysis area. (Lance et al. 1996).

Mammals - The East Copper River Delta landscape analysis area includes extensive wetlands and habitats ranging from shoreline, low elevation forest, and foothills to alpine, rock and ice. If the species documented in 1984 around Eyak Lake, approximately 30 miles to the west of the analysis area, use the East Delta, over 31 species of animals could be present in the area (Table 2.8) (Professional Fishery Consultant 1984).

Table 2.8-Mammal species documented in the Eyak Lake area (PFC 1984).

Species	Latin name
Masked shrew	*Sorex cinereus*
Dusky shrew	*Sorex obscurus*
Water shrew	*Sorex palustrus*
Little brown myotis	*Myotis lucifigus*
Collared pika	*Ochotona collaris*
Snowshoe hare	*Lepus americanus*
Hoary marmot	*Marmota caligata*
Red squirrel	*Tamiasciurus hudsonicus*
Beaver	*Castor canadensis*
Northern red-backed vole	*Clethrionomys rutilus*
Tundra vole	*Microtus oeconomus*
Muskrat	*Ondatra zibethicus*
Northern bog lemming	*Synaptomys borealis*
Norway rat	*Rattus norvegicus*
House mouse	*Mus musculus*
Porcupine	*Erithizon dorsatum*
Coyote	*Canis latrans*
Gray wolf	*Canis lupus*
Red fox	*Vulpes vulpes*
Black bear	*Ursus americanus*
Brown bear	*Ursus arctos*
American Marten	*Martes americana*
Ermine	*Mustela erminea*
American mink	*Mustela vison*
Wolverine	*Gulo gulo*
Northern river otter	*Lontra canadensis*
Canada lynx	*Lynx canadensis*
Harbor seal	*Phoca vitulina*
Sitka black-tailed deer	*Odocoilus hemionus sitkensis*
Moose	*Alces alces*
Mountain goat	*Oreamnos americanus*

A few other species are probably present in the East Delta analysis area, such as the least weasel (*Mustela nivalis*) and other voles and shrews. Marine mammals found along the coast include Dall's porpoise (*Phocoenoides dalli)*, harbor seal, sea otter (*Enhydra lutris)*, Steller sea lion (*Eumentopias jubatus)*, killer whale (*Orcinus orca)*, grey whale (*Eschrichtius robustus*), and humpback whale (*Megaptera novaeangliae*) (Christensen and Mastrantonio 1999). Following are mammal species meriting special attention.

Brown Bear

Brown bears are common throughout the analysis area, but certain habitats receive concentrated use. Avalanche paths are important sources of herbaceous vegetation in the spring, berry patches are used during summer, and salmon streams are important during summer and fall. Brown bears also prey on moose calves in early summer. MacCracken et al. (1997) thought brown bears to be the primary predator of moose calves. However, they reported that the translocation of 16 brown bears from the Copper River Delta in May 1987 (40-50% of the bear population) resulted in no detectable increase in calf survival or recruitment.

Brown bears are known to concentrate on salmon spawning streams throughout the analysis area. They also concentrate on beaches along Strawberry Reef, Softuk Bar, Okalee Spit, Kanak Island, and the Bering Glacier forelands when strawberries ripen in June and July (Steve Ranney, pers. comm.). Annually, stranded marine mammals such as gray whales, humpback whales, and others provide infrequent feeding opportunities for brown bears along the coastline.

Brown bear hunting season on the East Copper River Delta (Game Management Units 6A and B) runs from September 1 through May 31. Residents and nonresidents may take one brown bear every regulatory year. Seven outfitters currently have USFS permits for bear hunting camps in the analysis area.

Wolf

Wolves are probably one of the more recent immigrants to the area. Few large ungulates, other than mountain goats, were available as prey until moose were introduced in the 1950s. Wolves were not introduced and probably migrated into the area via the Copper River and spread to the Copper and Bering River deltas. Wolves were first observed in Martin Valley near Goat Mountain in the severe winter of 1971-72 (Ed King, pers. comm.). In 1996, researchers estimated between 34-50 wolves on the Copper and Bering River deltas, including 4 to 6 packs, 2 to 4 pairs, and several lone wolves.

Wolves occur at low densities on the Copper River Delta relative to wolf populations of interior Alaska (Carnes et al. 1996). Predation rates on adult moose are low, possibly due to the exceptional body condition of moose on the Copper River Delta, making them difficult prey for individual wolves or small packs. Alternative foods such as beaver and salmon, waterfowl and rodents may, therefore, be important to these wolves.

Harvest by humans, both legal and illegal, is the chief causes of wolf mortality on the Copper River Delta (Carnes et al. 1996). Most of this mortality has occurred west of the Copper River. Due to difficulty of human access east of the river in winter, little wolf mortality has occurred there. Wolves may be hunted between August 10 and April 30 with a limit of 5 wolves. They can be trapped from November 10 to March 31 with no limit. Construction of a road through the analysis area would negatively impact this wolf population by increasing human harvest of wolves (Carnes et al. 1996).

Steller sea lion

The Steller sea lion is a Species of Special Concern for the state of Alaska and the western population is considered endangered by the USFWS. Although the eastern population has remained stable at an estimated 39,000 for the last few years, the western population of Steller sea lions has been declining rapidly, from an estimated total of 227,000 in 1960 to one of 45-46,000 in 2000. In 1997, the U.S. Steller sea lion population west of 144ºW (Cape Suckling, Alaska) was reclassified as Endangered under the Endangered Species Act; the rest of the population remained classified as Threatened, a status it has held since 1990.

Steller sea lions inhabit the Gulf of Alaska, including the waters adjacent to the Copper River Delta. Their habitat includes marine and terrestrial areas that are used for a variety of purposes. Adults congregate on rookeries for pupping and breeding. Rookeries are generally located on relatively remote islands, often in exposed areas where access by humans and mammalian predators is difficult. Sea lions haul out on suitable beaches or rock outcrops. The Cape Saint Elias sea lion haulout is considered critical habitat by National Marine Fisheries Service. Sea lion numbers have declined dramatically from counts made in the 1970s and 80s (Fig 2.21) (Sease and Gudmundson 2002). Smaller numbers of sea lions may also haul out on the Martin islands, between Softuk and Katalla. Sea lions may be present at the mouth of Copper River tributaries and move upstream during salmon migrations. Steller sea lions eat a variety of fish and invertebrates.

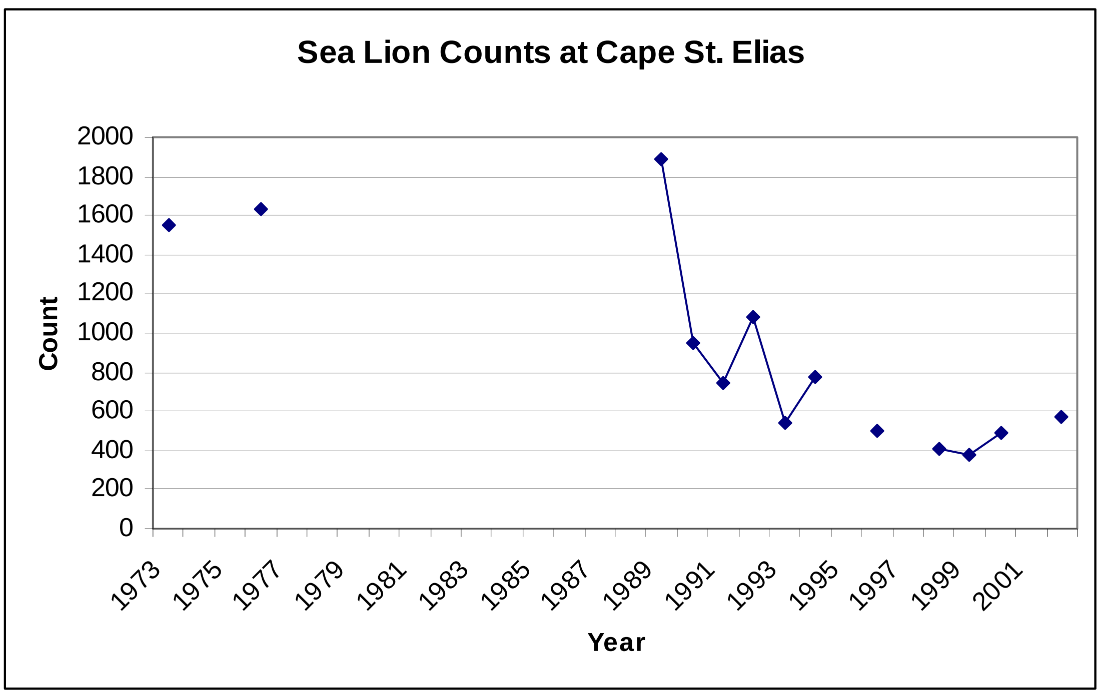


Figure 2.21 - Trends in Steller sea lion numbers using the Cape Saint Elias haulout. Years with no data point indicate that no survey was conducted (Sease and Gudmundson 2002).

Harbor Seal

The harbor seal is listed as a Species of Special Concern by the state of Alaska. It occurs along the coast in Alaska from British Columbia north to Kuskokwim Bay and west throughout the Aleutian Islands, including Prince William Sound, the Gulf of Alaska, and East Copper River Delta waters. Harbor seals haul out of the water on reefs, sand and gravel beaches, sand and mud bars, and glacial and sea ice periodically to rest, give birth, and nurse their pups. They haul-out in large numbers on sandbars at the mouth of the Copper River and follow spawning salmon up the river beyond Childs Glacier.

Mountain goat

Mountain goats use cliffs, alpine, subalpine, and old growth habitats. It is thought that winter habitat is the most limiting factor in southcentral Alaska (Suring et al. 1988). Goats are sensitive to habitat change, disturbance, and hunting pressure (Chadwick 1973). Aircraft can alter mountain goat behavior, and has the greatest potential to influence winter survival. Such disturbance can occur as far away as 1.24 miles from helicopters (Cote 1996). Mountain goats inhabit most of the alpine, mountainous portions of the analysis area, including the relatively low elevation Ragged Mountains and Don Miller and Suckling Hills near the coast.

Sitka black-tailed deer

These deer were introduced to islands in Prince William Sound in the 1930s and have subsequently populated most of the islands in the Sound and portions of the mainland. Deer occur in the analysis area in very low densities. Two deer were seen on Kayak Island in the mid 1990s and deer sign is occasionally seen at Katalla (Steve Ranney, pers. comm.). Currently, state bag limits in Game Management Unit 6 allows the harvest of 5 deer by state residents and no special subsistence season exists.

Moose

Moose are an important big game species throughout Alaska, but are not native to the Copper River Delta. They were established in the area through a series of annual translocations between 1949 and 1958 (Burris and McKnight 1973, Coady 1982) and the population steadily increased. Hunting began in 1960 and the population continued to increase until the severe winter of 1971-72 when 15-20% of the population died due to starvation. As a result of this die-off, the population has been maintained through hunting at 250-300 animals (Rausch 1976). Moose are highly valued by the local community as a food source and important to locals and visitors for viewing. The moose hunt in Game Management Units 6A and 6B are managed by the ADF&G by registration permit. Although no federal subsistence moose hunt occurs in the analysis area, a federal subsistence hunt for moose was proposed for units 6B and 6C in 1999. As a compromise, a federal subsistence hunt for cow moose was implemented in 6C but not in 6B. In 2002, 683 local residents applied for the 20 subsistence moose permits.

Amphibians - Two species of amphibians, the wood frog (*Rana sylvatica*) and the western toad (*Bufo boreas*) are uncommon residents of the area. Wood frogs inhabit diverse habitats from grasslands to forest, muskeg, and tundra and are documented west of the Copper River. Western toads are generally found in open, non-forested areas near fresh water. Both are likely present in the analysis area although little is known of their distributions. Western toads were abundant in July 1997 near Cape Saint Elias on Kayak Island (Dirk Lang, pers. comm.). Declines in amphibian populations have been documented worldwide; no data exists on the status of amphibians on the Chugach National Forest.

Human Dimension

Human Occupation

People have most likely been part of the Copper River ecosystem for millennia (Yarborough and Yarborough 1997:133). The lower Copper River and Pacific coast was the home of the Sugpiaq, or Chugach Eskimo, who considered the Pacific coast as far east as Controller Bay as their hunting grounds until the late 1700s (Birket-Smith 1953:20). The Eyak traditionally lived in the Malaspina-Yakutat Forelands area, controlling territory as far east as Dry Bay. They spoke a language related to Athapaskan, which may be distantly related to Tlingit.

The first indirect contact between Native Alaskans of the area and Europeans occurred in 1741, when Vitus Bering's second Russian expedition reached Kayak Island (Steller 1988). The first direct contact between these two peoples occurred sometime after 1778 when Captain James Cook's contacted the Sugpiag of Prince William Sound. Cook recorded landing on Kayak Island on May 12, 1778.

The early historic period was characterized by violent clashes between the Eyak and the Russians, the Eyak and the Tlingit, and combined Eyak-Tlingit battles with the Chugach Eskimo (de Laguna 1990:195). In the late 1700s, the Eyak were pushed west into the Bering River-Controller Bay area by the expanding Tlingit. By the early 19th century, the Eyak had moved into the Copper River area and the vicinity of what is now Cordova, forcing the Sugpiaq back into Prince William Sound (de Laguna 1990:189). By the end of the 19th century, the Eyak territory included the Copper River valley as far north as Childs and Miles Glaciers, the Pacific coast east towards Kayak Island, which was Tlingit territory, and west to Mountain Slough, Point Whitshed, and the edge of Prince William Sound.

The Eyak in the Controller Bay area were called the Chilkat Eyak. Their mainland settlements included one at the head of Controller Bay near the mouth of the Okalee River; a large village at Chilkat near the mouth of the Bering River, which may have replaced a village upriver or by Bering Lake, a village at Strawberry Point, Katalla, a village or intermittent settlement at Cape Martin, and Softuk (meaning "Behind the Cockles") Lagoon, northwest of Katalla and east of the mouth of the Martin River (de Laguna 1972:103-105; 1990:190). Settlements on islands in the Controller Bay area may have been seasonal or intermittent camping places, and some may have been Sugpiaq as well as Chilkat Eyak. Seton-Karr described a small settlement, "Kaiak", with houses which appeared to correspond to Sugpiaq -style summer houses. However, it is not clear if these were on Kayak Island, or Wingham Island, which was also known as "Little

Kayak" (de Laguna 1972:104-105). These settlements were occupied into the late 19th and early 20th centuries.

The third Native cultural group which occasionally used the Copper River area was the Ahtna. This Athapaskan group lived upriver on the Copper River, but came downriver from time to time to trade copper and caribou products for coastal goods (de Laguna 1990:190).

Two canneries were opened on Wingham Island in 1899. One was built by the Central Alaska Company, but was moved the following year. The other was built by the Peninsula Trading and Fishing Company which operated on the island in 1899 and 1890. the company moved the facility to "Coquenhena" (Kokenhinik), on the Copper River Delta, where it operated for seven years until a change in the river channel resulted in its abandonment (de Laguna 1972: 103). Both Kanak and Wingham Islands were turned into fox farms in the early twentieth century (de Laguna 1972:103).

Much of the history and many of the historic cultural resources in the analysis area are a result of the initial gold rush to Valdez in 1898-1899. Curious prospectors, who were unsuccessful in the interior or wished to try their luck in other areas, explored the land east of the Copper River and discovered coal fields near the Bering River and oil near Katalla. However, the coal-rich lands were temporarily withdrawn from settlement in December 1906 (Janson 1975:110). When the Chugach National Forest was created on July 23, 1907, the land east of the Copper River was outside the Forest Reserve. The area between the Copper River, and the current National Forest boundary was added on February 23, 1909. One of the reasons for this action was the wasteful cutting of commercially valuable trees by miners and railroad speculators (Rakestraw 1981:44, 48).

During the early 20th century, at least eight railroad companies brought employees to Katalla to survey and construct railroad lines. The Guggenheim-Morgan Syndicate decided against a Valdez terminal for their Copper River and Northwestern Railway (CR&NW) to interior Alaska, and purchased Michael Heney's "Copper River Railway", on which construction had begun in Cordova in August 1906. However the Syndicate then decided to suspend work on the Cordova line and instead run their standard gauge track from Katalla to the interior of Alaska via the Copper River, with a branch line to the nearby Bering River coal field (Clifford 1981:145). However, the poor harbor, dangerous sea conditions, and unpredictable weather at Katalla ultimately led the Syndicate to return to the Cordova design (Clifford 1981:146-147). Traces of sections of the line that was abandoned still exist between Lake Kahuntla and the east shore of the Katalla River, several miles to the northeast. The working line crosses the northwestern part of the analysis area. Work on the route east of the Copper River began in 1909 with the completion of bridges across the Copper River between miles 27 and 34 of the railroad and continued in 1910 with the construction of the Million Dollar bridge at Mile 47 (Clifford 1981:148-149). This railroad ran until 1938, and its bed became the base for the Copper River Highway in the 1950s.

One other railroad that was at least temporarily successful was the Katalla Coal Company, also known as the Goose City Railroad. This firm constructed a railroad to the Bering coal fields and operated for several years from Goose City, nine miles inland from Katalla. It closed down after the federal government withdrew the coal fields from entry for mineral claims as a result of the Pinchot-Balinger controversy (Clifford 1981:141).

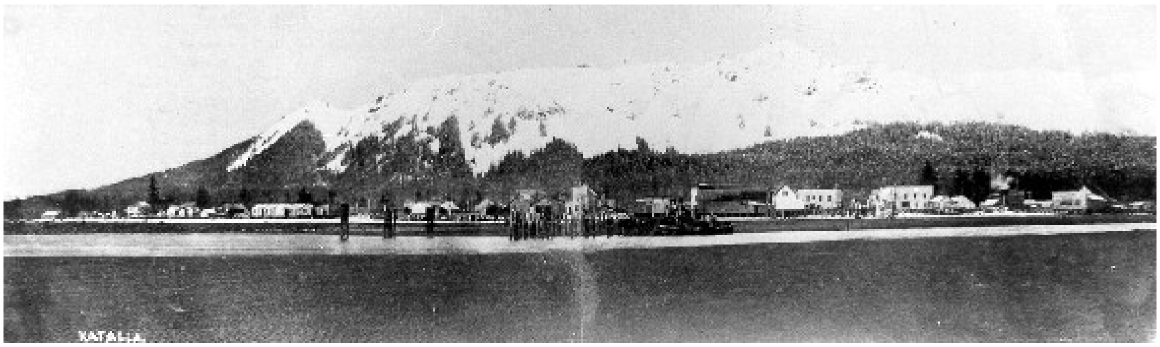


Figure 2.22 - Panoramic view of Katalla from water. Alaska State Library PCA 20-12-1

The Controller Bay and Navigation Co., which reorganized as the Alaska Anthracite Coal and Railway Company, built a sawmill and a large construction camp with bunkhouses and shops on the east bank of the Bering River in 1909 and constructed 17 miles of standard gauge railway by 1917. However, construction and financial difficulties caused the abandonment of the effort, as well as the company's 0-4-0 steam locomotive (the "Bering River Train") and other equipment (Clifford 1981:141-143).

A fourth railroad that had a physical presence in the area was the Alaska-Pacific Railway and Terminal Company, organized in 1906, who proposed a route with branch lines from Martin Island in Controller Bay to the Yukon River near Eagle City. The company built an artificial harbor west of the Martin Islands, a sawmill to produce tracks and ties, and actually laid some track. However, the sawmill was flooded by winter storms, and the company went bankrupt in 1907 (Clifford 1981:138-140).

Four other railroad companies organized and proposed routes in the Katalla area between 1907 and 1909, but no major construction resulted from their efforts. They were the Catalla and Carbon Mountain Railroad Company of Washington, the Kush-Ta-Ka Southern Railroad Company, the Bering River Railroad Company of Washington, and the Pacific Coal and Oil Company, also known as the "English Company" (Clifford 1981:140-142).

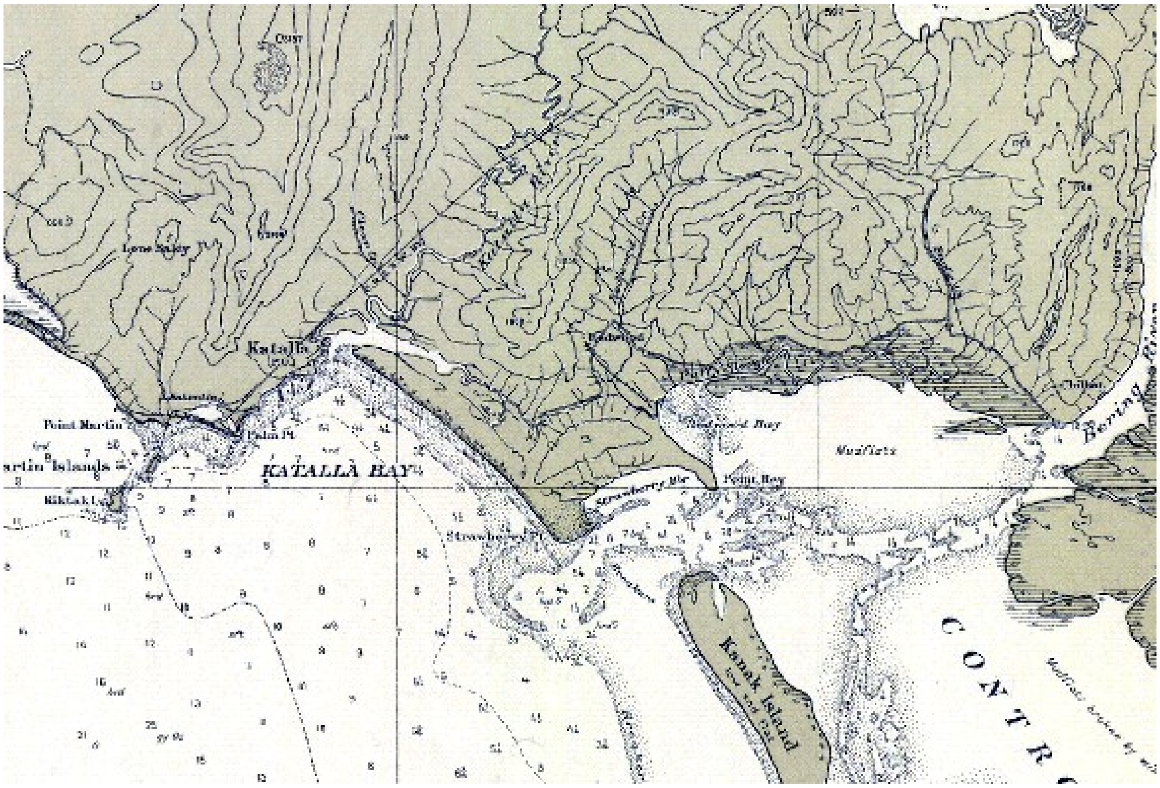


Figure 2.23 - Portion of the 1913 nautical chart showing railroad routes and trails in the Katalla and Controller Bay area. NOAA Historical Archives, Nautical Chart No. 8513, April, 1913.

The Balinger-Pinchot controversy, which occurred from 1907-1911, was pivotal in the decline of the economy of the Katalla area and the management of the National Forest System lands east of the Copper River. Richard Balinger, the manager of the General Land Office in the early 1900s, was interested in seeing the development of the Bering Coal Fields. Gifford Pinchot, Chief Forester of the Forest Service, was a proponent of conservation (Rakestraw 1981:49). When Balinger was appointed Secretary of the Interior by President Taft, his disagreements with Pinchot over land management, particularly involving the Cunningham Coal Claims in the Bering River region and associated fraud, ultimately led to Pinchot's removal in 1910, Ballinger's resignation, and the eventual cancellation of the Cunningham claims. Pinchot's successor, Henry Graves, continued the earlier conservation management practices. Because of the length of time that coal miners were required to wait for processing of their claims for patent, many went bankrupt, or were discouraged by red tape and delay of production. This contributed to the eventual decline of Katalla and the abandonment of all the coal-related railroads in the area.

Oil seeps were discovered near Katalla in 1896 by Tom Wolf, oil was struck on Claim 1 in 1901, and production began in 1902 (Shaw 2001:20). A total of 44 wells were eventually drilled. During the period between 1910 and 1920, when the Leasing Act was passed, this was Alaska's only patented oil field. It continued to produce until 1933 when the Chilkat Oil Refinery, which processed the oil into gasoline, burned down (Clifford 1981: 142).

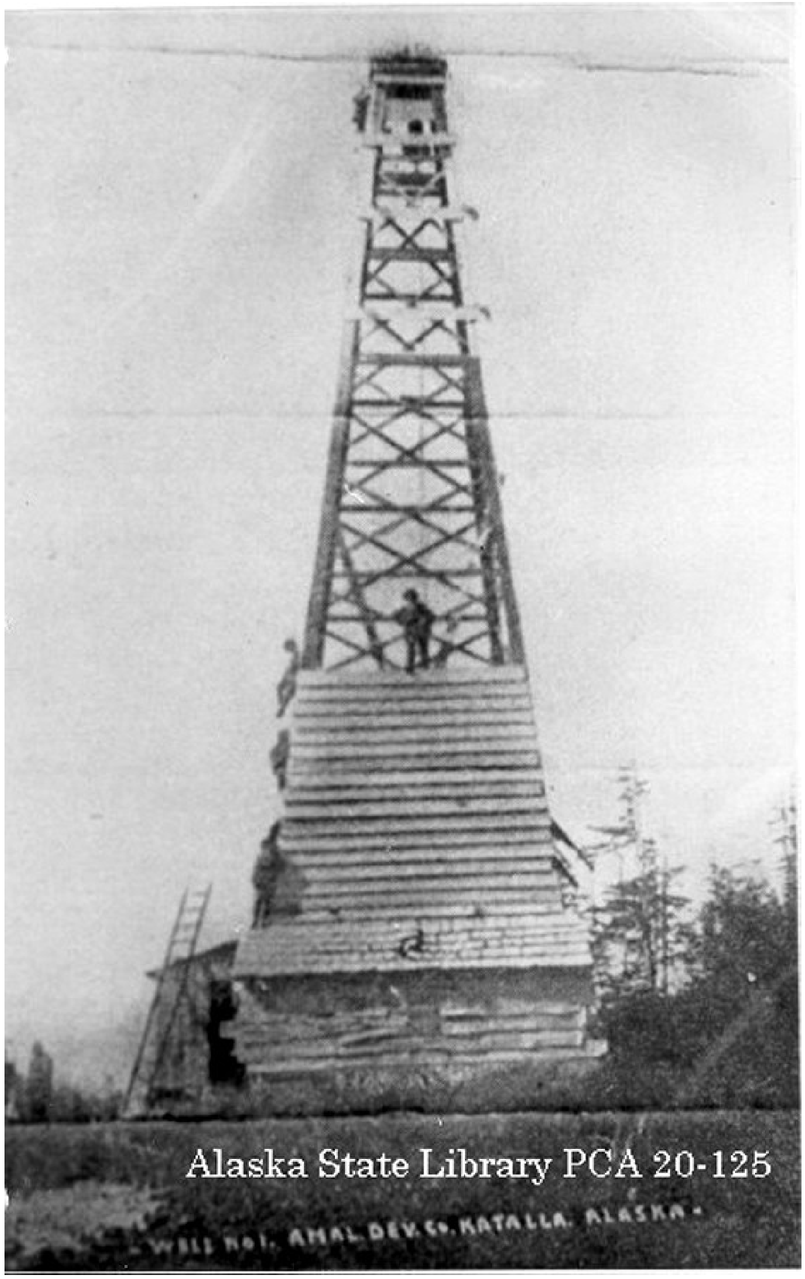


Figure 2.24 - Oil Well No. 1 at Katalla, Amalgamated Development Company, circa 1910. Alaska State Library, PCA 20-125.

Heritage Resources

The cultural resources of the analysis area 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. Inventories have been associated with specific projects as trail construction as required by Section 106 of the National Historic Preservation Act, however the entire analysis area has not been inventoried. Most identified cultural resources within the analysis area remain formally unevaluated for the National Register of Historic Places (NRHP).

There are 90 known cultural resource sites in the analysis area, of which one is a National Landmark (a higher designation than being listed on the National Register of Historic Places), 3 are on the National Register of Historic Places, 4 have been determined eligible for the National Register, and 82 are not yet formally evaluated. Maps and charts from the early 1900s show numerous railroads, trails, and associated buildings along the ocean coast and various streams flowing into the ocean between Cape Martin and the Bering River, suggesting that there may be many currently unrecorded historic sites throughout the southern part of the analysis area. Appendix A of the East Copper River Delta Heritage Resources Report, pages 20 – 21, (Yarborough 2004) summarizes the laws, presidential executive orders, and programmatic agreement that pertain to management of cultural or heritage resources on National Forest System lands.

Historic Sites Selected under Alaska Native Claims Settlement Act (ANCSA) - ANCSA recognized the importance of Native Alaskan historic and cemetery sites which may be no longer used, but are still culturally significant, and allowed for their selection by and conveyance to Regional Native Corporations under Section 14(h)(1) of the Act. There are 26 such selections along the coast and on the near shore islands, at locations noted historically to have Alaska Native settlements or to otherwise meet the criteria of Section 14(h)-1 within the analysis area, Table 2.9. They include the Bering Expedition Landing Site National Landmark, villages, seasonal settlements, cemeteries, fox farms, an abandoned cannery, and Cunningham's Oil Exploration Camp. Conveyance of selections determined to be eligible under section 14(h)(1) is to be finalized by 2009.

Table 2.9-Native Alaskan and related sites

AHRS #	AA #	Site Name	Description
XMI-00007	AA12456	100 Notched Trees	Camping site integral to camping network of Sugpiaq.
COR-00272	AA12439	Cape Martin Cemetery	Cemetery consisting of at least 3 burials. One is the grave of a young Tlingit woman marked by a stone monument with the date of 1900.
No #	AA12438	Cape Martin Site #1 (Gixdaqlaqt, Jeeskweidi)	Modest permanent village.
COR-00273	AA11076	Cape Martin Site #2 (Kuxuunlayah)	Eyak village.
COR-00011	AA11083	Chilkat Village Complex, (Jilkaat, Jildaht)	18 cultural features were identified within a 320m x 84m area along a narrow terrace: 3 standing frame structures, 3 collapsed structures, 2 outhouses, & a cemetery w/ 10 graves. Reported by USC&GS to be a Native village in 1890.
	AA11066	Katalla Complex #1 (Kaataalaa, Qaataalaa, Qaataalaq)	Large Eyak village, associated with legends.

Table 2.9-Native Alaskan and related sites			
AHRS #	**AA #**	**Site Name**	**Description**
XMI-00001	AA11065	Kayak Camp (Kayak Village)	Former settlement & steamer landing. The post office operated from 1900 - 1906. Remains include 7 frame and log structures, 5 graves, a boat cradle, a fox feeding station and pens, and misc. historic debris. CPSU reports that the remains are associated with an Eyak settlement (circa 1890), two canneries which operated here in 1889, and a later fox farm which was abandoned circa 1940.
XMI-00008	AA12455	Kayak Island, Site #2	Camping site integral to camping network of Sugpiaq.
No #	AA12457	Kayak Island, Site #4	Reported location of village and spirit house.
No #	AA12437	Okalee River Site #1, (Aaxdalih, Arwartuli)	Settlement inhabited first by Sugpiaq, later by Eyak inhabitants.
COR-00328	AA11077	Palm Point Cemetery	Reinvestigated by BIA and determined eligible
COR-00308	AA11084	Qaxtale (Okalee River), Kwinlah Slough	Settlement inhabited first by Sugpiaq, later by Eyak inhabitants.
No #	AA11069	Saxwt'ak (de Laguna site)	First Eyak settlement in the Copper River Delta.
COR-00278	AA11063	Structural Remains	A 3.6m x 5.6m wood frame structure on the crest of a sandy beach ridge overlooking a beaver pond to the south. Structure has collapsed into the cellar. A 2nd feature, 20m to the north, is marked by overgrown posts & a single log course for a 6m x 8m foundation. Cast iron stove remains occupy its center, but no superstructure remains were observed.
COR-00065	AA11078	Xatadulselye #3	A 1m x 1.2m x 1m high rock cairn & the remains of three cabins nearby (the nearest about 20m away). The cairn may mark a grave associated with the three cabins. Cabins may be the same as de Laguna's location of Tlingit houses.
COR-00278	AA11064	Xatadulselye complex #2	Eyak settlement with Beaver House and Wolf House.
COR-00277	AA11063	Xatadulselye village	Nineteenth century Eyak settlement.
No #	AA11082	Xatadulselye Village Complex	Eyak settlement with community structures.
XGB-00003	AA11084	Yekhidi (Cape Suckling)	Native cultural landscape, Controller Bay
COR-00110	AA11081	Bering River Cannery (Chilkat Cannery)	Abandoned Pacific American Fisheries cannery; some structures and pilings remain.
COR-00279	AA11082	Cunningham's Oil Exploration Camp	Disintegrated remains of 4m x 6.7m, NW-SE oriented flooring, assoc. structural debris, & refuse. A 2nd scatter of structural remains was located 13m to the southeast. Site corresponds with Clarence Cunningham's oil well and camp.
COR-00104	AA11079	Katalla (Catalla, Catella, Qatana)	Settlement established about 1903 as a supply point after discovery of oil in the area. The population was 188 in 1910; 84 in 1920; 44 in 1930; and 23 in 1940. The post office was established in 1904 and discontinued in 1943. About 1870 the Tcicqedi, an Eyak Eagle sib, had an Eagle House at or near this location.

Table 2.9-Native Alaskan and related sites			
AHRS #	**AA #**	**Site Name**	**Description**
XMI-00005	AA12458	Bering Expedition Landing Site **National Landmark**	Mouth of the creek where the party from the St. Peter is believed to have landed in 1741 and made the first investigations of the north Pacific coast by Europeans. No significant physical remains are at this site.
COR-00316	AA11085	Kaiak, Kayak Island Site #1	Sugpiaq/Tlingit settlement.
COR-00282	AA11080	Kanak Island Fox Farm, Keneq, Ginaq	Supiaq settlement associated with legend.
COR-00273	AA11076	Fox Farm	Eyak Native settlement.

European Exploration Period – Vitus Bering's landing site from what is technically the proto-historic period, before direct European contact, is noted above in Table 2.9 as a small settlement where Bering's crew went ashore on Kayak Island. Two additional sites relate to Cook's voyage in 1778, and another is from Russian logging in the late 18th or early 19th century, Table 2.10.

Table 2.10 - Historic Exploration Period sites.

AHRS #	Site Name	Description	Eligibility
XMI-00011	Cook's Landing Site		unevaluated
XMI-00002	Kayak Island	Believed to be the island Bering saw and named Saint Elias in 1741. Captain Cook visited the island on May 12, 1778 and buried a bottle with a paper and two small pieces of silver given to him by Dr. Kaye, chaplain of King George III.	unevaluated
COR-00111	Russian Cuttings	Evidence of even-aged regrowth of timber c. 200 years old. Probably a Russian period clearcut. A boiler of unknown affiliation is also present.	unevaluated

Bering Coal Field related sites - Seven of the eight historic sites related to prospecting and mining in the Bering coal fields are privately owned, Table 2.11. The Whale Claim is currently on National Forest System lands. None have been evaluated for their eligibility for the National Register of Historic Places.

Table 2.11 Bering Coal Field related sites			
AHRS #	**Site Name**	**Description**	**Eligibility**
COR-00012	Carbon Camp	Mining camp on Carbon Creek; collapsed buildings in 1973.	unevaluated
COR-00102	Cunningham Cabin	Cabin of Cunningham, whose claims in the Bering River coal fields was an important factor in withdrawal of coal lands in 1906 & 1909, & the Ballinger-Pinchot controversy.	unevaluated
COR-00101	Cunningham Tunnel	Presently there are shored entrances to 3 horizontal tunnels visible on the west slope about 15-30 yds above the present stream valley. Two tunnels are within 15-20 yds of each other and display at least 15 yds of narrow gauge track	unevaluated
COR-00100	Kushtaka Tunnel	Coal test tunnel by Bureau of Mines shortly after passage of coal-leasing bill. See U.S.Dept of Interior Regs. Governing Coal Land Leases in the Territory of Alaska, 1916.	unevaluated
COR-00106	Redwood	Abandoned mining or oil-drilling community reported in 1905 by G.C. Martin, USGS. Probably abandoned before 1906. On a tram road branch from the Katalla-Chilkat Wagon Rd.	unevaluated

Table 2.11 Bering Coal Field related sites			
AHRS #	**Site Name**	**Description**	**Eligibility**
No #	Tunnel	Between Kushtaka lake and Kuchtaka Ridge	unevaluated
No #	Tunnels	East of Carbon Creek	unevaluated
No #	Whale Claim	Gold prospect	unevaluated

Oil Field related sites - Six oil wells and a variety of oil drilling related machinery and structural remains have been documented in the Alaska Heritage Resource Survey (AHRS) or on historic maps of the area (Table 2.12). A 2001 survey of the historic oil field near Katalla documented 22 historic well heads, the remains of "a central pumping facility adjacent to Well 11, a tram system (a key feature for defining and researching the site overall), a gravity feed pipeline for collecting crude from the producing wells, a wagon road, four logistical support buildings (all collapsed) separate from well, two large tanks (in Katalla Meadow), and an historic residence camp near the southeast corner of Claim 1 (Shaw 2001:1).

Table 2.12 - Oil field related sites		
AHRS #	**Site Name**	**Description**
COR-00004	Chilkat Oil Company Refinery Site	Remains of foundations. Some structures, tanks, boiler, & equipment are around the site. Refinery produced distilled gasoline, kerosene, & diesel fuel from 1911 until 1933, when the plant was severely damaged by fire. Alaska's first oil refinery.
COR-00474	Claim 1 Residence Camp at Katalla	Camp associated with the producing oil field on Claim 1. Consists of several collapsed buildings, a tram line. It abuts COR-006 at approx the south shore of Oil Creek. This camp assoc with oil production in Alaska first producing oil and with the National Register site COR-004.
COR-00006	Katalla Oil Field Claim 1	Oil was discovered here in 1903. By 1933, when the Chilkat Oil Company discontinued operations, 18 wells had been drilled. Drilling machinery, tools, pipes, a tramway, and four collapsed buildings remain at the site. First oil well in Alaska drilled here.

Railroad related sites - Remains of several railroad ventures exist in the analysis area and include those from the Copper River and Northwest Railway, Alaska Anthracite Coal and Railway Company (associated with the Alaska Petroleum and Coal Company), the Katalla Coal Company, and the Alaska-Pacific Railway and Terminal Company, Table 2.13. Of these known sites, one, the Million Dollar or Miles Glacier Bridge, is on the National Register of Historic Places, and the second, the Bering River Cabin Site and Bering River Train, has been formally determined eligible for the National Register. The other twelve have not yet been formally evaluated.

Table 2.13 - Railroad related sites			
AHRS #	**Site Name**	**Description**	**Eligibility**
COR-00314	Alaska Anthracite Railroad Sawmill	Steam driven lumber mill about 1 mile east of Goose City, almost completely reclaimed by nature.	unevaluated
COR-00108	Alaska Pacific Railway	In 1907 a long bridge was constructed from Whale Island to the mainland; the railroad construction project was abandoned when the bridge was destroyed by ice. About 5 miles of grade and 1/2 mile of rail between Katalla and Whale Island were laid by 1908.	unevaluated

Table 2.13 - Railroad related sites

AHRS #	Site Name	Description	Eligibility
XBG-00118	Bering River Cabin Site	Remains of a collapsed wood-framed cabin, outhouse, & historic debris in the forest fringe at the base of the hillside associated with logging activities and railway line construction near the Bering River.	Eligible 12/15/1998
COR-00315	Bering River Train	Saddle-tank O-4-OT steam locomotive and cars, Dickson Works Engine #41751. Stands on a short spur line of the Alaska Anthracite Railroad (Goose City Railroad). The only locomotive associated with the construction of the Copper River & Northwestern Railway remaining in Alaska.	Eligible 1/4/1988
COR-00274	Burner Crossing	Place where trestles for the Copper R. & Northwestern Railway and the Alaska Pacific Railroad crossed, just west of Lake Kahuntla, near Point Martin. Remains of trestle pilings are still visible and can be traced to the point of intersection. Photographs of the crossing are published in Janson (1975) and Clifford (1981). Site of an armed conflict ("Battle of B.S. Hill") between CR&NW and APR&T interests over control of the right-of-way in the vicinity of Lake Kahuntla.	unevaluated
COR-00465	Clear Creek Railroad Trestle	Site consists of parallel rails spaced 0.20m apart oriented sw/nw, parallel to (~5m se) & at an elevation of about 4m above water level of Stillwater Creek. A feature of the railroad grade is a log culvert in Clear Creek. Significant in the understanding of railroads & their construction in Alaska.	unevaluated
COR-00398	Copper River & Northwestern Railway		unevaluated
No #	CR&NW Railway Caboose	reported by John Johnson 2/5/86.	unevaluated
COR-00271	CR&NW Railway Work Camp	A 4.2m x 1.6m x .55m pit (probably a latrine) and associated refuse. A small collection of artifacts was collected from the site & appears to date from the early 1900s. A published photograph (Clifford 1981) of Burner Crossing shows a wall tent here. Assoc. with the CR&NW railway construction.	unevaluated
COR-00109	Goose Point Railroad	In 1917, the AK Petroleum & Coal Co. constructed a 15 mile railroad from Goose Point to coal mines in the eastern district of the Bering River coal field. Abandoned, probably as a result of wartime inflation & material shortages. Much of the line is still visible.	unevaluated
COR-00024	Katalla Junction	Site of railroad war described in Rex Beach's The Iron Trail. Old trail leads to Bering River coal field and Katalla. During early 1900s CR&NW Railway planned a spur line to the coal fields, but Federal closure of coal fields caused plans to be abandoned.	unevaluated
COR-00107	Katalla Railroad	Six miles of standard gauge rail and bridges, constructed in 1906-1907- most is still visible but in poor condition. Constructed by the Katalla Company, financed primarily by Morgan-Guggenheim interests.	unevaluated

Table 2.13 - Railroad related sites			
AHRS #	**Site Name**	**Description**	**Eligibility**
COR-00005	Million Dollar Bridge (Miles Glacier Bridge, Mile 49 Bridge)	Associated with the CR&NW Railway. Significant as an engineering feat. A steel truss railroad bridge built in 1909-1910 crossing the Copper River where Childs and Miles glaciers face each other. The camelback style truss bridge is 1550' long and 30' high on concrete piers. It has 4 spans measuring (N to S) 400', 300', 450' and 400'. Detached concrete islands upstream protect the piers from ice bergs calving off Miles Glacier. In 1958, the bridge was decked and began service as a highway bridge. It was seriously damaged in the 1964 earthquake. The southern end of the north span dropped into the Copper River when the pier supporting it was heavily damaged. The other truss spans were distorted & all of the piers have been displaced on their foundations. A temp. ramp was installed to link the two northern-most spans & facilitate vehicle & pedestrian traffic. Alaska DOT is currently stabilizing the last span.	On Register 3/31/2000
no #	Railroad Spur		unevaluated
COR-00273	Whale Island Terminal	Foundation timbers of a structure about 12' x 20' in size heavily overgrown by a dense thicket of spruce; a second foundation may be obscured by another spruce thicket immediately to the west. Spikes & other railroad construction debris are scattered along the terrace and nearby beaches. Structures interpreted as railroad related on basis of their direct association with pilings for the Alaska Pacific RR trestle--they mark the location where construction of a dock facility was planned.	unevaluated

Other Sites - A variety of other cultural resources are present in the analysis area including cabins, a CAA Radio Station, cemeteries, lighthouses, and shipwrecks. The dangers to ships from the underwater hazards and rocky shores of the area are illustrated by the two lighthouses and 12 shipwrecks known in the vicinity of Katalla and Controller Bay. Only the *Portland*, the *Afognak,* and the *Gulkana* are noted in Table 2.14, as the others did not wash up on shore. The Cape St. Elias lighthouse has been listed on the National Register of Historic Places. The other 21 sites have not yet been formally evaluated.

Table 2.14 - Other Sites			
AHRS #	**Site Name**	**Description**	**Eligible**
A	Vandalized Grave		unevaluated
COR-00127	Cave Point Cave	A two-chambered cave, has a 4m in diameter entrance that runs 10m deep to where it tapers to a 1m crawl hole that widens after 1.5m into a 12m long x 2-3m wide x 2-5m+ high inner chamber. Three tests made did not produce cultural remains. However, it is a high potential area for finding remains of human occupation. Ketz (1983) documented a tin can, a liquor bottle dated to 1978, & 2 porcupine femurs within a talus deposit that partially obscures the cave entrance.	unevaluated
COR-00276	Katalla Cemetery	Cemetery containing five identifiable graves neatly laid out along a N-S axis. A double grave, marked by a stone monument, preserves the date 1929, but most of the interments appear to be earlier. This is probably not the main cemetery for Katalla.	unevaluated

Table 2.14 - Other Sites			
AHRS #	**Site Name**	**Description**	**Eligible**
COR-00277	Foundation Pilings	Nine foundation pilings for a 5.3m x 7.9m, N-S oriented structure. Structural debris representing superstructure was absent. Polished glass shards, a lantern base, and other metal artifacts associated with the foundation were noted.	unevaluated
COR-00281	*Portland*	The ship whose ton of gold delivered to Seattle in 1897 set off the Klondike Gold Rush. Proceeding north toward Cordova carrying freight for Katalla, the vessel ran into a heavy blizzard & struck an uncharted rock off Martin Island near the mouth of Controller Bay on November 12, 1910. Later, the vessel was run ashore east of Katalla in the mouth of the Katalla River, with 10 ft of water in the hold. Crew, passengers, & most of the cargo were saved. Hull was badly battered by storms and abandoned.	Eligible
COR-00313	Goose City		unevaluated
COR-00327	Two Historic Structures and One Foundation		unevaluated
COR-00473	Historic Pilings	Historic piling in raised uplands, probably a wharf or log handling facility assoc with previously logged area, on adjacent beach ridge. Consists of 2 rows of piling, with some missing from the sequence.	unevaluated
COR-00545	*Afognak*	Diesel tug, wrecked on Palm Point, Controller Bay, on September 15, 1949	unevaluated
No #	Bering Lake Patent	Cabin	unevaluated
No #	CAA Radio Station	Historic radio facility	unevaluated
No #	Cabin	On USGS 1951 map	unevaluated
No #	Cabin	On USGS 1951 map	unevaluated
No #	Cabin	On USGS 1951 map	unevaluated
No #	Cabin		unevaluated
No #	Cabin	On USGS 1951 map	unevaluated
No #	Cabin Ruins	On USGS 1951 map	unevaluated
No #	Fox Island Lighthouse		unevaluated
No #	Wagon		unevaluated
no#	*Gulkana*	sternwheeler wreck, Camp 49	unevaluated
XBG-00100	PA, 11168	Geological feature	unevaluated
XBG-00123	Historic Cabin Ruins & Associated Remains		unevaluated
XMI-00003	Cape St. Elias Lighthouse	Cape St. Elias is considered one of the most dangerous points on the northwest coast. Funded in 1913, the lighthouse was completed in 1916. It was an advanced design, with the most modern equipment of its day. It employed three lighthouse keepers. A private nonprofit now leases the site and lighthouse and is restoring it.	On Register 12/18/1975

Socio Economic

Cordova, the nearest town to the analysis area, developed quickly in 1906, adjacent to the Eyak village of "tc'i˙c", fueled by Michael J. Heney's decision in 1904 to file on the railroad right-of-way from Cordova to the Copper River, from which a line could be built north to the Bonanza Copper Mines and a spur east to the Bering River coalfields. Railroad construction began in March of 1906 (Lethcoe and Lethcoe 1994:63-64). This development brought a permanent non-native population to the area with businesses other than trading. The Copper River and Northwestern Railroad provided the first developed transportation link from Cordova up the Copper River to the interior. This corridor was used until 1938 when the copper mines were depleted. The Bonanza-Kennecott Mines yielded over $200 million in copper, silver and gold. Fishing became the economic base for Cordova in the early 1940s. The Copper River Flats and Bering river area are important to the commercial fishery. Today, Cordova supports a large fishing fleet for Prince William Sound and several fish processing plants, 343 residents hold commercial fishing permits, and nearly half of all households have someone working in commercial harvesting or processing (Alaska Department of Community and Economic Development). Copper River red salmon, pink salmon, herring, halibut, bottom fish and other fisheries are harvested. Reduced salmon prices have affected the economy. The largest employers are North Pacific Processors, Cordova School District, Cordova Hospital, the City, and the Department of Transportation. The U.S. Forest Service and the U.S. Coast Guard maintain personnel in Cordova. (Alaska Department of Community and Economic Development).

As of 2003, the population of Cordova was estimated at 2,372 by the Alaska State Demographer (the 2000 US Census Bureau estimate, the basis for all further comparisons, was 2,454). Table 2.15 displays a summary of the demographics for the town compared to the nation and the state of Alaska based on the 2000 census information.

The census estimates for small communities such as Cordova are derived from small samples of households (typically 1 in 6) rather than all households. Consequently, such information may contain unreported sampling error. Another factor to consider is that between 1990 and 2000, the City of Cordova increased in size from 5 square miles to 61 square miles when it extended the city limits east to the Airport at Mile 13 and south 7 miles on Whitshed Road. Through an analysis of demographic and economic information, the Alaska State Demographer projects that the population will remain fairly stable through 2008, with an annual decline of about one-tenth of a percent per year. The employment by sector may not truly reflect the number of fishing related jobs since many of the permit holders live out of town, either in the lower 48 or elsewhere in the state. Another factor to consider is that between 1990 and 2000, the City of Cordova increased in size from 5 square miles to 61 square miles when it extended the city limits east to the Airport at Mile 13 and south 7 miles on Whitshed Road. However, the town appears to be heavily reliant on fisheries related jobs. A cannery closing in the fall of 2003 was felt across all sectors. It later reopened under a new owner. Employment diversity among 13 industrial sectors in Cordova as measured by a Shannon –Weaver diversity index is comparable to that of the nation and state. This index, which ranges from 0.000 (or no diversity at all) to 1.000 (or perfect diversity) gives Cordova an index value of 0.937, compared to 0.930 for the nation and 0.931 for the state.

The number of people depending on retirement income is increasing at a rate higher than the state or nation as a whole. Also the commercial fishery is seasonal in nature. These two facts may find more people having free time available to recreate and enjoy the National Forest surrounding Cordova.

Table 2.15 - Cordova Community Vital Statistics

	Cordova	*Nation*	*State*
Population	2,454	281,421,906	626,932
1990-2000 population change	16.3%*	13.2	14.0
Population density (persons/mi^2)	40	94.7	1.1
Demographics:			
Male:Female Ratio	1.2	1.0	1.1
Estimated Mean Age	36.9	35.3	32.4
Pct Am Indian - Alaska Native	11.1	0.9	16.5
Pct 4-year College Educated	21.4	24.4	24.7
Households:			
Pct same house as 5 years Ago	58.0	54.1	46.2
Pct Family Households	62.4	68.1	68.8
Pct Owner Occupied Households	52.3	60.3	53.1
Median Household Income	$50,114	$41,994	$51,571
Pct Families below poverty level	4.3	9.2	6.7
Employment			
Pct Civilian Labor Force Unemployed	4.6	3.7	6.1
Pct with Private Wages/Salary	52.9	78.5	64.9
Pct gov't	28.7	14.6	26.8
Pct self employed	17.6	6.6	8.0
Unpaid family worker	.9	.3	.3
	0.937	0.930	0.931
Pct employed in Agriculture/ Forestry/ Fishing/Mining	14.1	1.9	4.9
Pct employed in arts/ enter/ accommodation/ Food services	6.3	7.9	8.6
Pct income w/retirement, change from 1990	98.4 (8.1 -> 13.1)	23 (15.6 ->16.7)	34.2 (12.8->14.7)

Executive Order 12898 directs each Federal agency to analyze the environmental effects, including human health, economic and social effects, of Federal actions, including disproportionate effects on minority communities and low-income communities, when such analysis is required by NEPA. The Environmental Protection Agency has lead responsibility for implementation of the Order. To date, no formal regulations--including those governing the USDA Forest Service--either (1) formally identify those key social, economic, or environmental conditions that would identify "low-income" or "minority" populations, or (2) formally specify the threshold values for those conditions. In order to address the spirit of EO 12898 eleven relevant demographic characteristics or measures of low-income and minority population (e.g., household and per capita income, poverty, race, language, and transience) for Cordova have been reviewed. None of the measures suggests that Cordova has significant low-income and minority populations, nor any clearly identifiable spatial distribution of such populations that could be disproportionately affected.

Minerals

The disposal of federal minerals located on National Forest System lands is managed under the U. S. mining (1872 Mining Law, as amended), mineral leasing laws, and mineral sale laws. The minerals managed with these systems are known as locatable, leasable, and salable mineral materials respectively. Locatable mineral development are managed under Forest Service regulations 36 CFR 228 Subpart A to minimize potential adverse impacts to surface resources. Leasable activity is managed by the USDI Bureau of Land Management but such activity must be consented to by the Forest Service. Oil and gas resources are managed under regulations 36 CFR 228 Subpart E. Oil and Gas in the Katalla Area is managed according to provisions contained in the 1982 CNI Settlement Agreement. Salable minerals are managed under regulations found at 36 CFR 228 Subpart C, Disposal of Mineral Materials. Mineral materials sales may be allowed, limited, or prohibited entirely. In addition, locatable, salable and leasable mineral activities are subject to standards and guidelines in the Revised Forest Plan (pp 16-18).

Locatable Minerals - The U.S. Geological Survey assessed the mineral resource potential for the Chugach National Forest for the Forest Plan Revision. Nelson and Miller (2000) focused strictly on locatable mineral resources and did not cover leasable resources such as coal, oil and gas, or salable resources such as common variety rock, gravel, and sand. According to their report, a little over 50% of the analysis area is not within an identified tract which means it lacks geologic criteria indicating potential for locatable mineral resources addressed in the report or contains deposits having a low probability of future development activity. The four deposit types evaluated in Nelson and Miller's report are: 1) Cyprus-type massive sulfide (copper, lead, zinc, gold and silver); 2) Chugach-type low-sulfide gold quartz veins (gold and silver); 3) placer gold; and 4) polymetallic veins (copper, zinc, lead, gold and silver).

No mines, prospects, or mineral occurrences are known within the Copper River Addition (CRA) portion of the analysis area. South of the CRA, three tracts have been identified as highly favorable for undiscovered mineral resources from an as yet, unidentified deposit type (Nelson and Miller 2000). These tracts are underlain by Tertiary units younger than the Orca Group rocks. Both the Valdez and Orca Group rocks are known hosts to gold, copper and other metallic deposits elsewhere, yet no metallic mineral occurrence of any significance is known in the analysis area.

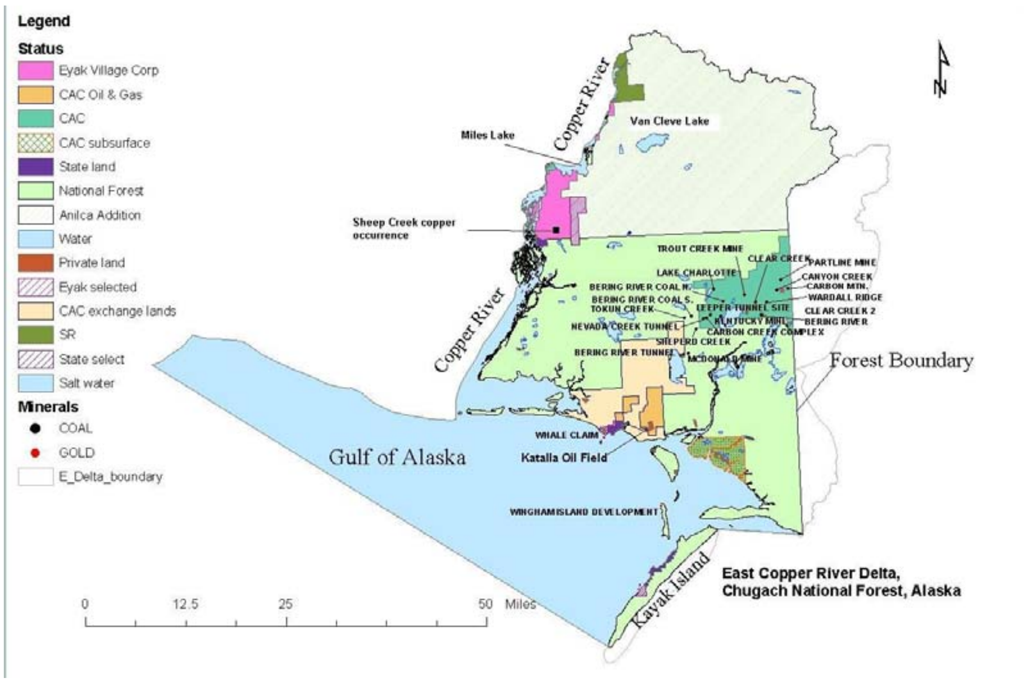


Figure 2.25 Minerals and land status of analysis area

Gold Occurrences

The U.S. Bureau of Mines sampled the "Whale Claim" site, shown on Figure 2.25**,** for placer gold sometime in the early 1980s (Jansons et al 1984). They collected a 0.075 cubic yard beach sands sample that contained 0.05 ppm gold in concentrate and rated the occurrence as having a low mineral development potential. A gold occurrence was reported at Wingham Island Development Association site (Figure 2.25). The U.S. Bureau of Mines attempted to locate the site in the early 1980s but did not find it. They concluded that the development potential is unknown.

Copper Occurrence

One copper occurrence is known near Sheep Creek, on Eyak Corporation land (Figure 2.25) consisting of a 60-foot wide, malachite-stained slate outcrop with a 6-inch wide shear zone containing chalcopyrite. The U.S. Bureau of Mines collected a grab sample that assayed 0.51% copper. They concluded that the site had low mineral development potential.

Mining Claims - As of January 2004, no mining claims, either placer or lode, exist in the analysis area. Several patented claims (private land) were located for oil and gas[7] but not for metallic minerals. Three tracts in the analysis area were determined to have mineral resource potential. One large tract was determined to be underevaluated. The East Copper River Delta Geology and Minerals Resource Report (Huber 2004) provides additional information.

[7] A one time, mining claims could be located for oil and gas; that is no longer the case. Once patented, claims become fee simple private land.

Mt. Hamilton, Don Miller Hills, and Kayak Island Tract

These three tracts have similar geology and have identified resources of coal, oil, and gas. All three tracts are considered highly favorable for undiscovered mineral resources from an as yet, unidentified deposit type. Anomalous metal values in drainage-basin samples indicate that some of the sedimentary rock units in these tracts are possible hosts for zinc-rich sulfide deposits. Heavy-mineral-concentrate samples contain abundant sphalerite[8] and barite[9]. Some samples contained greater than 50,000 ppm zinc, and locally cadmium and molybdenum values were elevated. These tracts were identified by Nelson and others (1984) as needing additional mineral study.

Miles Glacier Tract

The mineral estate within the 801,600 acre ANILCA Copper River Addition to the Forest is withdrawn from operation under the 1872 Mining Law, but is available under the leasing laws (ANILCA Sec. 502). The Miles Glacier tract covers most of the eastern half of the Copper River addition. It is considered under-evaluated and generally unfeasible to evaluate with respect to its mineral potential due to rugged topography and glacial cover.

Leasable Minerals - There is known potential for oil and gas, and coal deposits within the analysis area. The Copper River Addition (CRA) portion of the analysis area is closed to mineral entry but metallic minerals that are normally locatable (on lands open to mineral entry) are leasable on the CRA (Figure 1.3). It is considered under-evaluated, and generally unfeasible to evaluate with respect to its mineral potential due to rugged topography and glacial cover. There is little interest in exploring for mineral resources in this area.

[8] Zinc-iron sulfide mineral. Sphalerite is the main ore for zinc.

[9] Barium sulfate. Barite is the main ore for barium. Barium is used as a drilling mud additive, in the paper and rubber industries, as a screen for intense radiation when mixed with cement and other uses.

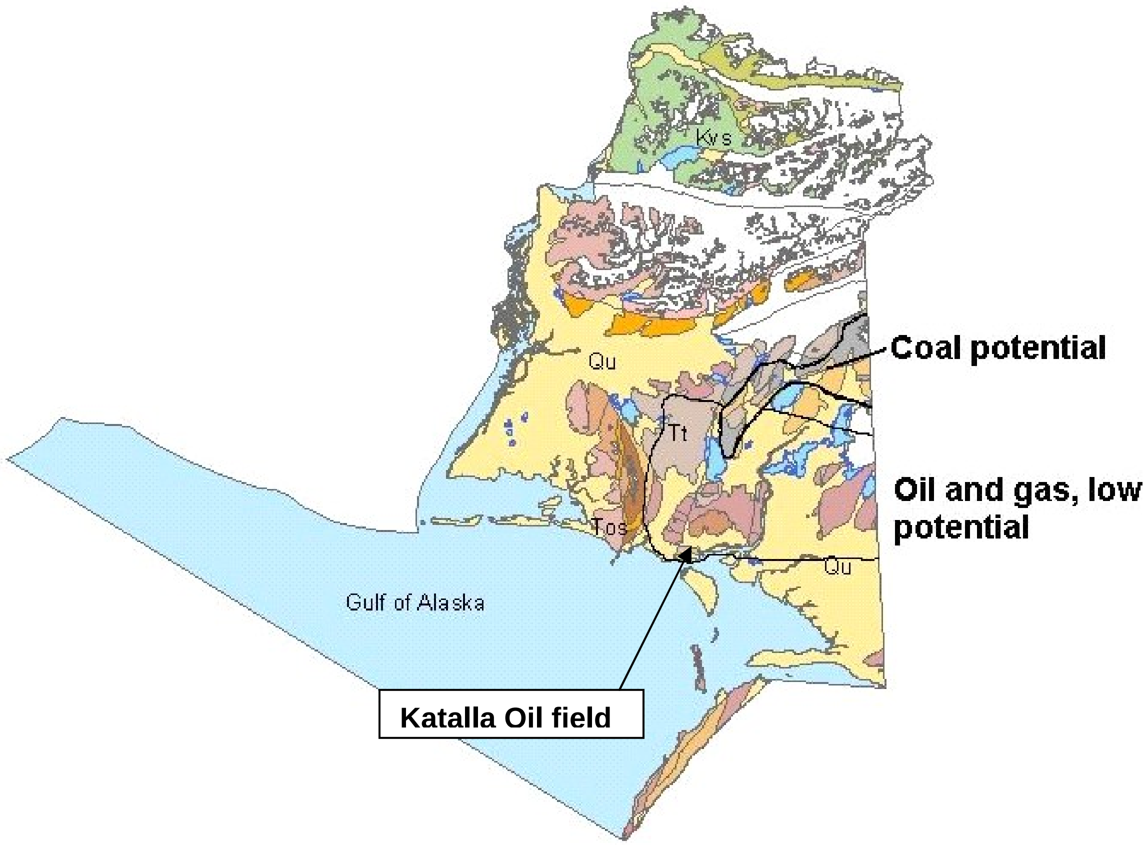


Figure 2.26 – Coal and Gas potential in the analysis area from Nelson and others, MF 1645-A, 1984.

Oil and Gas Resources

The U.S. Geological Survey rates approximately 160,000 acres of the analysis area as having a low potential for oil and gas (Figure 2.26). Oil seeps were discovered in the Katalla district and on the north side of Controller Bay about 1896 (Martin 1921). Forty-four wells were drilled in this area between 1901 and 1932 with 28 of them being drilled in the "Katalla field" (Fig. 2.27). The 18 producing wells of those 28 were within a 60-acre area and drew oil from fractured sandstone and siltstone of the Katalla (renamed Poul Creek) formation, at depths ranging from 360 to 1,750 feet (Miller, 1959). Most of the productive wells were on Claim No. 1, MS 599, patented under the placer mining law prior to enactment of the oil and gas leasing law (Miller 1959). Production in the Katalla district amounted to 153,922 barrels of oil over 30 years. The refined oil was used for fishing fleets and other local uses. Production ceased in 1933 when the refinery burned down and was not rebuilt due to economics.

Sporadic exploration has occurred to the present because of the abundant surface evidence of petroleum seepage and the presence of some suitable hydrocarbon source rocks. In the mid-1980s, a well drilled on Claim No. 1 was a dry hole. Recently, another well has been proposed within 40 feet; this well would be drilled deeper into the Tokun Formation. The potential for significant oil and gas is lessened by unfavorable geologic conditions such as: the lack of suitable reservoir rocks; complex geologic structure; and complex diagenetic histories that may have led to destruction or migration to the surface of some of the hydrocarbons generated (Plafker 1971).

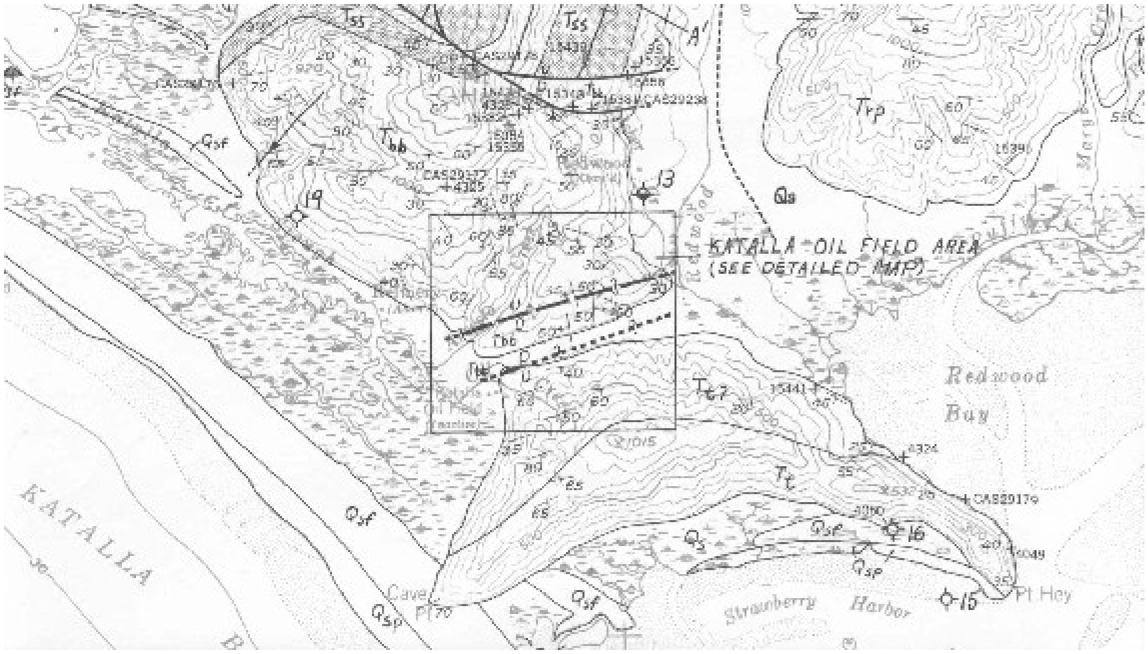


Figure 2.27 - Katalla Oil Field Area

The Katalla Area as defined in the 1982 CNI Settlement Agreement consists of 10,134 acres of land where the surface estate is National Forest System land and Chugach Alaska Corporation holds a term interest in the oil and gas resources. All other minerals are reserved to the United States. The patented claim is a 60-acre inholding of private land surrounded by the Katalla Area land. Unless a well capable of producing is drilled by December 31, 2004, the oil and gas rights revert to the United States. If a paying well is drilled, then these rights continue until production ceases, then the oil and gas rights revert to the United States.

The Katalla Exchange Preference Area, 55,375 acres adjacent to the Katalla Area, is subject to the exchange preference as described in the 1982 CNI Settlement Agreement, page 41 (Appendix C). If the Forest Service decides to make the area available for leasing, Chugach Alaska Corporation shall have the first opportunity to acquire, by exchange, the rights to explore, develop, and produce oil and gas from the exchange preference area. The 1982 agreement states that the United States is not be obligated to make a decision to opening all or part of the Katalla Exchange Preference Area. The exchange preference expires in 2007, 25 years from the date of the agreement. To date, the Forest Service has not made the area available for leasing. Refer to Figure 1.3 for locations.

Coal

Coal-bearing rocks underlie an area estimated to be about 10,000 acres of the Chugach National Forest and about 27,000 acres of Chugach Alaska Corporation (CAC) lands.

The coal potential area is shown in Figure 2.28. Coal-bearing rocks are exposed in a 20 mile long and 2 to 5 mile wide belt running northeast from the east shore of Bering Lake. It is bordered on the northwest by the Martin River Glacier and on the southwest by the Bering Glacier and the Bering River drainage basin. The coal in the eastern half of the field is mainly anthracite and in the western half is mainly semi-bituminous. It occurs in structurally complex seams that are locally thin and lack continuity. Barnes (1951) concluded that the prospects of proving a large reserve tonnage of economically mineable coal in a single block were not encouraging. However, Nelson and others (1984) ranked the coal as having a high mineral potential. A USGS report (MF-1645-A) references hypothetical resources of 36 million short tons as determined by Holloway (1977), while a coal resource of 3.6 billion tons has been inferred by others. The outcrop length of the Kushtaka-Kultieth Formation in the Carbon and Monument Mountains area suggests a minimum resource of 1.2 billion short tons of coal.

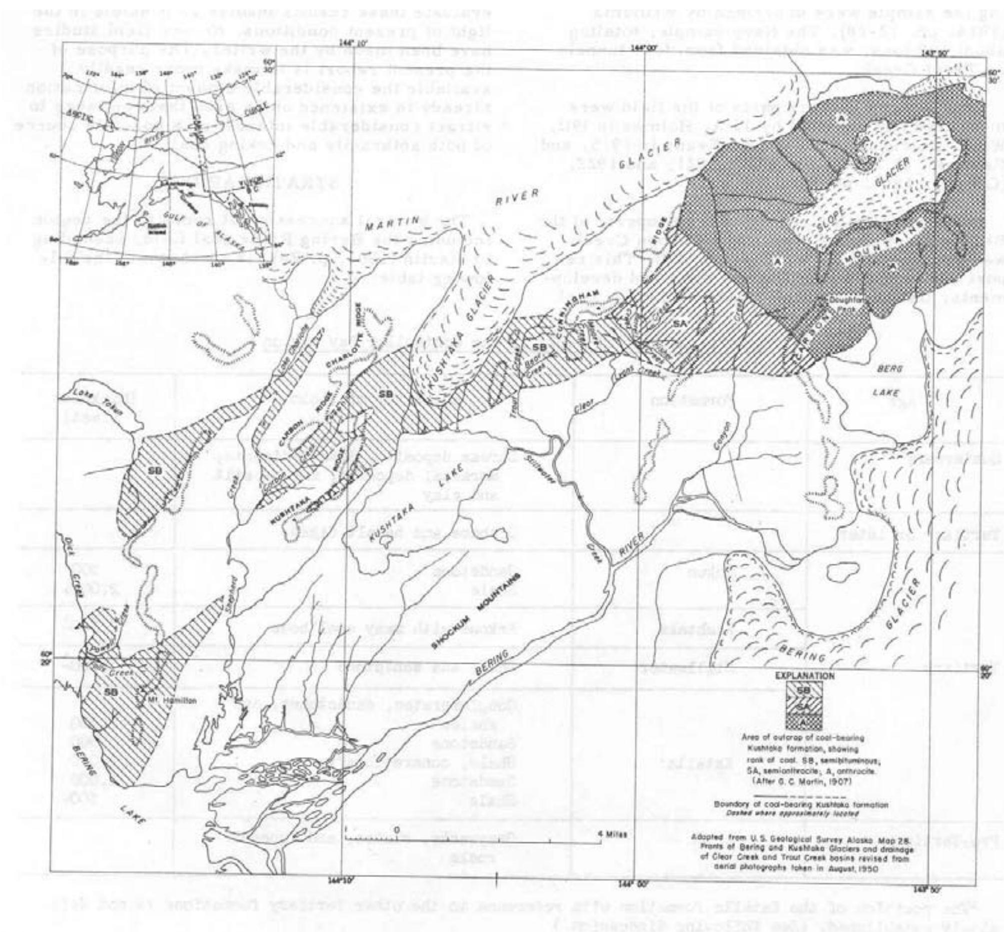


Figure 2.28 – Coal fields in the analysis area

The Bering River Coal Field was first documented in reports by the U.S. Geological Survey in 1896, and since then numerous investigations have taken place. Coal exploration and development was most active in the first two decades of the 20th century. In 1903, the Bering River Coal Company had already begun construction on a power house and additional support buildings, and had done a great deal of underground and surface development work (Colp and Wolff 1969). Between 18,000 and 20,000 tons of coal were produced and hauled by the Bering River Railroad. Sometime in the early 1920s the mine and facilities were abandoned. The demise is attributed to political difficulties involving railroad construction, claim conflicts, and federal land policies.

In the 1950s, there was renewed interest in mining in the area. The Jewel Ridge Coal Corporation investigated this area in the summers of 1957 and 1958. The Cortella Coal Corporation began prospecting on Carbon Creek in 1968, with trenching and some diamond drilling (Moening 1968, Renshaw 1969). Seimiol Consultants did some additional mapping and cross sections along Carbon Creek and proposed a potential reserve of 95 million tons. In the early 1970s, Inlet Oil Corporation held the area under prospecting permit, and made application for a mining lease of about 5000 acres, located on the western half of the coal field and either side of Carbon Creek. Coal mines and prospects are shown on Figure 2.25, most are on CAC land. None of the investigations after the 1920s resulted in production.

In 1981, CAC signed an agreement for exploration and development of the Bering River Coal Field with the Korea Alaska Development Corporation (KADCO). The KADCO studies were conducted between 1981 and 1984. CAC used the results of the 1981 work to make their land selection, completed in June 1982. Under ANSCA, the Chugach Natives Inc. (now Chugach Alaska Corporation) gained title to the most promising coal reserves in the Bering River Coal Field. KADCO eventually acquired about 85% of the CAC's coal rights and owns them today. In 1999, KADCO indicated to the Forest Service that they might be willing to sell those rights. Chugach Alaska Corporation wrote to the Forest Service and indicated that they were strongly opposed to any such sale.

Salable Minerals

Sand and gravel resources are abundant but undeveloped in the analysis area. Several mineral material investigations have been made in the area, including one by the USGS (Kachadoorian 1961) at the request of the Alaska Road Commission during the summer of 1955. Kachadoorian described the engineering geology of the Katalla segment of a proposed highway from Mile 39 on the Copper River Highway to Icy Bay, approximately 110 miles east of the town of Katalla. He evaluated quaternary units, sedimentary, and metamorphic rock units for their suitability as road foundation material and riprap. He rated the beach, alluvial-gravel, and terrace deposits as good road foundation, as well as the well-drained outwash and moraine deposits. He rated the sedimentary rock as generally excellent road foundation and fair riprap and the metamorphic rock as excellent road foundation and good riprap. Kachadoorian indicated that the best sources for good borrow material generally are alluvial-gravel deposits and talus (if crushed).

Numerous mineral material sources have been identified along the 29-mile Carbon Mountain road easement on National Forest System lands. These resources would be developed and used to build the road. Total quantity required for road construction is estimated at 287,000 cubic yards. Anticipated pit/quarry locations are identified in

Carbon Mountain Road Design Plans dated Nov. 18, 1998 (on file with the Cordova Ranger District, Chugach National Forest).

Roads

The analysis area contains approximately 2.1 miles of Forest Service System and easement roads, 11 miles of State Highway # 10 (Copper River Highway), and about 1 mile of the CAC Carbon Mountain Road. The Copper River Highway is 48 miles long and provides limited access along the northwestern edge of the analysis area. After crossing the Copper River, the highway terminates at the Million Dollar Bridge in the North Copper River/Tasnuna River watershed. It was established in the early 1950s using the abandoned Copper River and Northwestern Railroad bed.

Childs Glacier Road - is a two lane, native surfaced 0.803 mile road maintained at level 3 accessing the Childs Glacier/Million Dollar Bridge Recreation Site and the State of Alaska's fish counting facilities which are permitted through CAC. A portion of road will be relocated and the length will increase by another two to three tenths of a mile when the Recreation Site is expanded within the next few years.

Figure 2.29 – Constructed portion of Carbon Mountain Road, across Clear Creek to Sheep Creek drainage. Photo taken August 2003.

Carbon Mountain Road - The Carbon Mountain Road begins at Mile 41 of the Copper River Highway passing through Eyak Native Corporation lands before accessing National Forest System lands. The Forest Service retains public access on the road easement (originally reserved as the Kustaka Lake easement) with the Chugach Alaska Corporation. Currently this easement has been converted to a road only on Eyak Native Corporation lands. The remainder has been surveyed. When the timber market improves the Chugach Alaska Corporation plans to construct the road.

The easement meanders in a southeasterly direction for about 29 miles to access CAC lands called the Carbon Mountain Tract. The location follows the route identified in the 1982 Settlement Agreement which guaranteed this access. A road easement was issued to CAC in March 2000 and on November 1, 2000, the road plans and bridges other than Martin River were approved for construction with the requirement that used superstructures be reviewed and approved by the Forest Service Regional Director of Engineering prior to installation. The Regional Director of Engineering must also approve the technical analysis and bridge design of the Martin River Crossing prior to construction.

Recreation Facilities and Use

Recreational developments within the East Delta analysis area include; a day use site and future campground, trails, easements, and public recreational cabins. Combined, these facilities provide a variety of recreation activities such as hunting, hiking, boating, fishing, wildlife viewing, camping, sight seeing, cross-country skiing, snow machining and riding OHV's. Figures 2.30 and 2.31 display the location of the recreation facilities in the analysis area.

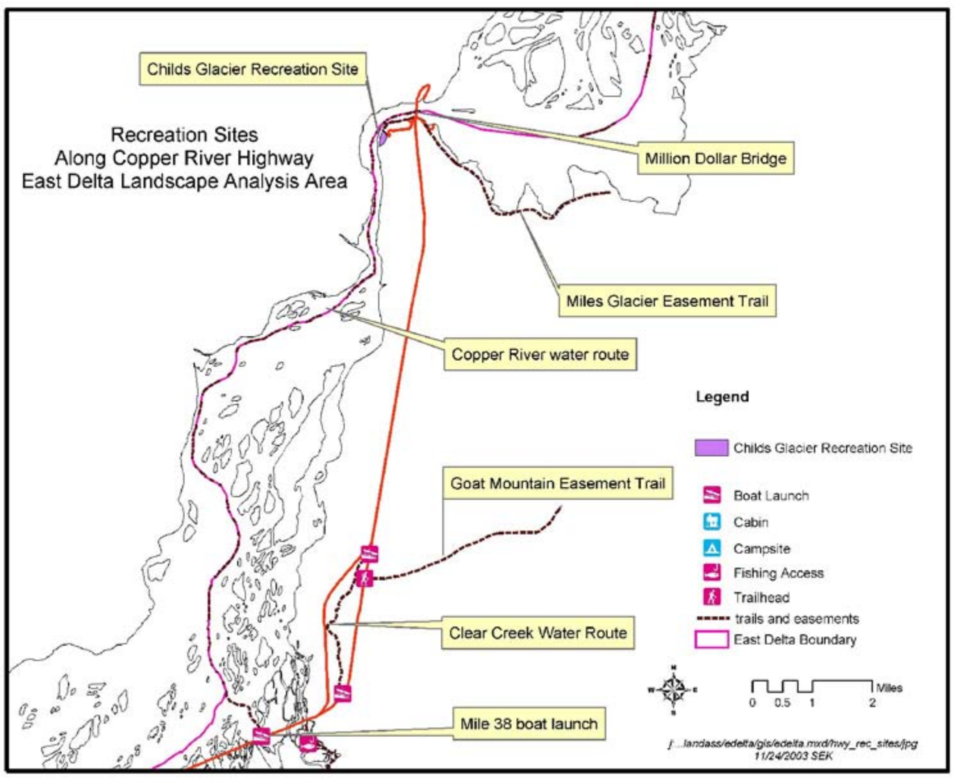


Figure 2.30 – Trails, cabins, and developed recreation sites in the north half of the analysis area

Boat Launches – No official boat launches are present in the East Delta analysis area. Several places are used to launch boats including Mile 37.4 and 37.7 on Clear Creek.

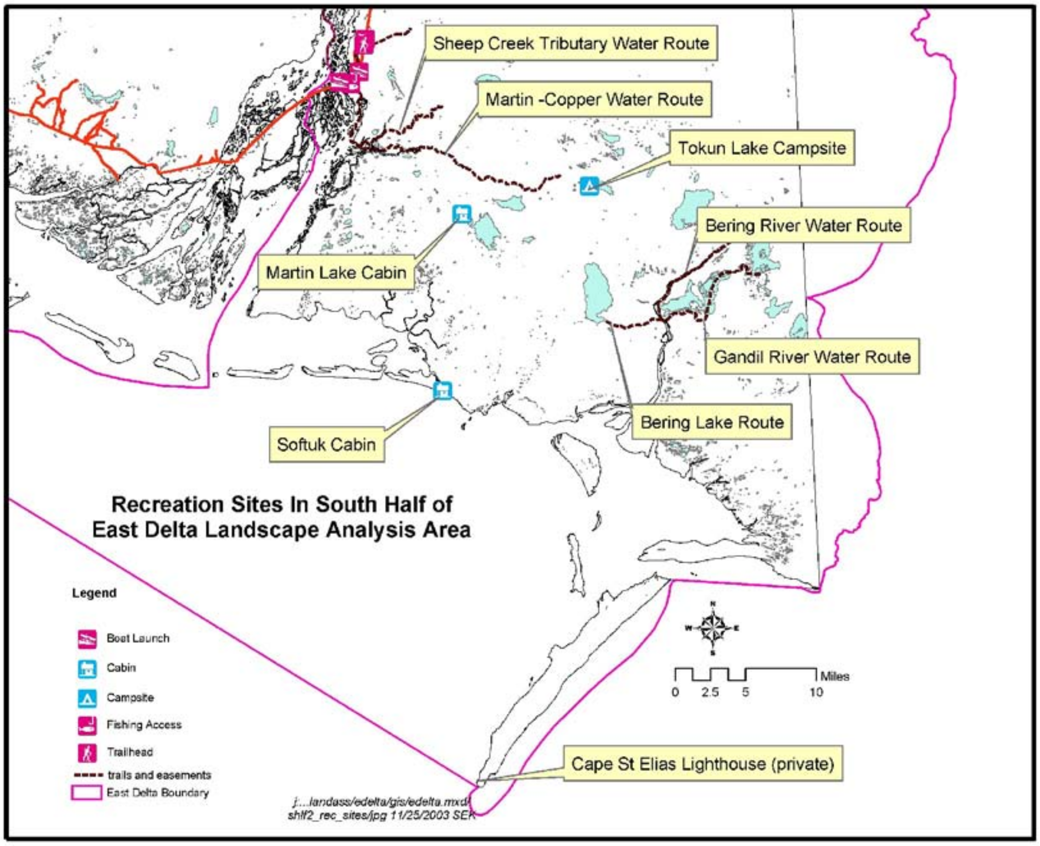


Figure 2.31- Recreation sites in the south half of the analysis area.

Cabins – There are two public recreation cabins and two deteriorating administrative cabins in the analysis area.

Martin Lake Cabin

This 12 x 14 foot Pan Abode cedar log cabin is located on Martin Lake. It has an oil stove, and sleeps 6. It is accessible by floatplane (about 30 minutes from Cordova). Use fees are $35.00/night. Recreation opportunities include fishing, big game and waterfowl hunting, camping, and viewing wildlife and scenery. The cabin's foundation was reconstructed in 2002. It is heavily used during August and September for fishing and hunting. Because of the high demand for this cabin, a lottery reservation system may be reinstalled in order to establish a more equitable process.

Softuk Bar Cabin

This cabin is located on the outside beach of Softuk Bar about 40 miles southeast of Cordova. The cabin was dismantled and moved from either Canoe Pass or Eyak River in the mid 1980's and relocated to Softuk Bar in 1987. It is accessible by wheeled plane landing on the beach at low tide. The Pan Abode cedar log cabin is 12 x 14 feet, sleeps six, and has both oil and wood stoves**.** The cabin is available year-round for $25.00/ night. Recreational opportunities consist of hunting big game and waterfowl, clamming, and viewing wildlife and scenery. Softuk cabin is one of three District cabins that receive low to minimal use.

Administrative cabins

Shepherd Creek Cabin is approximately 2.5 miles north of Bering Lake on Shepherd Creek. It was discovered in the early 1980s by District law enforcement personnel and thought to be associated with a big game guide. Forest Service personnel finished closing it in and put a roof on the approximately 12x10 foot native log cabin. The cabin was used for administrative purposes between 1984-1992 but has not been used by Forest Service crews since then. The cabin's condition has deteriorated and barely suffices as a shelter at this time.

Redwood Bay Cabin is in the western end of Redwood Bay which is five miles east of Katalla. Its purpose and date of construction are unknown. It was known to exist prior to 1980 and was used for administrative purposes by the fish crew in the late 1980s while conducting stream surveys. It has not been used by the Forest Service since that time.

Developed Recreation Facilities – The Childs Glacier/Million Dollar Bridge Recreation Site is one of, if not the most, visited facility on the District. The Childs Glacier area has been a destination site since the railroad days. The current facilities on two forty acre parcels were developed in 1990 and 1991 because it was a popular area, the original access road paralleling the bank of the Copper River was eroding, and trespass was an issue on private lands. The facilities consist of a viewing platform and double vault toilet at the Million Dollar Bridge and at the Childs Glacier viewing area, another platform and toilet, as well as five picnic sites - two of which are covered; interpretive signing, bear-proof garbage and food storage containers and interconnecting trails. In September 1997 five tent sites were constructed to provide a safe camping outside the wave zone and parking/driving areas. By 2007, the site will be expanded to include RV camping, additional picnic sites, a group use pavilion, additional parking and toilets.

Trails – There are two trails in the analysis area, both located near the Childs Glacier/Million Dollar Bridge Recreation Site.

The Copper River Trail is located within the Childs Glacier/Million Dollar Bridge Recreation Site and connects the two forty-acre parcels. The northern terminus is located at the Million Dollar Bridge viewing platform and the southern terminus is located at the Childs Glacier viewing platform. The trail is approximately 0.7 miles in length and has a native gravel surface. It was originally constructed to a class IV or V accessible level but waves caused by the calving action of Childs Glacier have eroded portions of the trail and washed river gravel over sections of the original surface. Currently only the upper half is considered accessible. The trail was built in 1991 when the rest of the facilities were constructed.

The Childs Glacier Trail trailhead is located approximately 100 yards north of the north end of the Million Dollar Bridge on the west side of the Copper River Highway. The Class III trail extends 1.1 miles up onto Childs Glacier and was constructed in 2000 and

2001. It is an easement through Eyak Native Corporation lands. Currently, the trail is flooded by several beaver dams/ponds and only passable with high rubber boots. Two possible solutions have been identified: 1) negotiate with Eyak Corporation to relocated the trail; or 2) construct an elevated structure or floating structure to span the approximately 700 foot flooded area. A feature to be added is an area at the 1.1 mile mark where people can rest, enjoy the view, and become informed about how to conduct their activities on both public lands and private property. The site will have benches and signs.

Unofficial Sites – At Mile 38, an abandoned section of highway about 0.5 miles long accesses Clear Creek and is conducive to camping, rafting, picnicking and fishing. It has no developed structures. This section of road was abandoned when Mile 38 to Mile 42 of the highway was relocated to the east to avoid flooding.

At Mile 37.7 of the highway, a vehicular pathway has been created over the years by people launching air boats to access the Martin River Valley area and anglers fishing the confluence of Clear Creek and the Copper River. The road is not maintained and no structures or improvements are present.

Easements

Forest Service Easements through State lands - The Forest Service retains two 60-foot wide road easements on State lands at approximately Mile 37.7 and Mile 38 of the Copper River Highway accessing Clear Creek. Site easements for parking and river access purposes also occur. The 39 mile road easement (#80-490) is approximately 3/8 of a mile long and has been allowed to grow in with alder and is managed as a trail. At the end of the trail adjacent to Clear Creek there is a 2 acre site easement. The 37.5 mile road easement (#80-493) is a primitive river rock road which passes through State administered lands for approximately 3/4 mile before accessing the National Forest. The road terminates approximately ½ mile into the National Forest on the lower reaches of Clear Creek. There is a five acre site easement which occurs at the junction of the Copper River Highway and the road easement.

With the passage of ANCSA, the Forest Service and other federal agencies in Alaska were tasked to establish trail and site easements across the new private lands to access isolated parcels of public land. These site and trail easements are called 17(b) easements, referring to section 17(b) of ANCSA. The federal agencies are appointed as administrators of the 17(b) easements on lands within their jurisdiction, but the Bureau of Land Management is assigned overall responsibility for the recording, final platting, and rule making. Site easements are authorized along shorelines, navigable rivers, and at easement trailheads. Trail and site easements are not recreational trails or sites. Easement trails are intended for accessing public lands only; they may not be used simply as hiking trails or for any other purposes unless authorized by the landowner. Similarly, easement sites may only be used for day use or overnight camping if the user intends to access public lands from the easement or the site is adjacent to navigable salt or fresh waters.

The 1982 Settlement Agreement between CNI (now CAC) and the Forest Service established specific protocols for how these two organizations were to work together.

The agreement established streamside, site, and trail easements similar to 17 (b) easements except that these easements were specifically for recreational purposes although trespass was not allowed on corporation lands. These easements are commonly referred to as CNI easements.

Typically the specific uses allowed on both CNI and 17(b) easements depends on the easement type. On 25-foot right of way trails, travel by foot, dogsleds, animals, snowmobiles, two and three-wheeled vehicles, and small OHV's(less than 3000 lbs gross weight (GVW) is allowed. On one-acre sites, vehicle parking (e.g., aircraft, boats, OHV's, snowmobiles, cars, trucks), temporary camping, loading or unloading is limited to 24 hours. On 60-foot road easements, travel by foot, dogsleds, animals, snowmobiles, two and three-wheeled vehicles, and small and large OHV's, tracked vehicles, four-wheel drive vehicles, automobiles and trucks are allowed.

Typically district easements have been marked with signs, carsonite posts, orange diamonds (5" X 7"), and chainsaw blazes on trees greater than 6" diameter. The trails are not built to normal Forest Service trail standards. They are normally cleared with chainsaws to a six-foot wide corridor with an 8-foot high clearing limit and do not have a tread. As possible, easements are also designed at 20% grades or less. Most easements are surveyed. Corner monuments are placed at sites and at the beginning and ending of trail and road easements.

Table 2.16 lists the 6 trail, 9 site, 5 road and 1 streamside easements in the analysis area and Figure 2.29 displays their locations. The National Park Service also retains numerous CNI and ANCSA easements on the east bank of the Copper River, Wernicke River, and Bremner River on National Park lands adjacent to the analysis area.

Table 2.16-Easement trails and sites within the East Delta analysis area

Name	Easement ID Number	Length (miles)/ comments
ANCSA 17(b) Trails		
Goat Mountain Tr.	EIN 197G	3.5 miles (Eyak lands)
Miles Lake Trail	EIN 196 G	3.6 miles (Eyak lands)
Baird Canyon Trail	EIN 89aD1D9G	3.9 miles (CAC – not conveyed as yet so not an easement yet)
Wernicke River Trail	EIN91bD1	1.8 miles (CAC – not conveyed yet so not an easement yet)
State Road Easements		
Mile 37.7 road and site easement	80-00-490	0.732 miles – level 2 mtnce
Mile 38 road and site easement	80-00-493	0.615 miles – level 2 mtnce
ANCSA 17(b) Sites		
Goat Mountain Site	EIN 200	Not located – being negotiated with Eyak Corporation
Baird Canyon Site	EIN 89D1D9G	0.63 ac - Land not conveyed to CAC yet, so not an easement yet.
Wernicke River Site	EIN 91D1A	0.78 ac. - Land not conveyed to CAC yet so not an easement yet.
CNI Easements		
Miles Lake Road	CNI 1	Local easement across CAC lands between

Table 2.16-Easement trails and sites within the East Delta analysis area		
Name	**Easement ID Number**	**Length (miles)/ comments**
		Forest Service tracts
Miles Lake ADF&G site EZ	CNI 2	ADF&G warehouse and sonar on CAC
Copper River Highway	CNI 3	Hwy through CAC parcels near Miles Lake
Copper River Streamside	CNI 4	Southern and Eastern shore of Copper River on CAC Miles Lake parcels
Tokun Ridge Trail	CNI 9	On CAC lands from Carbon Mtn rd to NF near Tokun ridge. Also registered as an ANSCA easement
Tokun Ridge Trailhead Site	CNI 10	2 ac site adjacent to Carbon Mtn Rd. Also registered as ANSCA easement.
Stillwater Trail	CNI 11	Rd on CAC lands from Kushtaka Lake adj. To Stillwater creek. Reg. As ANSCA easement with a site
Kushtaka Lake Rd	CNI 12	Originally reserved easement in CAC carbon Mtn tract. Same as Carbon Mountain Rd.

Special Uses

Nine special use permits for commercial non-consumptive outfitter/guide activities and one for minerals exploration are authorized on National Forest System lands in the analysis area to the following companies:

Alaska River Rafters (COR6) - In addition to commercially guided river rafting on the Copper River (in the analysis area, the section rafted includes Wernicke River to Mile 37 on the Copper River), this permit holder is authorized use of the Childs Glacier Recreation Site.

Camp Alaska Tours (GLA23) - The permit authorizes activities in many locations including commercial interpretive sightseeing, photography, hiking, and sightseeing opportunities. In the analysis area, use is authorized at the Childs Glacier Recreation Site.

Cassandra Corporation - The Cassandra Corporation holds a permit with the district for ancillary support facilities on National Forest for the drilling of an exploratory well. Support facilities include a barge off-loading site, a temporary staging area and use of an existing temporary road.

Copper Oar (COR89) - This permit holder is authorized Copper River rafting activities from Cleave Creek at the northern border to 27 mile on the Copper River. Four campsites are authorized.

Copper River and Northwest Tours (COR9972-04) - This is a bus tour permit authorizing commercial sight seeing activity along the Copper River Highway. Stops occur at the Childs Glacier Viewing Site as well as other places along the highway.

Fishing and Flying - The permit holder is authorized for fishing expeditions in various locations of the East Copper River Delta.

Native Sun Charters and Copper River Tours (COR 50) - This jetboat sightseeing operation may be issued a permit in 2005 for sightseeing activities along the Copper River and limited access to the west shoreline of the Copper River for photography and hiking as well as freshwater fishing at the mouth of Fickett Glacier Creek.

Osprey Expeditions (COR 82) - This permit holder is authorized Copper River rafting activities from Cleave Creek at the northern border to 27 mile on the Copper River. Four campsites are authorized.

Sundog Expeditions (COR 81) - This permit holder is authorized Copper River rafting activities from Cleave Creek at the northern border to 27mile on the Copper River. Four campsites are authorized.

The Native Village of Eyak - The permit holder is conducting multiple activities on the district. Within the analysis area, the holder is coordinating a Chinook salmon escapement monitoring project on the Copper River in the Baird Canyon and Wernicke River area. A fishwheel is authorized as part of the permit.

Big Game Outfitter/Guides - The district currently authorizes nine different big game outfitter/guides to operate within various areas of the East Copper River Delta analysis area. Species hunted include moose, mountain goat, black bear and brown bear.

Cape St. Elias Reserve

The Cape Saint Elias Reserve, located at the southern tip of Kayak Island (Fig 2.32), was withdrawn from public lands September 5, 1914 and set aside for lighthouse purposes by executive order 2041 prior to inclusion to the Chugach National Forest in 1925. The reserve includes 413.4 acres of land. The United States Coast Guard later built the lighthouse and has managed the reserve since its reservation. The lighthouse is no longer in use and the USCG is now in the process of disposing of the land. The Forest Service, the Cape St. Elias Light Keeper Association, and the USCG are currently negotiating that disposal.

As an interesting side note a passage from Lander (1996) includes documentation of the March 28, 1964 Gulf of Alaska earthquake and Tsunami at Cape St. Elias:

> "The earthquake was felt for five minutes but did little damage to the U.S. Coast Guard lighthouse and station at Cape Saint Elias on the southwestern tip of Kayak Island. It did cause an uplift estimated at 6 to 8 feet and a rock fall on Pinnacle Rock, an offshore promontory connected to Cape Saint Elias by a gravel bar at low tide. One Coast Guardsmen, Frank O. Reid, had gone to Pinnacle Rock to photograph sea lions and suffered a broken leg from the rock fall. His three comrades were worried that he had not returned and went to look for him at 6:00 P.M. The first tectonically-generated tsunami reached the point at 6:16 P.M., almost an hour after the earthquake. It covered the gravel bar by 4 feet of water, catching the three Coast Guardsmen with chest deep water as they carried their injured comrade on a

> stretcher. A surge 10 feet high came 10 seconds later and swept all four into the sea. Frank Reid was lost, but the other men survived."

Thanks to Milo Burcham, Subsistence Wildlife Biologist, Cordova Ranger District for this excerpt.

Figure 2.32 – Cape St. Elias Lighthouse on south end of Kayak Island. (Aug 2003)

Chapter 3 – Issues and Key Questions

Physical

Disturbance regimes

1. Role of uplift and subsidence in managing habitats on the Delta.
    - *Refer to Chapter 4, and Develice et al. (2001), and Boggs (2000).*
2. How do glacial recession and glacial processes affect streamflows, channel and valley morphology, and water quality throughout the East Delta? How do these changes affect management of the East Delta?
    - *See hydrology and geology sections in Chapters 2 and 4.*

Hydrology and Water Quality

1. How do glacial processes and glacial dynamics affect water quality, channel morphology, streamflows, and natural lakes as they relate to fisheries, wildlife, ecology, and human uses.

    \- *Under the present climatic trends, glaciers in the East Delta analysis area have been generally receding and thinning over the last century. These glacial dynamics have large effects on sediment loads and rates of channel migration in glacial rivers, as well as the frequency and magnitude of catastrophic glacial outburst floods. The stabilization and incision of river channels on the outwash plains as a result of glacial recession also affect the water elevations of natural lakes. These changes impact fish and wildlife habitat, the distribution and growth of vegetation, recreational uses, and transportation routes. Changes in glaciers, channel morphology, and lakes can be evaluated using aerial photography.*
2. How do changes in the configuration of channels in the Copper River Affect the Copper River Highway and its bridges?

    \- *Downstream of the Million Dollar Bridge, the channels of the Copper River are actively migrating. Recent encroachment of the Copper River toward the east and into Clear Creek presents maintenance issues for the highway. Scour and aggradation in the channels under the highway bridges also necessitate maintenance or long term solutions. These issues are important because the highway provides access to the popular Childs Glacier and Million Dollar Bridge areas. This issue can be evaluated using aerial photographs as well as streamflow and morphology data for the Copper River.*
3. What would be the effect of oil drilling in the Katalla Oil Field on water quality in Katalla Slough and its tributaries? How would any future coal mining activities affect water quality in the Bering River coalfields area?

    \- *Cassandra Energy Corporation plans to resume oil drilling operations in the historic Katalla Oil Field. To evaluate the effects of oil drilling on water quality, Chugach National Forest personnel collected baseline water quality data on hydrocarbon concentrations from 2000 to 2003 adjacent to and downstream of natural oil seeps. Future effects of oil drilling can be evaluated based on these data. Although no coal mining is currently proposed in the Bering River coalfields, such activities would potentially affect water quality in many streams and lakes in the area. Baseline water quality data from the 1960s and 1970s could be used to assess any future impacts.*

4. How would hydrologic processes in the East Copper River Delta affect the proposed Carbon Mountain road and how would the proposed road alter these processes?
   - *The proposed Carbon Mountain Road would cross much of the East Delta and several glacial rivers. Active channel migration and glacial outburst floods can potentially cause construction, maintenance, and safety issues at channel crossings along the route. The frequency and magnitude of these hydrologic processes are related to glacial dynamics. The construction of a road bed across these many drainages would also disrupt processes of channel migration and influence sediment deposition. These issues can be evaluated using aerial photography and hydrologic data.*

Biological

Fish

1. What will be the impacts of Carbon Mountain Road construction on fisheries habitat? How can we minimize its impacts?
   - *Road has been designed to minimize impacts to fisheries. Establish monitoring sites at major stream crossings. Refer to Carbon Mountain environmental analysis.*
2. Will the CAC road significantly increase recreation access along the road corridor and what effect will this have of fish populations?
   - *Refer to Chapter 5 for potential monitoring projects.*
3. What effect will coal mining and timber harvest in the Carbon Mountain area have on fish habitat and populations on the surrounding public lands? Will water quality be negatively affected in downstream reaches of Shepherd Creek, Martin River, and Bering River watersheds?
   - *Refer to Chapter 4 for discussion and Chapter 5 for potential projects.*
4. Will sport fish and other recreation use increase in the analysis area as a result of improved access or the increase in demand for remote wilderness experiences? What effect will increased use have on fish habitat and populations?
   - *Refer to Chapter 4 for discussion and 5 for potential monitoring projects.*
5. What will be the effects of oil and gas development on fish resources in the Katalla River area? Will water quality change as a result of this development? Will this development negatively affect recreation use in the area?
   - *Monitor water quality. Refer to Katalla EA..*
6. How much and in what condition is the current fish habitat on the East Delta for the key species? Where are the major spawning, rearing, and overwintering habitats for the key species?
   - *Refer to Chapter 2.*
7. Are Atlantic salmon or other species of farmed salmon present on the East Copper River Delta? What impact might these fish have on native and wild salmon populations? What is the rate of straying of upper Copper River hatchery sockeye? Are there genetic impacts from straying salmon on wild Delta stocks?
   - *Refer to Chapter 4 for discussion and Chapter 5 for potential projects.*
8. What are the factors influencing the productivity of the key species in the analysis area? Are there physical properties of watersheds that influence life history

patterns in juvenile anadromous salmonids? What role does riparian vegetation, especially alder, play in fish production? How does fish species composition, abundance, and growth compare between the major riparian vegetation types on the Delta? How will patterns of riparian vegetation succession change production? Is there a correlation between riparian vegetation, invertebrate prey abundance, and fish growth? Are juvenile salmonids using the lower Delta and estuaries as rearing habitat and what is its relative importance to salmon production?
    - *Refer to Chapter 4 for discussion and 5 for potential monitoring projects*.
9. What are the major disturbance regimes in the analysis area and how do they affect fisheries resources? At what rate are the Bering and Martin Lakes filling in and what is the effect on fish populations? How much and what kind of habitat is being created from disturbances such as glacial outwash flooding?
    - *Refer to Chapters 2 and 4 for discussion and 5 for potential monitoring projects*.

Vegetation

1. Could any Threatened, Endangered or Sensitive plant species occur in the area?
    - *Refer to Chapter 4, Vegetation section.*
2. Are there any invasive plant species?
    - *In 1997, a basic inventory for non-native plant species was conducted in the Copper River Delta area (Duffy 2003). Refer to Chapter 4, Vegetation.*
3. There is blowdown in Martin River valley, but it is not accessible.
4. Are there plans for timber harvest?
    - *Not on National Forest System lands. May be harvest on adjacent private lands if market improves.*

Wildlife

1. What are the Threatened, Endangered and Sensitive species in the analysis area and what is their status?
    - *See Chapter 2, wildlife section*
2. What is the distribution of game species in the analysis area? This includes those species popular for wildlife viewing.
    - *See Chapter 2, wildlife section.*
3. What are the effects of plant succession on habitat for species of concern.
    - *See Chapter 4, wildlife section.*
4. Will moose or wolves be affected by the construction of the CAC road on the east Copper River Delta?
    - *See Chapter 2, wildlife section.*
5. What habitats are important to brown bears on the East Copper River Delta?
    - *See Chapter 2, wildlife section*.
6. Will human activity at Cape St Elias disturb nesting seabirds or Steller sea lions?
    - *See Chapter 2, wildlife section. No data exists on human use and impacts on wildlife at Cape St. Elias. Studying these effects is listed as a potential project.*

Human

Heritage Resource Issues

1. Where are the areas where proposed development may have an impact on heritage resources?

- *The high sensitivity zones for cultural resources are identified using a predictive model to describe areas where proposed development may have an impact on heritage resources. Refer to Chapter 4 for descriptions of areas.*

2. There is concern that the tribe be consulted on all heritage resource questions and projects.
    - *The Forest currently consults with the Native Village of Eyak and Chugach Alaska Corporation regarding projects in the analysis area in accordance with the National Historic Preservation Act, (16USC470a(d)(6)(B). For new projects, this initially occurs through the quarterly Schedule of Proposed Actions. In addition, if projects are proposed in the vicinity of known sites of Native cultural and religious significance, or within Chugach Alaska Corporation 14(h)(1) selections, direct consultation regarding that particular project and site will occur with the appropriate Native group(s).*
3. One concern raised during scoping was what effect will the potential oil drilling and mining in Katalla area have on heritage resource?
    - *Historical properties were addressed in the Environmental Assessment for Oil and Gas Exploration in the Katalla Area and the determination was no effect to historic properties (Chapter 2, p. 49, and other locations in the EA.)*

Minerals and mining potential

1. Are the lands open to mineral entry?
    - *All public domain lands are open to mineral entry unless specifically closed. Of the National Forest System lands in the analysis area, only the Copper River Addition portion is closed to mineral entry. When lands are closed to mineral entry, leasing or sales of mineral materials may still occur. However, both leasing and mineral materials sales are discretionary.*
2. What is the potential of mineral exploration and development?
    - *The potential for mineral development varies across the analysis area. If valuable minerals are not known to be present, or are covered with icefields or glaciers, there will be less interest in developing mineral resources. The Katalla area on the other hand is a known area of interest for oil and gas. See Chapters 2 and 4, mineral development for further discussion.*
3. How does CAC oil and gas rights and subsurface ownership affect management of National Forest System lands?
    - *See chapter 4 for discussion.*
4. Is there a demand for sand and gravel from National Forest System lands?
    - *If state and private sources are adequate to meet local demands then the Forest need not provide community pits or offer mineral materials sales. If such sources are inadequate, then the Forest should make such resources available for local needs only when the disposal is not detrimental to the public interest and that the benefits exceed the total cost and impacts of resource disturbance (FSM 2850). Mineral materials must be sold at fair market value.*
5. What is the status and potential impacts of the Carbon Mountain Road?
    - *Road access to CAC land is guaranteed under the 1982 CNI Settlement Agreement. See Chapter 2 and 4 for further discussion.*

Recreation

1. What is the public demand for recreation opportunities within the analysis area and how does it compare to capacity? (Trails, heliskiing, outfitter guides, wildlife viewing, motorized and non-motorized)
   - *See Chapter 4 Conditions and trends.*
2. Impacts of Recreation use – Off-road vehicle, airboat, and sport fishing use of the area.
   - *See Chapter 4.*
3. Potential for trespass on private lands to occur by National Forest users.
   - *The Native Corporations and the District communicate, coordinate, and consult regularly on easement issues. At the top of the list is trespass on Native Corporation lands which, in part, is generated by the very existence of public access easements or special use activities authorized by Forest Service permits. This issue goes beyond Forest boundaries; it is the leading easement issue statewide. The Forest Service has increased its efforts to ensure that the public is better educated to the legal uses of easements by taking an active role in informing the public and ensuring easements are well signed with the correct information.*
   - *Another easement issue occurring along the Copper River as well as other locations is the erosion or accretion of riverbank material which reduces or adds to the land base upon which access rights to easement sites and trails exist. Legally, if a site easement is eroded, it is lost and there is no legal obligation by the landowner to replace it with another. The district is addressing this issue with the Native corporations on a case by case basis.*
4. Are there any concerns about impacts of airboat and jet boat use?
   - *An area of concern that has generated significant comment in recent years is the impacts of jetboats and airboats. In general, the use of jetboats has been unregulated and likely will remain so as the Forest Service does not have the authority to regulate navigatable waterways nor the areas below the Ordinary High Water mark of freshwater systems. Airboats, on the other hand, have been regulated by State of Alaska statutes and Forest Service seasonal restrictions or motorized/non-motorized designations identified in the Forest Plan.*
   - *Airboat and jetboat use on the Copper River up-river from the Childs Glacier Recreation Site has been especially contentious. Outfitter/guides wishing to use the Copper River for sightseeing and/or fishing and hunting opportunities have been heavily targeted by environmental groups and concerned citizens who feel the impacts to fish, wildlife, and the pristine quiet character of the river is unacceptable. The situation is further aggravated by the lack of authority to administer river uses and multiple ownerships or administration of lands within the Copper River corridor. The affected parties include the Eyak Corporation, Tatitlek Corporation, Chugach Alaska Corporation, State of Alaska, Bureau of Land Management, National Park Service, and the Forest Service. North of the National Forest boundary, other affected Native Corporations and Villages are affected.*

5. Recreation needs – high demand in the future. High speed daily ferry starts in 2005 from Whittier /Valdez. Expected increase 600% in visitors to Cordova. Still limits on available hotel & BB space for visitors.
    - *See chapter 4 Conditions and trends.*
6. Potential impacts of lodge cabin facilities on State lands near the coast (OHV, etc)
    - *The Lodge on the Kiklukh River near Cape Suckling is located on State lands just east of the National Forest Boundary. Although the majority of recreation use associated with this facility occurs off Forest, OHV activity is evident on National Forest System lands. The level and type of use on adjacent National Forest System lands needs to be monitored and managed if this type of use continues.*

Special Uses

1. What is the demand for special use permits for other land uses in the analysis area such as radio repeaters and non-consumptive guiding? How many should be allowed?
    - *The demand for special uses in all areas; outfitter/guides, electronic sites, research, photography and other areas is ever increasing and as the competition for use of the National Forest System land base increases so does the complexity of conducting NEPA and coordinating these activities.*
2. There is concern about the illegal, non-permitted use of National forest system lands by a variety of outfitter/guides (river rafters, heliskiiers, big game guides, and fishing guides. One concern in particular is the guiding for coho salmon sport fishing taking place on the East Copper River Delta. These activities take place primarily in August and September.
    - *With the addition of a full-time law enforcement officer to the Cordova District we are seeing a great improvement in our ability to prosecute violators and provide a Forest Service presence in the field which serves to curb the incentive to operate illegally.*

3. Carrying Capacity is an issue for both outfitter and guides and unguided public – what is the capacity? There is much SUP activity, including big game guiding and rafting.
    - *See chapter 4, the District is conducting a carrying capacity analysis.*
4. It is important to coordination with Native landowners, especially on the Copper River.
    - *The District is increasing its efforts to consult with the Corporations about planned special use permit activities and is looking for ways to jointly fund (with the corporations and other land administrators of the Copper River) an additional law enforcement presence within the Copper River to monitor activities and trespass.*
    - *An MOU is also being developed cooperatively with the Eyak Corporation. It is in a final draft stage and highlights ways that the Eyak Corporation and the Forest Service can work together.*

Chapter 4 – Conditions and Trends

Geomorphic processes in the area

Geomorphic processes are the dominant driving successional force on the delta. Land and aquatic features are constantly changing under the influence of glacier and riverine sediments, tectonic uplift, and tidal action (Kruger and Tyler 1995). The stratigraphy reflects the repetition of uplift, subsidence, and sedimentation. The relics of past vegetation are interbedded with fine sediments from tidal deposits and coarse sediments from glacial meltwater flood (Thelinius 1995). The river and stream channels are highly dynamic because of high relief, glaciated watersheds, an abundance of newly deposited glacial outwash, and amount of precipitation. The Copper River transports large quantities of sediment, 69 million tons per year (Brabets 1997), resulting in continuously shifting channels downstream of the Million Dollar Bridge.

Glacial

The Copper River Delta began to form about 9000 years ago, during rapid glacial retreat in the Holocene (Reimnitz 1966). The Copper River was the outlet for a catastrophic flood that occurred when the glacier dam that held Lake Atna failed. This flood drained the 2000 mi^2 lake transporting large amounts of sediment to the Gulf of Alaska to begin the development of the Delta. These deposits did not emerge above sea level until over 2,500 years later (Reimnitz 1966). During the past 5000 years, tectonic uplift has occurred regularly, approximately every 600 years (Boggs 2000). Although high rates of subsidence compensate for the rapid uplift and sedimentation rates, the net result is a seaward expansion of the Copper River Delta.

A warming climate and changes in the distribution of precipitation are causing glacial recession. Over the last century, glaciers in the area have decreased in size considerably, although overall recession on some glaciers has been punctuated by short periods of glacial advance. With continued glacial recession, outburst flood events have become less common, glacial rivers are carrying lower sediment loads and in some cases are incising, and some of the outwash plains are stabilizing.

Tectonic

Periodic tectonic uplift alters the quantity, type, and distribution of wetlands and tidal flats. The 1964 earthquake was the most recent of at least five similar coseismic uplifts that occurred in the last 3000+ years (Thilenius 1995). The intervals between previous uplifts were about 790, 670, 950, and 600 years. The release of force from the 9.2 magnitude earthquake caused dramatic changes in elevation throughout Southcentral Alaska (Combellick 1992). This catastrophic earthquake, with an epicenter 80 miles northwest of the mouth of the Copper River, resulted in 6 to 12 feet of uplift on the Copper River Delta (Reimnitz 1966). This caused significant changes in the landforms and vegetative cover, and many tidal areas became supertidal wetlands. Minor channel changes occurred throughout the area. The earthquake caused the destruction of all highway bridges constructed of pilings made of old rails, and one section of the Million

Dollar Bridge collapsed where it remains today (Brabets 1997). Alaska Department of Transportation is currently reconstructing and stabilizing the structure.

Tectonic uplift elevated some soils away from the environment that contributed to their formation. This introduced different soil forming processes which consequently changed the physical and chemical nature of the soils. Soils that were once under water were now exposed to air and others were lifted away from regular tidal influences and associated saline inputs and deltaic marine deposits (Boggs 2000). These changes expressed themselves in the succession of vegetation communities throughout the affected areas (Thilenius 1990).

Erosion

Erosion processes present include surface erosion, stream bank erosion, and landslides. Surface erosion is normally not a problem in areas as well vegetated as the analysis area. Recently deglaciated areas or those high in the mountain summits and covered with frost-churned rocks are an exception. In these areas, the soil stratum has not developed sufficiently to support vegetation to keep sediments intact and protected from wind and water. Also, areas recently disturbed from mass wasting, avalanches, or stream down-cutting will be more susceptible to surface erosion for the same reasons.

Stream bank erosion is a natural process that occurs throughout the study area as streams migrate along the outwash plains, especially in the uplifted marshes. The uplifted marshes are developing on soils rich in silt which erodes easier than sand and clay. However, the riparian vegetation along steams stabilizes the bank by reinforcing the soil with its root system. The soils that support this vegetation along all the major streams in the analysis area are formed on deep alluvial deposits of silt, sand and gravel with a very thin top layer of organic materials essential for growth. If the riparian vegetation is damaged, the bank will be susceptible to increased rates of erosion until the vegetation recovers. Disturbing the riparian soils will leave the stream banks vulnerable for a considerably longer time.

Landslides on forested land are dependent on several factors. Douglas N. Swanston (1997) developed a rating system for slope stability on the Tongass National Forest which factored in topographic attributes, soil properties, geology, and hydrologic conditions. This system was later modified for use on the Chugach National Forest by Dean Davidson (Velarde 2004). Of these factors, slope gradient is the most critical. Figure 4.1 shows critical slope breaks for the analysis area. Landslides most frequently occur on slopes greater than 72% (Swanston 1997) and stability between 56% and 72% depends on other factors such as topographic position and restrictive layers. The Mountain Sideslopes unit (Fig 2.6) is particularly susceptible to landslides based on these criteria. Many of the soils in this unit are underlain by compact glacial till that can serve as a slippery surface if water is restricted and starts to flow just above it. On-site appraisal of these criteria is essential for most types of site-specific activities.

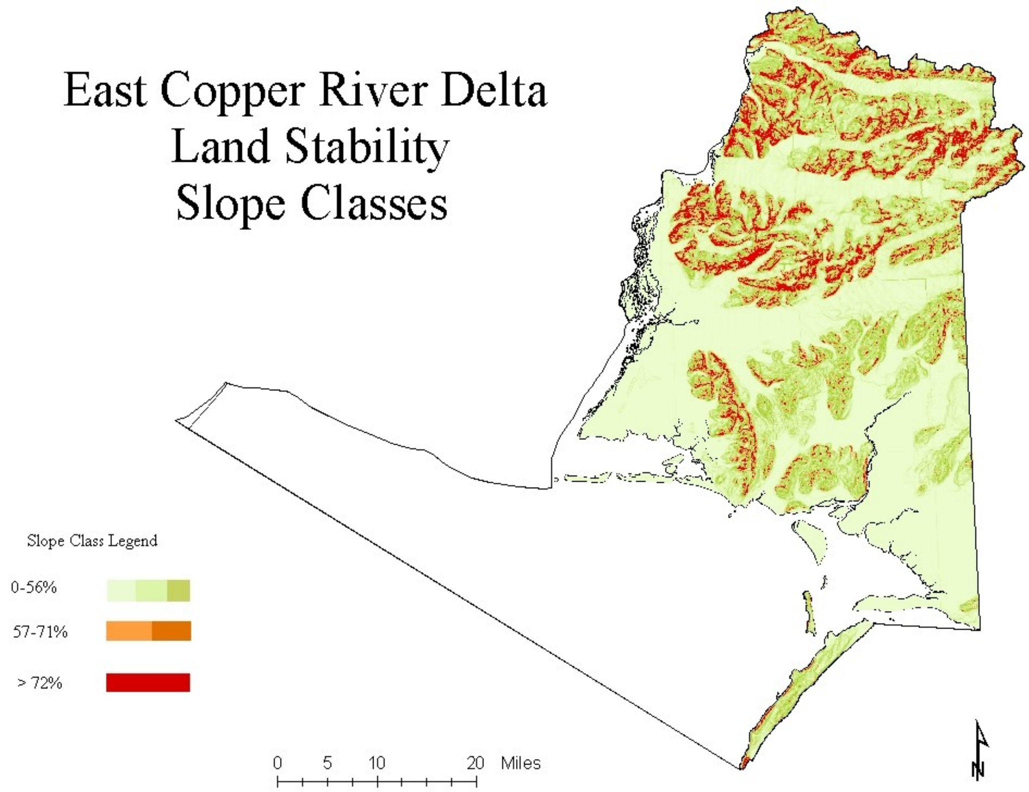


Figure 4.1-Critical land stability slope classes for the East Copper River Delta analysis area. Information from Chugach National Forest Corporate Database.

General hydrologic trends

Northern Area

The terminal lobe of the Miles Glacier expanded into the Copper River Valley prior to 1840, followed by a period of glacial recession. Between 1885 and 1888, the Miles Glacier advanced to about 120 yards of the location of the Million Dollar Bridge, but by 1908, it receded about 3 miles. Another glacial advance, shortly after the construction of the bridge in 1910, brought the Miles Glacier to within 9400 feet of the bridge and the Childs Glacier to within 1500 feet of the bridge (Tarr and Martin 1914). Miles Glacier has receded considerably since 1911; the terminus currently lies about 5 miles east of the Million Dollar Bridge. The glacier is presently about 32 miles long with a 3 mile wide terminus in Miles Lake.

Around 1910, the northern portion of the glacial terminus consisted of a large stagnant bulb covered with ablation moraine and alder growth that extended across the Copper River valley and forced the river against the west side of the valley. The northern bulb subsequently receded, and the Copper River broke through the northeastern margin of the terminal moraine, abandoning the marginal channel on the west side of the valley. Abercrombie Rapids, formerly located in the marginal western channel, currently lie in the constricted channel created by the morainal deposits from this bulb. The glacial terminus currently lies at the outlet of the Miles Glacier valley. The southern portion of the terminus has receded about 7000 feet in the past 25 years (Fig 4.2). The static northern portion of the terminus consists of morainal deposits and outburst flood deposits from Van Cleve Lake. Despite rapid down-valley movement, the glacier will continue to recede and thin under the current climatic trends. The glacier currently extends below sea level, and Miles Lake will continue to expand some distance up the Miles Glacier valley as the glacier recedes.

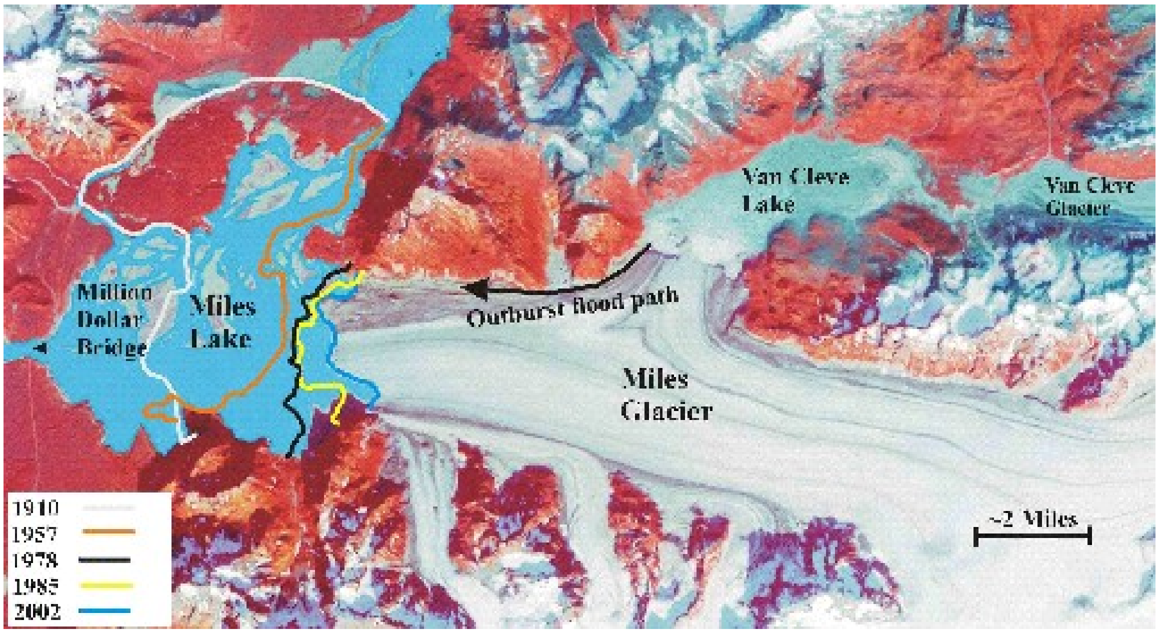


Figure 4.2-Glacial recession on Miles Glacier from 1910 to 2002 (2002 base photo).

1910 glacial extent from Tarr and Martin (1914), 1957 extent from USGS quadrangle map, 1978-2002 extents from Chugach National Forest aerial photography.

Miles Glacier creates a glacial dam for Van Cleve Lake, which drains the Van Cleve Glacier (Fig 4.2). This lake fills and the dam breaks periodically, creating large outburst floods that greatly enhance flows in the Copper River. Historically, this has happened approximately every 6 years, generally in late summer, releasing between 150,000 and 200,000 cfs into the Copper River (Brabets 1997). Such outbursts can cause dynamic channel changes and damage to the highway when flows are already elevated during summer runoff or when ice becomes mobilized during winter outburst events. With recession and thinning of the Miles Glacier, Van Cleve outburst events are likely to become smaller. The most recent of these events occurred in July 2003 (Fig 4.3).

Figure 4.3 – Van Cleve Lake looking south to Miles Glacier. Lake is empty after outburst flood event. (Aug 2003)

Copper River Delta Area

Copper River - Miles Lake acts as a settling pond for bedload sediment transported by the Copper River and Miles Glacier. The lake outlet is well armored by the coarse terminal moraine deposits of the Miles Glacier, but additional bedload and suspended sediment enters the river at the Childs Glacier. Childs Glacier has receded relatively little in the past century and continues to affect channel morphology of the Copper River downstream. Glacial outburst floods from Van Cleve Lake can also have measurable impacts on the Copper River and its delta downstream by greatly augmenting the discharge and sediment loads. Although the highest recorded flows on the Copper River do not correspond to Van Cleve outburst events, these outburst floods can easily double the flow in the Copper River and threaten downstream bridges. Downstream of the Million Dollar Bridge, the Copper River is an actively migrating outwash system, as it transports incoming sediment and adjusts sediment in its bed and banks.

Between 1908 and 1981, the majority of the Copper River occupied the western channels near Flag Point, although small channels existed on the east side of the river. The large flood of 1981 caused sediment deposition in the western channels and a shift in flow patterns toward the east. This resulted in a ten times increase in the cross sectional area of the channel under bridge 342 (on the east side of the river). The Alaska Department of Transportation lengthened the bridge and built upstream spur dikes as a result of this scour. Data from 1991 to 1995 show that about 40% of the Copper River flow is under this bridge (Brabets 1997). Channel bars downstream of the highway are generally well vegetated because the fixed location of the highway bridges prevents channel migration and the formation of new channels downstream of the highway. At bridge 342, the channel upstream of the bridge has widened to accommodate the increased flow, but the channel downstream of the highway reflects the narrower width of the bridge.

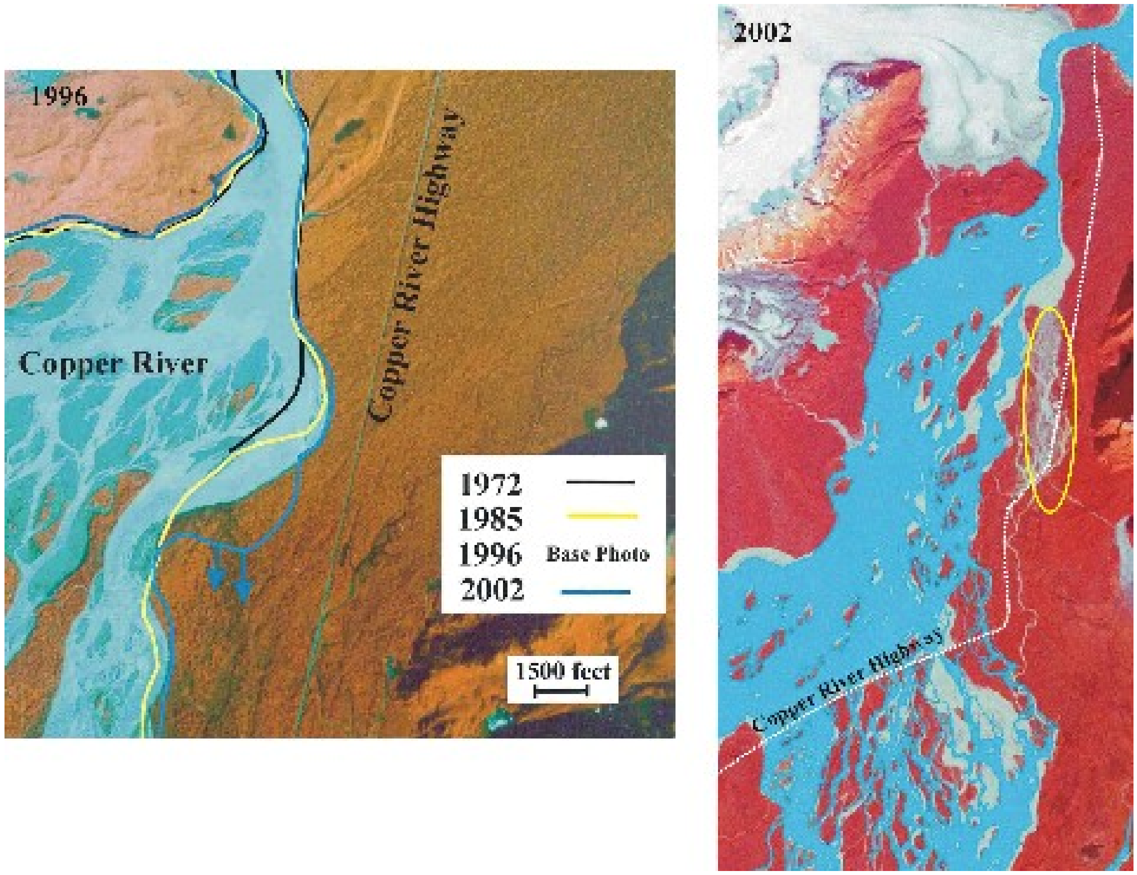


Figure 4.4: Recent channel changes on the Copper River downstream of Childs Glacier.

Left photo from 1996. Right photo from 2002, with gray areas representing lands eroded away between 1950 and 2002. The yellow oval shows new channels in Clear Creek.

Recently, the eastern migration of the Copper River has begun to threaten the Copper River Highway where it crosses a portion of the Copper River outwash plain between milepost 40 and 44. Recent channel changes have caused the easternmost Copper River channel to migrate 2500 to 3000 feet southeast, allowing flows from the Copper River to enter Clear Creek, a groundwater-fed tributary just east of the highway (Fig 4.4). This causes potential problems with undersized culverts on the highway, scour of the road, and ice damage during the winter. Actions may have to be taken in the near future to preserve the Copper River Highway. However, recent observations suggest that the channel is beginning to migrate back toward the west. With the projected increase in visitors to the area, it is very important to maintain access to the Childs Glacier/Million Dollar Bridge area.

Martin River and tributaries - The Martin River Glacier is the prominent glacier draining onto the East Copper River deltaic plain. The smaller McPherson, Johnson, and Slide Glaciers also contribute glacial sediment to the delta. The lower 10 miles of the Martin River Glacier is characterized by exposed ice, superglacial lakes, ice sinkhole depressions, and morainal material. Much of the lower glacier is covered with a veneer of superglacial drift supporting growth of alder, willow, and spruce forests (Reid 1970). Trees growing on the terminal portion of the glacier are up to 350 years old. The terminal moraine, of late Wisconsin age, lies about 2 to 4 miles beyond the present terminus. The two-mile long lake on the morainal material at the glacial terminus has enlarged only slightly over the last 25 years, and its outlet feeds the Martin River. The terminal portion of the glacier is relatively static, in part because of the insulating effects of the superglacial morainal material.

Superglacial lakes on the lower portion of the glacier are generally less than a half mile wide, periodically filling and releasing surges of water into subglacial drainage systems. Several glacial outburst systems have existed along the margins of the Martin River Glacier, where glacial ice has dammed small tributary valleys. High flood terraces with 50 to 150 year old vegetation along the river are evidence of past large outburst floods on these systems. Although the potential exists for small outburst floods where small glacially dammed lakes continue to form and release, these events will become less frequent as the glacier continues to thin and recede.

The Martin River is a dynamic braided glacial outwash channel that flows west onto a large outwash plain and into the Copper River. During the first half of the 20th Century, the lower portion of the channel was situated just north of Martin Lake, along the north end of the Ragged Mountains. As a result of uplift during the 1964 earthquake, the Martin River shifted to the north, from a point near Little Martin Lake (URS Corporation 1986). Martin Lake and Little Martin Lake continued to drain into the old Martin River channel, no longer draining into the Martin River. The river is confined on the north by a low gradient fan with a series of groundwater-fed channels draining from the northeast. Additional channel changes have occurred more recently in the Martin River as a result of outburst flooding and large storm events. Dynamic channel changes and rapid bank erosion occur in the channels that are adjacent to morainal deposits and soil-covered glacial ice at the glacial terminus.

Martin and Little Martin Lakes occupy shallow basins in small tributary valleys to the wide Martin River outwash plain. Because the Martin River no longer provides sediment to the outwash plain north of Martin and Little Martin Lakes, the clear water lake outlets are slowly incising into the outwash plain. Also, as the Martin River Glacier continues to recede and outburst floods diminish, the Martin River is stabilizing into a single channel and incising into its outwash plain. As a result, the lake outlets have incised, the water level of the lakes has dropped, and the lakes have decreased in size. Over the past half century, Martin Lake has decreased in size by about 10% (Fig 4.5). This trend will slowly continue in the future.

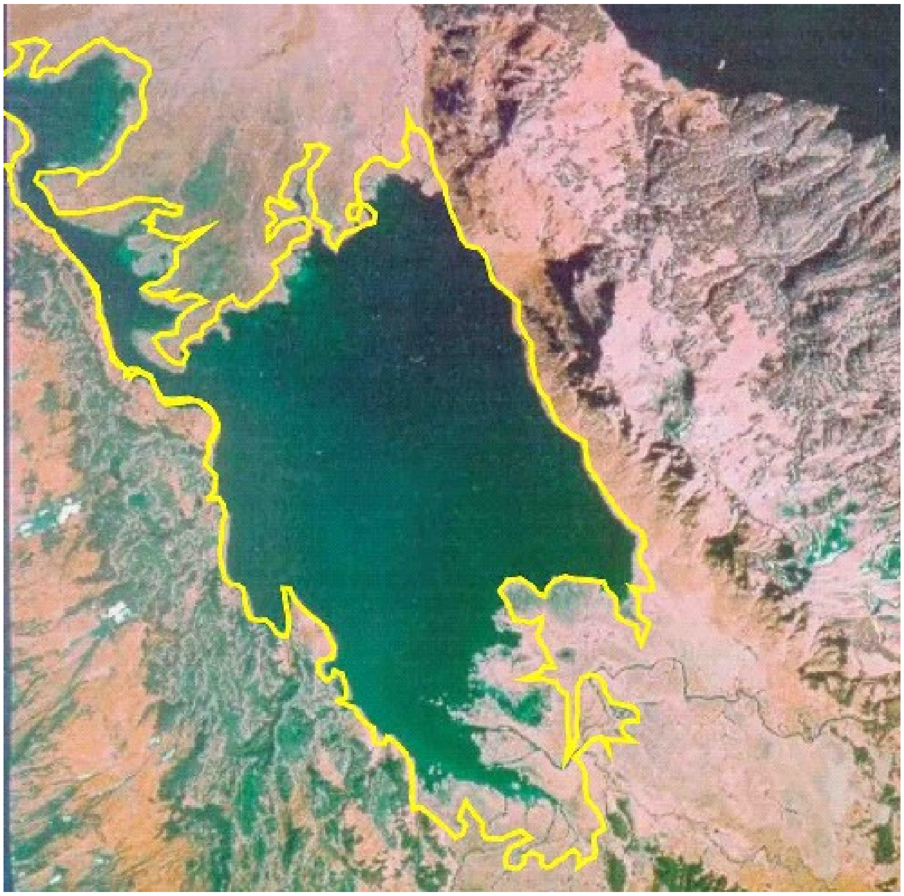


Figure 4.5 - Change in the extent of Martin Lake from approximate position in June 1959 (green line) to July 1996 (base photo), based on Chugach National Forest aerial photography.

The McPherson Glacier, the source of Sheep Creek, is a hanging glacier draining a small watershed onto the Copper River Delta. In the past, this glacier dammed off a tributary side valley, creating a lake that produced frequent outburst events on Sheep Creek. By the 1980s, the glacier receded to the extent that glacial outburst floods no longer occurred. The glacier continues to recede and thin, but because the glacier currently extends across most of the tributary valley, outburst floods may resume if the glacier re-advances.

The wide, braided channel of Sheep Creek has shifted across the outwash fan repeatedly during the last century, and the dynamic, braided channels of the outwash plain have presented a severe hazard to the Copper River Highway. Two outburst events in the 1960's washed out portions of the highway (Post and Mayo 1971). Although outburst floods do not currently occur, heavy late summer rainfall on exposed glacial ice can also result in high peak flows. Some of the flow infiltrates into the course substrate of the fan to re-emerge as groundwater to the south.

The Johnson Glacier, a hanging glacier at the source of Johnson River, created a similar situation with glacial outburst events in the first half of the 20th century. However, the glacier has receded 8000 feet in the last 50 years, a proglacial lake now lies at its terminus, and glacial outburst events no longer occur. Future outburst events can occur where flows in ice-free tributary valleys are dammed by the main valley glacier. The Johnson River channel has shifted from a braided to a predominantly single channel system over the past 50 years. Portions of the channel remain braided, but as sediment loads have decreased, it is stabilizing and incising into the outwash plain.

Wetlands are an integral part of the low elevation areas of the East Delta, as they attenuate flood flows, improve water quality, and provide abundant habitat. Uplift from the 1964 earthquake altered the abundance and distribution of wetlands in the analysis area, transforming tidal marshes along the coast into uplifted marshes. Beaver activity is high in these areas, and their dams often control channel morphology.

Construction of the Carbon Mountain Road could affect the configuration of the channels in this area. Hydrologic conditions make road construction and maintenance difficult. The dynamic nature of the Sheep Creek outwash plain and the potential for sizeable floods could result in road damage at channel crossings. Also, bridges on such a road would prevent channel migration at the bridge locations, preferentially directing and concentrating flood flows. Scour and deposition would occur in these areas, increasing the likelihood of channel avulsion and road failure. Johnson River is stabilizing and incising, and a bridge over its predominantly single channel would be less problematic. However, this glacial system is still prone to large peak flows from rain and snow, and glacial melt. Periodic outburst events on the Martin River would also have to be considered for a bridge constructed over this large river.

Bering River Area

Bering Glacier - Over the past century, the western lobe of the Bering glacial terminus has receded 1 to 3 miles from its most recent terminal moraine at the west end of the present proglacial lake (Field 1975). In the past 20 years, this lobe has receded up to 6000 feet in places, greatly increasing the size of its proglacial lake, and it is likely to continue receding under the current climatic trends, further enlarging the proglacial lake. Recession of this glacier has been interrupted by periodic glacial surges that recur approximately every 20 years. Surges in 1957-1960 and 1965-1967 caused the glacier to advance over 6 miles. During the most recent surge, from 1993 to 1995, the terminus advanced at a mean rate of 36 feet per day in the fall of 1993 (Roush et al. 1994).

One of the largest glacial outburst systems in Alaska originates at Berg Lake, where the Bering Glacier creates an ice dam across a tributary valley (Fig 4.6). Outburst events generally coincide with glacial surges of the Bering Glacier. The most recent outburst flood occurred in May 1994, lowering Berg Lake over 300 feet in 72 hours. The timing of this event had a large effect on wildlife and migratory birds that occupied the outwash plain at the time (Noserale 1998). Currently, Berg Lake is partially full, but maintains an outlet along the edge of the glacier so that outburst events do not occur. Based on the current trends and despite overall glacial recession, the glacier is likely to surge again, damming the outlet of Berg Lake, filling the lake, and causing another outburst event. Such a surge can be initiated by just a few years of above-normal precipitation on the Bagley Icefield. Berg Lake outburst events have the potential to inundate the entire Bering River valley, including Bering Lake.

Bering River and tributaries - With the Bering Glacier receding, dynamic changes have occurred in the western lobe proglacial lake and its outlet. This lake receives glacial melt from a portion of the Bering Glacier, as well as flows from outburst events from Berg Lake. Prior to about 1980, the lake outlet to the Bering River was on the north end of the lake. Likely due to a large outburst flood in the early 1980s, a new outlet formed through the terminal moraine deposits on the western side of the lake and the northern outlet was abandoned (Fig 4.6). The new outlet drains into the Gandil River, dramatically decreasing the sediment loads carried by the upper Bering River. As this new channel has become established, it has incised, lowering the level of the lake. Since 1982, the channel transformed from an undefined, braided channel to a well-defined, meandering channel.

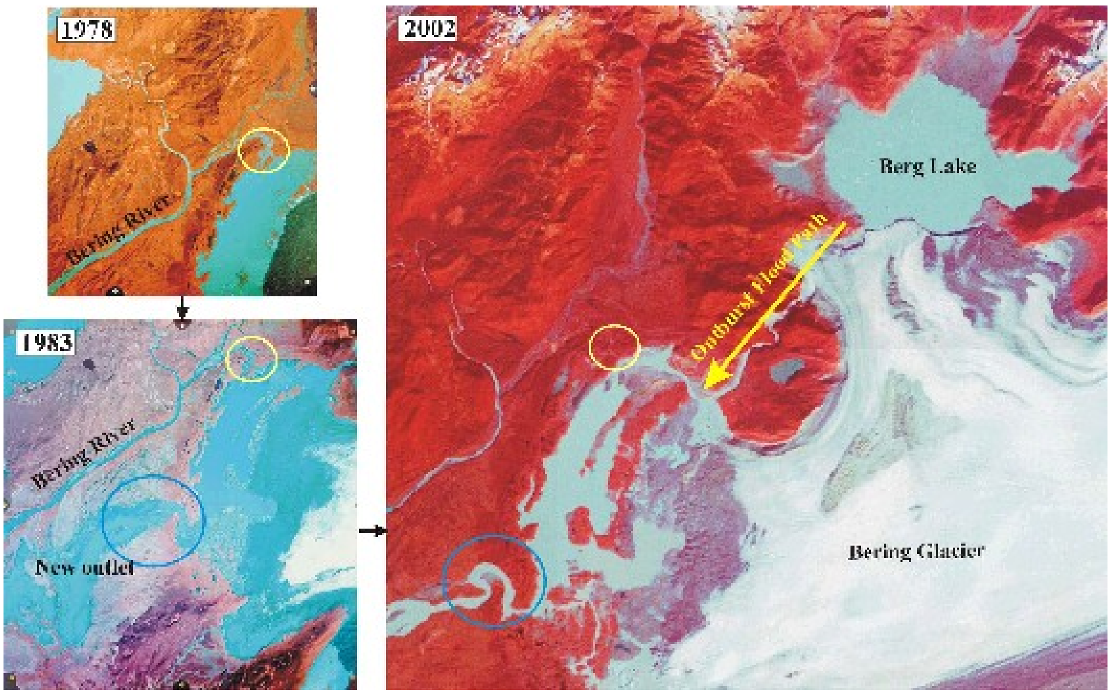


Figure 4.6 - Sequence of glacial and morphologic changes at the Bering Glacier terminus from 1978 to 2002. The yellow circle represents the old outlet to the Bering River. The outlet shifted to the southwest end of the lake and into the Gandil River (represented by the blue circle), abandoning the old outlet channel.

The proglacial lake at the western lobe of the Bering Glacier is growing as the glacier recedes, despite the fact that incision of the outlet is causing the lake elevation to lower. The southern proglacial lake, draining into the Campbell River, is currently separated from the main lake by a bedrock ridge. As the glacier recedes further, the lake will join the larger lake to the north, which is at a lower elevation. This would likely cause flows in the Campbell River to greatly diminish, as glacial runoff from the lake would then flow out of the larger lake into the Gandil River. This change would alter the sediment transport regime of the Campbell River, which would then be supplied primarily by groundwater.

Bering Lake - Bering Lake is very shallow with an outlet flowing east into the Bering River. Uplift from the 1964 earthquake caused the lake's size and depth decrease. It continues to shrink as Bering River system floods deposit sediment in the lake. Past catastrophic Berg Lake outburst floods have inundated the entire Bering River valley, including Bering Lake. Sedimentation from such events has contributed to the lake reducing in size by 50% in the last century (URS Corporation 1986). Because the potential remains for outburst floods from Berg Lake, Bering Lake is at risk of further infilling with sediment. Also, the Bering and Gandil Rivers are slowly incising into the outwash plain as glacial recession continues, sediment loads decrease, and the outwash plain stabilizes. This results in further incision of the Bering Lake outlet and a decrease in the lake elevation, although this process is limited by the very low relief of the Bering River outwash plain. Random soundings taken in 1980, the most recent bathymetric data, suggested a maximum depth of about 5 feet in Bering Lake (Cunningham 1980). Under the current trend, Bering Lake will continue its natural succession from a shallow lake to a terrestrial environment.

Bering River coal field - Coal was mined from the Bering River coal fields in the early 20th Century, but no mining is currently taking place. In this area, coal mining, as well as road construction, could have variable detrimental effects on water quality in streams and lakes. Increased sedimentation in streams and lakes is the largest threat from these activities, especially if strip mining techniques are used (Blanchet 1984). Heavy precipitation in this area increases the likelihood of slope instability and sediment delivery to streams. Settling ponds could increase water temperatures, and acid mine runoff is another concern for water quality where high sulfur content coals are mined. High acidity in streams and lakes allows for increased solubility of trace and heavy metals, creating more toxic conditions for fish.

Katalla River

Stream channels in the Katalla River (Fig 4.7) watershed have changed relatively little over the past century. The lack of glaciers and the relatively low relief in much of this area contributes to non-dynamic channels. Oil drilling operations at the Katalla Oil Field have the potential to affect water quality in Katalla Slough. During the peak of the oil drilling operations from 1902 to 1933, hydrocarbon concentrations in Katalla Slough may have been elevated, but no data are available. Recent data suggest that the streams adjacent to active oil seeps have naturally elevated hydrocarbon levels (MacFarlane 2003).

Hydrocarbons from these natural seeps are rarely detected downstream in Katalla Slough. Future development of the Katalla Oil Field, as proposed by Cassandra Energy Corporation, may increase hydrocarbon concentrations in Katalla Slough, but the magnitude of this effect, in any, is unknown. The consequences of water quality degradation include loss of fish habitat and production, effects on wildlife, and the loss of aesthetic values.

Figure 4.7 – Looking westerly across the mouth of the Katalla River

Islands

Aside from the 1964 earthquake, relatively few geomorphic changes have occurred on Kayak and Wingham Islands over the past century. No glaciers exist on these islands, and the short, high gradient channels carry low sediment loads and are not highly dynamic. The barrier islands off the coast, including Kanak Island, Okalee Spit, and Softuk Bar, are constantly changing through the processes of ocean currents, wind, and tectonic uplift. Each of these land features increased in size as a result of uplift from the 1964 earthquake.

Conditions and trends of fisheries resources

Large-scale natural changes in habitat (earthquake, flood etc.) do occur in the analysis area. These changes can affect the fisheries resources both positively and negatively. Current information can serve as baseline data to evaluate changes resulting from large scale natural disturbances when they occur.

Besides commercial fishing, other recent human impacts to fisheries resources in the analysis area include oil extraction from wells located at Katalla from 1902 – 1933, exploratory wells in 1982 – 1988 (USDA Forest Service 2002e), and timber harvest in the Katalla area for the building of the town, rail road lines, bridges, roads, and oil derricks (USDA Forest Service 2002e). The present effect of past developments on fisheries resources in the Katalla area appears to be minimal (USDA Forest Service 2002e). Overall, the stream habitat in the analysis area is in relatively pristine condition due to the absence of anthropogenic impacts; therefore, the current conditions described in chapter 2 serve as reference conditions.

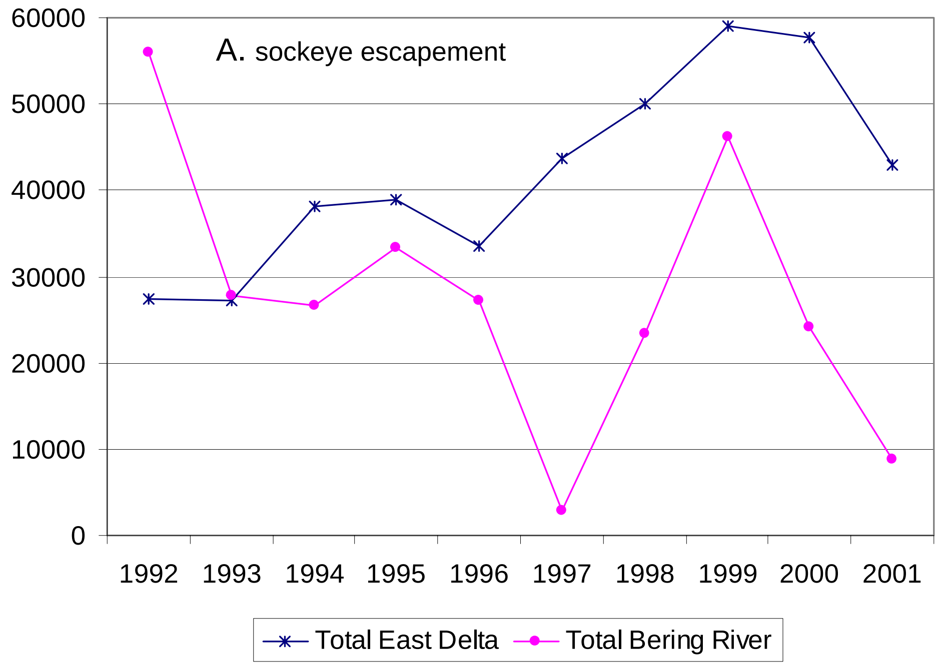
Population trends of the key fish species

The ADF&G conducts aerial escapement counts on the major Copper River Delta systems that contribute to the sockeye and coho salmon fisheries. However, no population data exists for Dolly Varden or cutthroat trout. The counts in individual stream systems are used to ensure adequate overall escapement on the Delta during the management of the commercial fishery. The peak aerial counts are used as an index of the number of spawning fish in streams and are used to project future returns. These indices are the best indicator of recent trends in fish populations at a smaller scale. The counts are attempted weekly from the first week of June until October. Weather conditions can limit flights, so they typically become less frequent in the fall. River turbidity can impair the observer's ability to see fish during periods of rain. Even so, this data provides the best recent abundance trend for salmon in the major streams of the area.

Aerial counts occur on the following streams in the analysis are: Clear Creek (Goat Mountain), Pleasant Creek, Martin River, Ragged Point River and Lake, Martin Lakes (Little and Big), Pothole Lake, Tokun Lake and River, Martin River Slough, Bering River and Lake, Shepherd Creek, Stillwater Creek, Kushtaka Lake, Katalla River, Gandl River, Dick Creek, Nichawak River, and Controller Bay.

Sockeye salmon escapement – In the middle of the analysis area**,** the East Delta watershed region, aerial escapement counts of sockeye salmon show an increasing trend over the years 1992 – 2001 (Fig 4.8). Total escapements have ranged from 27,352 to 59,125 and averaged 41,888 sockeye salmon over this time (Grey et al. 2001). The major stream systems contributing to the sockeye escapement in this region are the Martin River Lakes, Tokun Lake, and Clear Creek (Fig 4.9). The high escapement numbers from the East Delta region correspond with the increasing trend in harvest from the Copper River District fishery. These numbers also correspond with the distribution data recorded in the USFS GIS database (Fig 2.17). The East Delta watershed region is an important producer of sockeye salmon in the analysis area.

Aerial escapement counts of sockeye salmon from the Bering River region show a decreasing trend over the years 1992 – 2001 (Fig 4.8), with total counts ranging from 2,865 to 55,895 during this time (Gray et al. 2002). The Bering River run accounts for the majority of the fish counted and the total trend observed for the region closely resembles that from the Bering River system alone (Fig 4.9). Total escapement counts from the region have been below 10,000 fish in 1997 and 2001 (Fig 4.8) to over 55,000 in 1992.



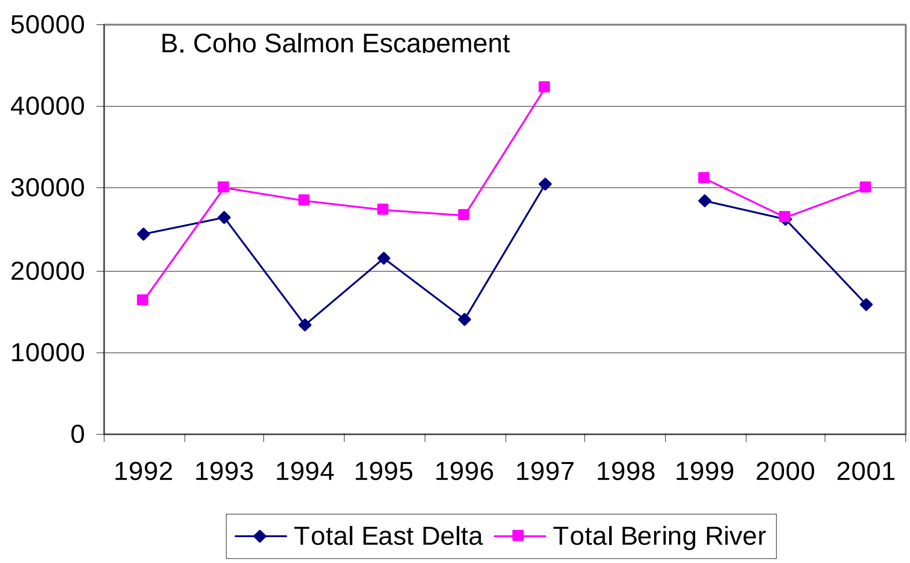
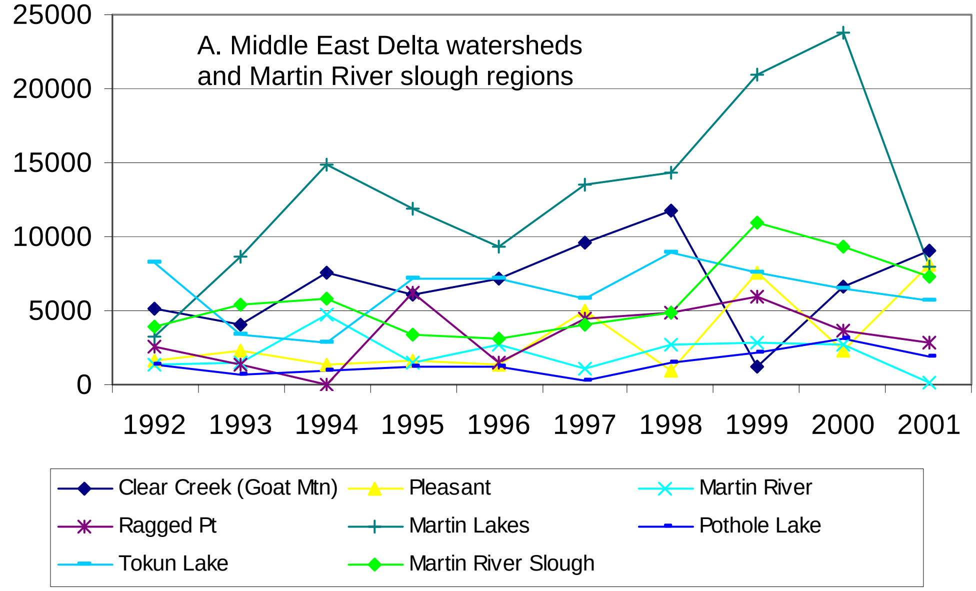


Figure 4.8 - Recent trends in total escapement for sockeye (A) and coho salmon (B)

in major stream systems of the East Delta (includes Martin River Slough) and the Bering River (includes Katalla and Controller Bay) regions. Values are peak numbers of fish counted during aerial surveys. Missing values indicate the inability to determine numbers due to poor weather and visibility conditions. Data from Gray et al. 2002.



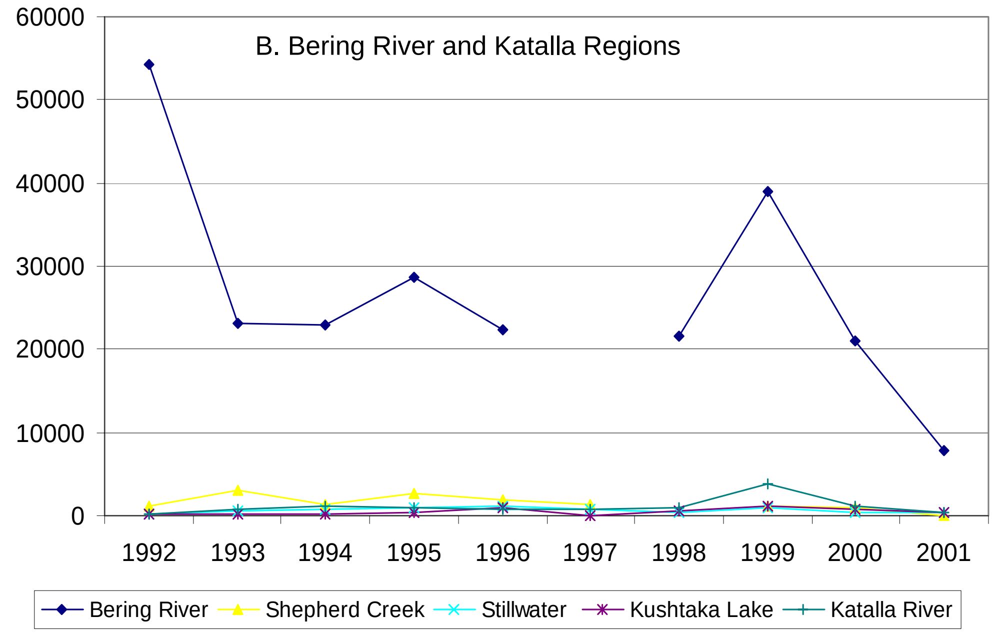


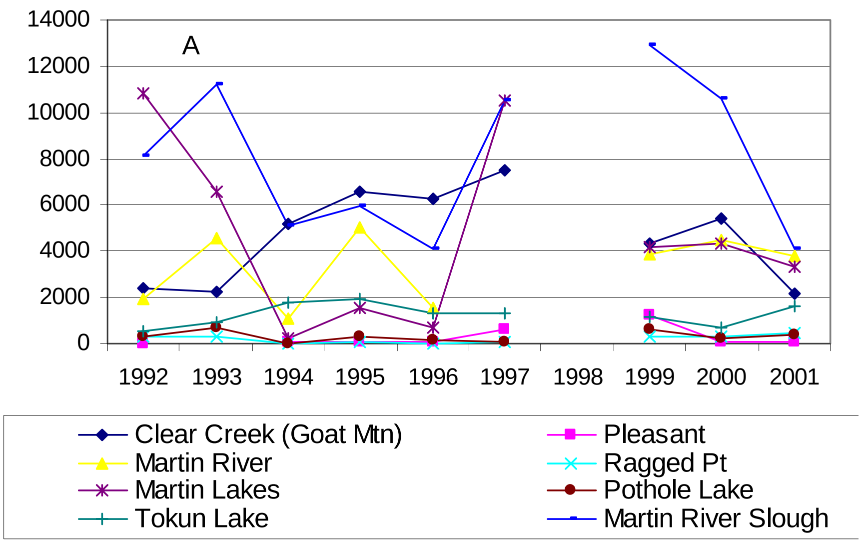
Figure 4.9- Recent peak aerial escapement counts for sockeye salmon in major stream systems in the East Delta and Martin River Slough regions (A) and the Bering River and Katalla regions (B). Missing values for some streams or entire years indicate the inability to determine numbers due to poor weather and visibility conditions. Data from Gray et al. 2002.

This downward trend in sockeye escapement may be correlated with decreased rearing habitat and water quality conditions in Bering Lake. This lake is shrinking over time as a result of periodic outburst floods and down cutting of the outlet stream (MacFarlane

2004). The lake is currently very shallow, less than 3 feet throughout much of the lake. As the lake shrinks so too does the rearing potential for sockeye salmon. Biologists have been concerned about losing fish habitat in Bering Lake since at least 1980 (PWSAC 1980; USDA Forest Service, unpublished data archives 1980). Scales from returning adult sockeye salmon indicate that most juveniles rear in freshwater for 1-year before migrating to the ocean (Rick Merizon, ADFG, personal communication). Water temperatures of 20°C were observed throughout the water column during a sampling event in the summer of 2003 (Steve Moffitt, ADF&G Cordova, personal communication). Juvenile sockeye rearing habitat in the summer and winter may limit production in this shallow lake.

Coho salmon escapement - Aerial escapement counts of coho salmon from the East Delta watershed region and the Bering River region show stable trends over the years 1992 – 2001 (Fig 4.8). Over this time, total East Delta watershed region escapements have ranged from 15,781 to 30,560 and averaged 22,322 coho salmon while total Bering River region counts have ranged from 16,300 to 42,400 and averaged 28,803 (Gray et al. 2002). The major stream systems contributing to the coho escapement in the East Delta watershed region, are the Martin River Lakes and Clear Creek (Fig 4.10). From the Bering River region, the biggest escapement counts are seen in the Bering River and Controller Bay streams systems (Fig 4.10).

The high escapement numbers for coho salmon in these stream systems correspond with the distribution data recorded in the USFS GIS database (Fig 2.17). The Bering, Controller Bay, and East Delta watershed regions are the major producers of coho salmon in the analysis area. However, the Katalla River and Martin River Slough regions appear to be significant contributors, especially considering their small size (Fig 4.10**;** Figs 2.17 and 2.15).



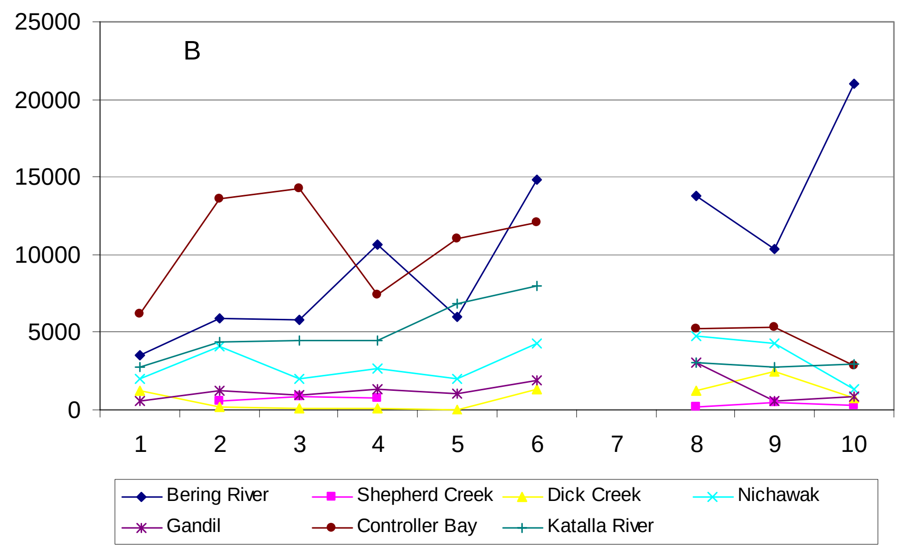


Figure 4.10 - Recent peak aerial escapement counts for coho salmon in major stream systems in the East Delta watershed region (including Martin River Slough) (A) and the Bering River (including Katalla and Controller Bay) region (B). Missing values for some streams or entire years due to poor weather and visibility conditions. Data from Gray et al. 2002.

CAC road escapement counts - From 1998 to 2000, the Forest Service conducted on-the-ground escapement counts of salmon in several clear water streams crossed by the CAC road corridor. These surveys identified Sheep Creek, Falls Creek, Green River, and Holographic River as potentially important salmon streams. The escapement surveys provided baseline data on run timing and relative abundance of spawning sockeye and coho salmon in these streams (Table 4.1; Fig 4.11). Sockeye salmon were predominantly present through June but a few fish were still seen as late as October 3. Falls Creek, Green River, and Holographic River had the highest counts of sockeye salmon, generally occurring in early July. Coho salmon were present as early as September 9 and the highest numbers generally occurred in late September and early October. The beaver pond sloughs and complexes of the lower Sheep Creek drainage contained high numbers of coho salmon.

Table 4.1 - Number of salmonids counted in streams crossed by the CAC road corridor.*

Year	*Date*	*Sockeye*	*Coho*	*Cutthroat*	*Dolly Varden*
1998	*14-Jul*	*1,966*	*0*	*40*	*0*
	9-Sep	*125*	*1260*	*0*	*0*
	28-Sep	*10*	*3622*	*0*	*100*
1999	*24-Jun*	*3875*	*0*	*0*	*0*
	8-Jul	*6750*	*0*	*0*	*0*
	23-Jul	*106*	*0*	*25*	*20*
	19-Aug	*6*	*0*	*50*	*70*
	9-Sep	*0*	*1502*	*213*	*100*
2000	*7-Jul*	*880*	*0*	*340*	*50*
	27-Jul	*73*	*0*	*60*	*2080*
	13-Sep	*0*	*650*	*0*	*0*
	3-Oct	*25*	*1985*	*91*	*200*

*on-the-ground escapement surveys conducted by USFS during summer and fall 1998 – 2000.

Cutthroat trout, rainbow trout, and Dolly Varden - Information on the current status of these species in the analysis area is limited. No aerial escapement counts have been done. Concern about the status of trout populations along the CAC access road corridor is increasing. Several studies have improved our knowledge of fish distribution along the road corridor, but much more remains to be learned (Steinhart et al. 1997; USDA Forest Service unpublished CAC road survey reports 1998 and 1999).

Cutthroat trout and Dolly Varden were counted when possible during on-the-ground escapement counts of salmon conducted by the Forest Service from 1998 to 2000 (Figure 4.11, Table 4.1). No distinct pattern in numbers of fish or timing of their presence was discernable; however, some important patterns of use and distribution were observed. The highest numbers of cutthroat trout were counted in Holographic and Green rivers and in the beaver pond complexes of the lower Sheep Creek drainage. Dolly Varden numbers were highest in Helicopter Slough and the beaver pond complexes of the lower Sheep Creek drainage. These two species seem to have small but aggregated populations that are highly mobile. The current information comes from surveys that only examined a small segment of the analysis area. In 2000, the ADF&G began a study to provide baseline data on the length, age and distribution of trout in the East Delta region (Miller 2002). This study will provide more comprehensive data on trout throughout the analysis area.

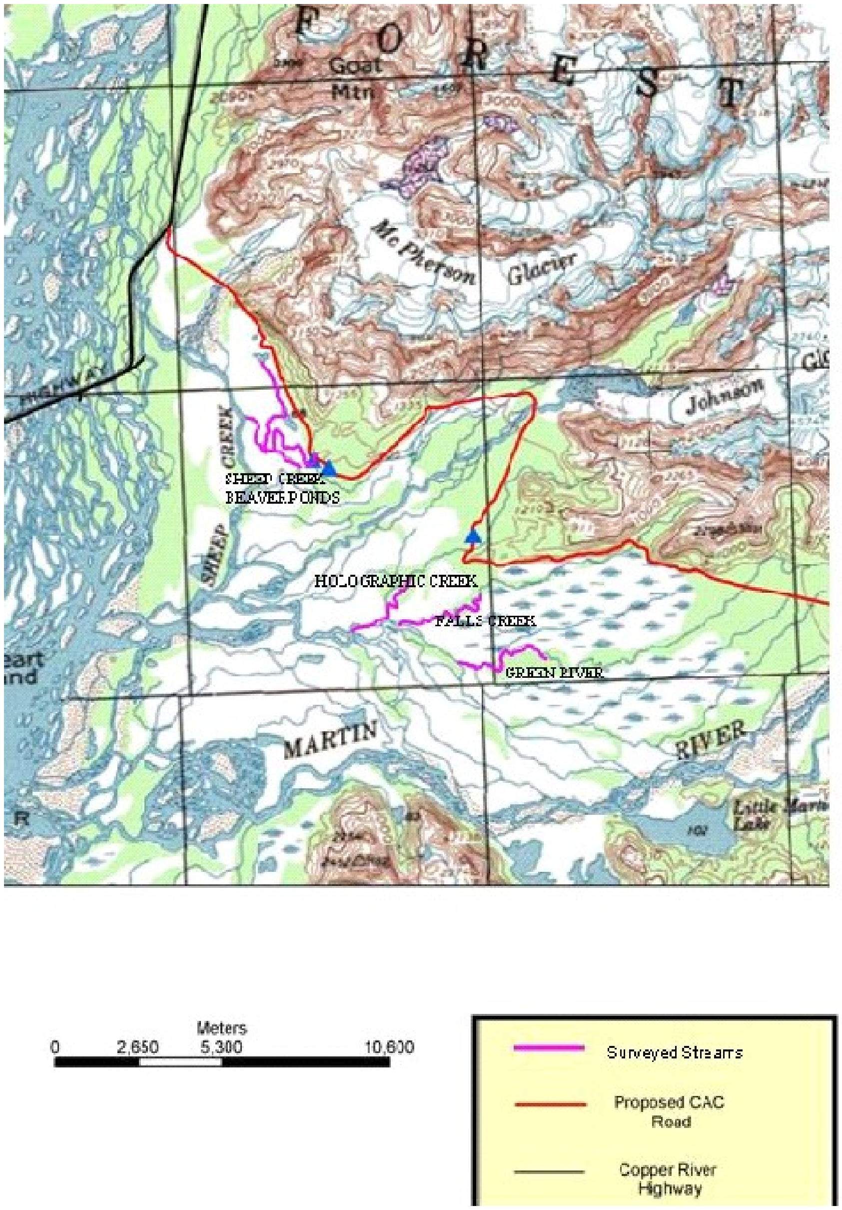


Figure 4.11 – Streams surveyed in Sheep, Johnson, and Martin River area from 1998 – 2000. Blue triangle indicates stream crossings where habitat surveys were conducted.

Human Influences on the fisheries resources

In general, human use of the fisheries resources should not cause habitat or population degradation that would lead to a change in currently observed trends or patterns of natural variability.

Commercial Fishing – Over the last 100 years, commercial fishing represents the largest human-induced impact to the fisheries resources in the analysis area. Commercial fishing began in 1889 and catch statistics for the Copper River Delta fishery have existed since

1924 (Thompson 1964). The multiple stocks harvested by the fishery present problems for using harvest data to monitor fish populations at smaller spatial scales (entire Copper River Delta vs. Upriver stocks; East Copper River Delta vs. West Copper River Delta). ADF&G uses aerial escapement counts on individual systems in the analysis area to manage the commercial harvest of salmon. These counts provide a recent range of natural variability in salmon escapement numbers in the analysis area. A lack of historical information makes comparisons between recent and historical ranges of natural variability impossible. The harvest and escapement data do show recent trends in populations and provide a range of variability for future comparisons.

In 2001, 535 drift gillnet permit holders fished in the Prince William Sound and Copper River districts of the Prince William Sound Management Area (Gray et al. 2002). Watersheds from the analysis area drain into two of these Districts: the Copper River and Bering River (see Gray et al. for maps of these Districts). Commercial fishing has begun in mid-May and has typically closed in the fall in these Districts since the early 1960s (Gray et al. 2002). Open periods of fishing occur during this time by emergency order with a recent pattern of 2 “open periods” of fishing per week (Gray et al. 2002). Chinook, sockeye, and coho salmon are the targeted species.

The fishery consists of upriver, Copper River Delta, and Bering River stocks. The upriver stocks migrate up the Copper River to spawn in streams in the interior of the state and are composed of both wild and hatchery fish. The sockeye and coho salmon returning to the freshwaters of the analysis area are all wild fish. Chinook salmon returning to upriver spawning habitats may migrate through the most southern portion of the analysis area and are harvested during the commercial season, but few chinook salmon spawn in the freshwater streams of the analysis area.

The commercial harvest of sockeye salmon in the Copper River District has increased since 1974 while harvest on the Bering River has decreased (Fig 4.12). During this period, harvest ranged from 18,908 to 2,955,431 fish and the most recent ten-year average (1992-2001) was 1,533,317 from the Copper River District(Gray et al. 2002). The ten year average from 1974 – 1983 was 504,242 fish, indicative of the increasing trend in harvest. On the Bering River District, harvest during this time has ranged from 0 to 179,273 and the most recent ten-year average (1993-2002) was 15,993 (Gray et al. 2002; Rick Merizon, ADF&G biologist, personal communication). The ten year average from 1974 to 1983 was 60,829, indicating a decreasing harvest trend on this District.

The unusually high harvests of fish reported for 1979 and from 1982 to 1984 were the result of fishing that occurred outside of Kayak Island. These catches included fish that were destined for watersheds throughout the North Pacific Coast, not just for the Bering River area (Steve Moffitt, ADFG Research Biologist, personal communication). Omitting these years indicates a more steady harvest level of around 20,000 fish. The recent decline in harvest is probably due to a reduction in effort on this District as market prices have fallen (Steve Moffitt, ADFG Research Biologist, personal communication). Fishing can be more profitable on the Copper River District because it is much closer to Cordova where the fleet is harbored.

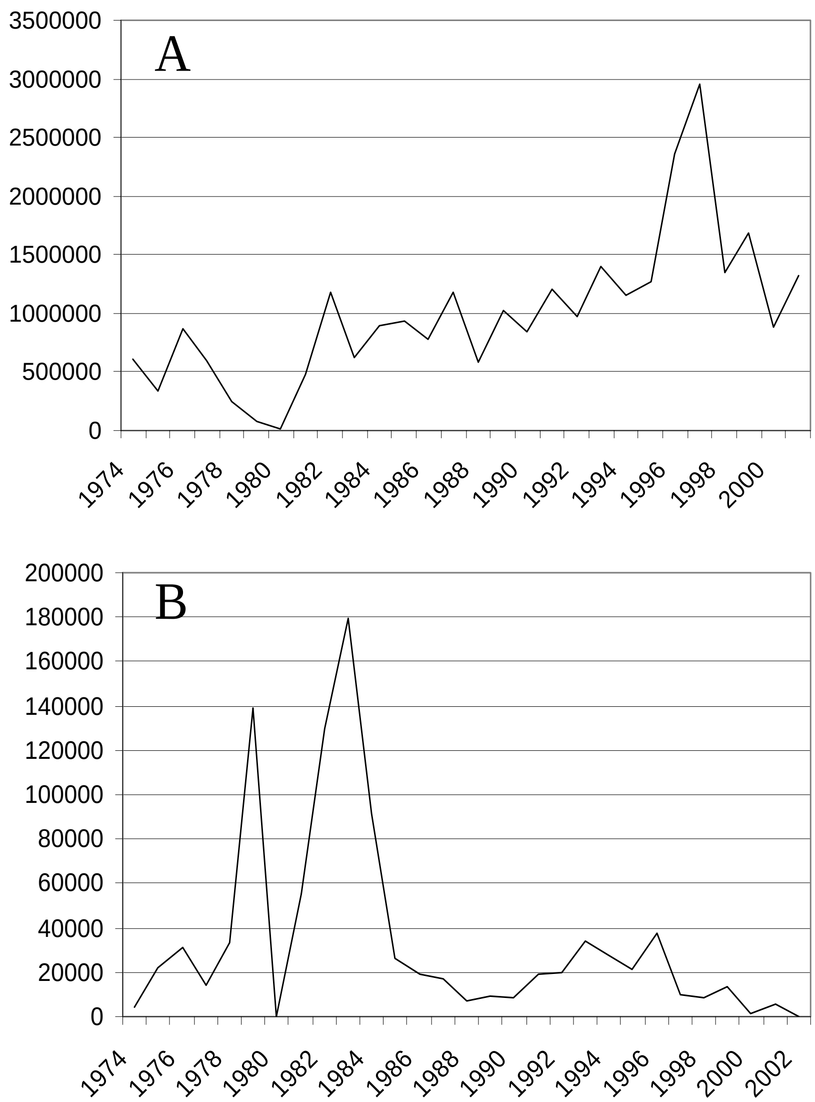


Figure 4.12-Commercial harvest of sockeye salmon on the Copper (A) and Bering (B) River Fishing Districts from 1974 – 2001 (Copper) and 1974 – 2002 (Bering). Number harvested is given on the y-axis. Data from Gray et al. 2002.

The Copper River District fishery is enhanced by the Gulkana River hatchery located in the upper portion of the Copper River. Egg boxes were first used at this site in 1973 and since 1988 a target of approximately 35 million eggs has been incubated each year. Fry releases occur throughout the upper Gulkana watershed including Paxson, Summit, and Crosswind Lakes. Fry releases did occur in the 10 Mile Lakes from 1973 to 1978 as part of a stocking study. The recent ten-year average (1993 – 2002) for sockeye fry releases from the hatchery was 25.7 million fry (Prince William Sound Aquaculture Corporation, www.ctcak.net/~pwsac/hatcheries.htm). These hatchery fish supplement the commercial, subsistence, and sport fisheries of the Copper River. During the 2002 season, 223,211 hatchery sockeye salmon were harvested in the commercial gillnet fishery, (Farrington 2003) equally approximately 18% of the total harvest for that year.

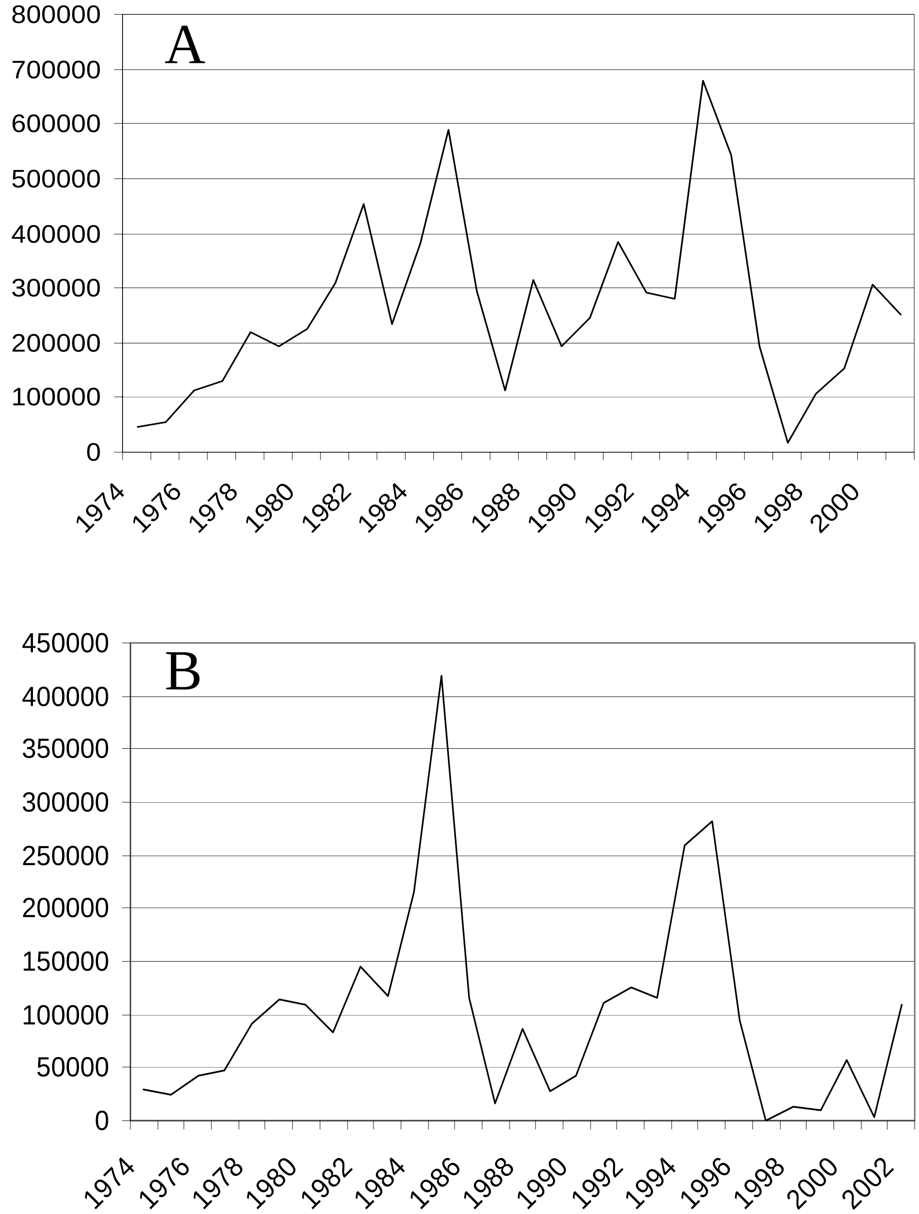


Figure 4.13-Commercial harvest of coho salmon on the Copper (A) and Bering (B) River Fishing Districts from 1974 – 2001 (Copper) and 1974 – 2002 (Bering). Number harvested is given on the y-axis. Data from Gray et al. 2002.

The commercial harvest of coho salmon on the Copper River District has varied widely since 1974 ranging from 18,656 to 677,633 fish with a recent ten-year average (from

1992 – 2001) of 295,641 fish (Gray et al. 2002; Rick Merizon, ADF&G Commercial Fish Biologist, personal communication). The harvest of coho salmon in the Copper River District has been much less than that for sockeye salmon (Figs 4.12 and 4.13).

Commercial coho salmon harvest from the Bering River District has also varied widely since 1974. The harvest of coho salmon from this District has ranged from 97 to 419,276 fish with a recent ten-year average (from 1993-2002) of 94,044 fish. (Gray et al. 2002; Rick Merizon, ADF&G Commercial Fish Biologist, personal communication). Coho salmon harvest has been greater than that for sockeye within this District but less than the coho salmon harvest within the Copper River District (Figs 4.12 and 4.13).

Commercial harvest data gives little indication of the population trends for salmon stocks in the analysis area. The variability in commercially harvested salmon species may be more indicative of effort than of population trends. Low market prices may deter some fishers from fishing at all, especially in the Bering River District where the relative cost of travel to the fishing grounds is high. This harvest data is also represents fish going to many watersheds both on the Delta and upriver to interior Alaska. Upriver and Delta sockeye salmon stocks cannot be differentiated in the harvest nor can East Delta and West Delta salmon stocks. The watersheds of the analysis area are only a small portion of a much larger area being managed for commercial, subsistence, and sport fishing.

Atlantic Salmon - Atlantic salmon may already be present in the analysis area. they have been caught by commercial gill netters fishing on the Copper River Flats. ADF&G biologists have documented two confirmed Atlantic salmon recoveries in the gillnet fishery over the last 3 years (Steve Moffitt, ADF&G research biologist, personal communication). Another suspected Atlantic salmon was captured by biologists in freshwater Martin River, but genetic analysis revealed this fish to be a coho salmon (Nielsen et al. 2003). Two Atlantic salmon were caught in a freshwater stream in the Yakutat area in 2003. Escaped Atlantic salmon have successfully reproduced in a British Columbian stream (Volpe et al. 2000), and these juvenile salmon can compete with wild fish for resources (Volpe et al. 2001). The fact that no other Atlantic salmon have been reported in the freshwaters of the analysis area may only be due to its remote nature.

Salmon Farming - Salmon farms in coastal British Columbia pose a great threat to wild salmon stocks in Alaska. There are at least 90 operational farms in British Columbia the most northern of which is in the Straight of Georgia at Bella Bella (ADF&G 2002). Since 1991, hundreds of thousands of farmed fish have escaped from the net pens where they are raised and escaped fish have been captured in marine and freshwaters of Alaska. Escaped fish can have detrimental effects on Alaska’s wild salmon populations through competition, predation, disease spread, and hybridization. Chinook, coho, and Atlantic salmon have been farmed since the early 1970’s but Atlantics have become the most commonly farmed species since the late 1980’s because of their adaptability to captivity, fast growth, and wide ranging spawn time that ensures year round availability to the market (ADF&G 2002). Atlantic salmon are an exotic species in the Pacific Ocean. A Canadian governmental moratorium on new farms was lifted in 2002 and this industry is expected to expand in the future (ADF&G 2002).

Sportfishing - The Copper River Delta provides a world-class salmon sportfishing experience. People fish for coho and sockeye salmon, Dolly Varden, and cutthroat trout, but fishing for coho salmon in the late summer and fall months appears to attract the most anglers. Access to the streams in the analysis area is limited, since there are very few roads, access is by boat or aircraft. Clear Creek and Sheep Creek are two creeks that can be reached from the Copper River Highway at about Mile 41.

Sport fishing can have direct and indirect impacts on fish populations. Populations can be directly affected by harvesting fish or through handling stresses resulting from capture and release (Clark and Gibbons 1991; Meka 2003). Fishing combined with other recreational activities can affect salmonid populations indirectly through the destruction of habitat. The salmonid habitat is affected through changes in the stream and riparian zone caused by excessive foot traffic and trampling. These changes can lead to increased erosion, loss of cover habitat, and decreased food sources and water quality (Clark and Gibbons 1991).

Overall, sport fish effort and harvest in the analysis area is probably minimal. Most of the streams are in remote locations where access is limited. However localized use occurs at some popular streams such as Clear Creek, accessible by vehicle via the Copper River Highway. This stream flows through both private and public land. Most other streams in the analysis area are accessible only by boat, helicopter, or airplane. One popular remote location is Martin Lake and Martin River where a Forest Service public use cabin is available to potential anglers. Tent camping occurs along this river during peak times. The Bering Lake system receives some use as well.

Two private sport fishing lodges operate on the Katalla River. An estimated 80 clients from both lodges combined fish annually on the river (USDA Forest Service 2002e). Currently, these lodges only operate in August and September during the coho salmon run. However, one of the lodges has expressed an interest in expanding operations to include May and June when anglers can target steelhead and chinook salmon (Ken Hodges, USFS Fisheries Biologist, personal communication).

During the summer, sockeye salmon and trout are generally the target species in the analysis area while coho salmon are targeted in the late summer and fall. The greatest use likely occurs in the fall when coho salmon return to streams in the area. Coho salmon tend to be more aggressive towards lures, therefore are easier to catch than sockeye salmon. Angler catch and harvest rates are highest during the fall on the road accessible streams of the Delta (Miller and Stratton 2001).

Sea-run cutthroat and steelhead trout are fished in the Martin River in the spring. In 1999, a large portion of the East Delta, including the Martin River, was designated as the Copper River Special Management Area for Trout (Miller 2002) which requires anglers fishing for trout to use single hook artificial lures and to practice catch-and-release. This regulation was enacted because of the concern about improved access to streams in the special management area provided by the proposed CAC road and the potential impacts to trout populations.

Data on sport fish effort, catch, and harvest is limited for the streams in the analysis area. The ADF&G has conducted a statewide mail-in sport fish survey each year since at least 1983. These surveys show that angling effort has generally increased in the Prince William Sound Management Area (Miller and Stratton 2001). Estimates of angler catch and harvest of coho salmon on Clear Creek have been generated from the surveys. This stream parallels the Copper River Highway for several miles and is therefore the most accessible to anglers fishing in the analysis area. The catch and harvest of coho salmon increased over the ten year period from 1990 to 1999 and the catch was over 1000 fish annually from 1996 – 1999 (Miller and Stratton 2001). However, since 2000 a shift in channel morphology in the Copper River has caused part of the river to flow into Clear Creek. The influx of this turbid glacial water has made it harder to catch fish and fewer anglers may be fishing on this creek.

The Forest Service conducted voluntary angler interviews to obtain additional data on the sport fish effort, catch, and harvest during the coho salmon season in 2002. From August 19 to September 29, interviews were conducted with passengers departing the Cordova airport on every out-bound flight. Based on these interviews, 267 departing passengers fished on streams in the analysis area over this time (Table 4.2). Clear Creek had the most anglers at 112, but the most coho salmon were caught at Katalla and Kiklukh. The Kiklukh is on state owned land west of Controller Bay and just outside of the analysis area. Based on the passenger responses, anglers experienced high catch rates of coho salmon in the streams that they fished. On average, 32 fish were caught per angler. However, only 4.5 coho salmon per angler was harvested. This low harvest rate suggests that anglers released most of the fish that were caught.

Table 4.2- Number of anglers, catch, and harvest on the East Copper River Delta*

Location	**Anglers**	**Coho Salmon**		**Dolly Varden**		**Cutthroat**
		Catch	Harvest	Catch	Harvest	Catch
Martin River/Lake	34	1853	68	42	10	6
Katalla	58	2135	304	62	1	5
Softuk	1	23	10	6	0	1
Kiklukh	60	2817	398	9	0	11
Bering	2	50	3	30	0	50
Clear Creek	112	1548	409	2	0	0
Total	**267**	**8426**	**1192**	**151**	**11**	**73**

* anglers surveyed at the Cordova Airport in the fall of 2002 (USDA Forest Service, unpublished data, Cordova Ranger District 2002).

Subsistence Fishing - Subsistence fishing has occurred on the Copper River Delta as long as man has inhabited the area. In recent times, most of the subsistence fishing for salmon has occurred in the near shore marine waters using gillnets. Access to the East

Copper River Delta is limited and reduces the local residents' ability to subsistence fish. The availability of freshwater and saltwater fish resources closer to Cordova also reduces the need to travel to the East Copper River Delta to harvest fish for subsistence.

In the summer months, access to the East Delta is either by vehicle on the Copper River Highway, jet boat in the main river channels, or by airplane. The Copper River Highway crosses from the West Delta to the East Delta when it crosses the Copper River 27 miles from Cordova. The highway continues to the Childs Glacier/Million Dollar Bridge recreation area where it ends. Other than the Copper River, only one stream which contains salmon, Clear Creek, is accessible from the highway. There are few other access points from the highway to East Delta streams for subsistence fishing opportunities. River jet boat access to the East Delta generally starts at Clear Creek, and follows downstream to the Copper River and then up the Martin River. The Martin River system is the largest tributary to the Copper River from the East Delta and contains several species of salmon on a seasonal basis. Some larger jet boats will access the lower East Delta from the mouth of the Copper or Bearing Rivers. Airplane access is limited to float planes landing on small lakes and sloughs, and wheel planes landing on ocean beaches and widely scattered, non-maintained bush airstrips.

Access to the East Copper River Delta in the winter is by snow machine, but because of the severe winter weather little or no subsistence fishing activities occur during the winter months in this area.

Subsistence fishing for salmon occurs in the marine waters of the Copper River Delta using small boats with 50 fathom gillnets. Many of the East Delta River systems empty into this area or into the lower Copper River and some of the sockeye, chinook, and coho salmon harvested for subsistence are bound for these systems. The number of subsistence permits issued has been trending upward since 1995, with 126 issued in 1995 and 468 issued in 2001. The subsistence harvest has fluctuated between 880 and 5,118 salmon during those same years, with 2000 being the peak year (Gray et al. 2002).

Subsistence fishing in freshwater for rainbow/steelhead trout is not legal under state or federal regulation in any of the streams within this analysis area. The state does not allow subsistence fishing for salmon in freshwater and no federal regulations for subsistence fishing have been established in this area. There are numerous drainages that empty into the Copper River or into the North Gulf Coast from the East Delta. Most of these systems contain sockeye, coho, and pink salmon, while a few also contain chum salmon and the occasional chinook salmon. Salmon can be harvested by sportfishing with Clear Creek, Bering, Katalla and Martin rivers receiving the most use by sport fishermen for personal consumption. The current daily sportfishing bag limits for salmon in this area varies by species.

The freshwaters south of Miles Glacier, east of the Copper River and west of Cape Suckling are managed by the state of Alaska as a trout special management area, which prevents the sport harvest of rainbow/steelhead or cutthroat trout and restricts gear to unbaited, artificial lures. The one exception for sport harvest of these trout species occurs in Clear Creek where trout can be retained.

The subsistence harvest of fish is allowed by permit only in the freshwaters in this analysis area under state and federal regulation, except that eulachon (*Thaleichthys pacificus)* do not require a permit. The State Board of Fisheries has determined that eulachon have a customary and traditional subsistence use in Prince William Sound. There is no limit on the allowable take per individual for subsistence on this species. The most common means of harvest is with a dip net. In this analysis area, the largest run of eulachon occurs in the Copper River, but runs are thought to occur in the Bering, Katella and Martin Rivers as well as other coastal streams. It is not known if any subsistence harvest of eulachon occurs in the streams on the East Delta.

The reported subsistence harvest of fish species other than salmon in 1999, 2000 and 2001 was, 3, 5, and 1 fish respectively. (Sharp et al. 2000, Johnson et al. 2002, Gray et al. 2002). Some or all of this reported harvest comes from marine waters and these fish are incidental to salmon in the gillnet subsistence fishery. There has been no reported subsistence harvest of fish from the East Delta streams.

Subsistence harvest of razor clams occurs on the outside ocean beaches of this analysis area. The clams are found in the intertidal zone and vary in density. The State of Alaska regulates the clam harvest and requires the harvester to have a permit and stipulates that only clams 4.5 inches in length may be taken or possessed. Harvesters can only access these beaches either by airplane or boat. The total reported average annual razor clam harvest by subsistence or sport harvesters for all of Prince William Sound, which comes primarily from the East and West Delta beaches, from 1998 to 2002 was 49 pounds. This amount is much reduced from the 1988 to 1992 reported average annual harvest of 2,440 pounds (Berceli et al. 2003).

Future subsistence harvest in this analysis area is expected to grow slowly as the population of Cordova increases and access improves. Currently, the subsistence harvest of salmon is done in marine waters offshore of this analysis area. The harvest of salmon in freshwater is accomplished under sportfishing regulations.

The ability of freshwater trout and whitefish stocks to meet subsistence needs is unknown. Little or no data is available on population sizes, ranges or habitat carrying capacities. Trout population studies are needed to determine the exploitation rate that could take place and still maintain a sustainable harvest.

The biomass of eulachon that enter East Delta river systems in any one-year is also unknown. Subsistence harvest of eulachon in these systems is expected to be minimal in the future. However, the eulachon that enter these river systems may be part of a larger stock of fish that enter the Copper River and future runs could be affected by harvests in other Delta locations. More studies are needed to determine the stock spawning biomass and the biologically sustainable harvest amount of eulachon.

The razor clam harvest in the whole Copper River Delta area including the East Delta has been at low levels for an extended period of time. Very few 4.5 inch clams are available for harvest. Historically, larger clams were harvested, but some unknown factor appears to be limiting clam survival and growth. Research that provides insight into this problem and how to correct it could potentially provide the biggest benefit to subsistence fish users on the East Delta.

Roads - At present, few roads exist in the analysis area; nearly the entire area is roadless (USDA Forest Service GIS 2000). Thus, the overall impacts to fishery resources due to roads are minimal. A few areas are currently being affected by roads. The Copper River Highway travels approximately 10 miles through Eyak Native Corporation land in the East Delta analysis area. Several small tributaries to the Clear Creek system are crossed by the Copper River Highway from approximately Mile 38 to Mile 42. Some of these channels are overflow channels of the Copper River. The flow of the Copper River has shifted eastward toward the Clear Creek system inundating these small channels and even washing the road out in several places. The current culverts at these crossings are inadequate to handle the larger volumes of water. Although this road is on a 300-foot wide State owned right-of-way, the affected stream, Clear Creek, flows thru National Forest System land downstream of the impact.

An in-active 2.5-mile long road located in the Katalla watershed on National Forest System land was built and used for the operation at the Katalla Oil Field from 1909 – 1932 and from 1982 – 1988 (USDA Forest Service 2002e). This old road crosses seven streams, most of which are small tributaries to Katalla Slough. The largest crossing is at Arvesta Creek, a known spawning stream for coho salmon. Two of the smaller tributaries provide rearing habitat for juvenile coho salmon and Dolly Varden (Unpublished USFS survey data 2001). This road may be reconstructed in the future as part of the oil exploration project at Katalla (USDA Forest Service 2002e).

In 1999, Chugach Alaska Corporation began constructing a road to access their holdings in the Carbon Mountain Area. The road has been constructed across Eyak Native Corporation lands from mile 41 on the Copper River highway to the National Forest Boundary at Sheep Creek. No firm date has been set for completing the remaining 30 miles of road along the easement to CAC lands. The construction of this road could affect fisheries resources in the analysis area. The concerns associated with the road fall into two general categories: (1) changes in stream habitat quality and/or quantity, and (2) improved access to streams. Roads can change stream habitats in many ways that lead to degraded fish habitat including increased sedimentation of spawning gravels (Bjornn and Reiser 1991; Furniss et al. 1991). Road culverts can block fish passage and reduce the amount of habitat available for rearing salmonids (Furniss et al. 1991). Roads provide easy access to streams, which can change the extent and intensity of recreation effort in the area (Clark and Gibbons 1991). Increased angler effort can directly effect fish populations through harvest and indirectly affect populations through habitat degradation.

As a result of the CAC proposal, several survey projects were conducted to collect data on the fish presence and general habitat characteristics in the streams located along the potential road corridor. The surveys were conducted by the Forest Service (USDA Forest Service CAC unpublished data reports 1998, 1999, 2000) and the Prince William Sound Science Center (PWSSC) (Steinhart et al. 1997). Although road construction was not subject to the NEPA process (ANILCA sec. 910), the easement exchange and road placement depended on input from the Forest Service. The surveys helped determine the best road placement and construction designs within the easement.

Detailed reports of these surveys are located at the Cordova Ranger District. Some of the key findings were:

a) The road corridor was moved following the initial survey by PWSSC in 1997 to reduce the number of fish bearing streams crossed by the potential road.
b) The current road corridor crosses 196 streams, 55 of which are fish bearing.
c) Coho salmon were the most frequently encountered species.
d) Streams designated as non-fish bearing were dry or steep gradient.
e) Most of the streams crossed were small (mean bank full width crossings ≈ 2.5 m).
f) Recommendations were made to move or improve on the designs for 2 bridges and 18 culverts.

The current road location attempts to minimize impacts to fish habitat. The road was shifted from a lower elevation route to one that more closely follows the mountain footslope. This move avoids major anadromous salmon spawning and rearing habitat and reduces the number of streams crossed. The streams crossed are smaller and more contained providing a more stable crossing point. However, higher stream and road gradients mean more potential for erosion. The stream crossings may have a higher potential to affect cutthroat trout. Cutthroat trout use these small tributary streams for spawning and rearing. Cutthroat trout may be more easily affected by habitat changes due to their relatively small population sizes.

Basic physical stream characteristics including bank full width, depth, stream gradient, and substrate were initially recorded at all of the potential road crossings (USDA Forest Service CAC unpublished data reports 1998, 1999). This important information provided baseline data and was used to design stream crossings (bridge/culvert size and placement). However, a more thorough survey design would be necessary to detect long term changes in stream habitat as a result of the road. Recognizing this, the Forest Service conducted more intensive surveys at three crossings in 1999 (USFS CAC unpublished data report 1999; see Fig 4.11 for location). However, using only three stream crossings limits how adequately stream habitat impacts can be quantified for the entire road corridor.

The negative impacts that roads can have on salmonids and their habitat have been well documented (Furniss et al. 1991). Roads can affect salmon migration, spawning habitat, egg-embryo survival, and juvenile rearing habitat (Furniss et al. 1991). Unnatural changes in stream channel geometry and a subsequent channel adjustment can occur when road culverts or bridges are not properly installed (Furniss et al. 1991). Bridges tend to restrict channel geometry least and therefore affect fish and fish habitat the least (Furniss et al. 1991). Improper culvert placement can lead to drastic channel adjustments that pose many problems to salmonids, especially in the migration of both adult and juvenile fish (Evans and Johnston 1980; Furniss et al. 1991).

The information collected thus far is in regards to the impacts of the proposed road to stream habitat. Improved access will also impact fisheries resources by increasing the amount of recreational use in the area (Clark and Gibbons 1991). Recreational users can impact fish populations through the harvest of species during sport fishing and by degrading fish habitats in areas where use is concentrated along streams such as in popular fishing locations. The road will improve access to 55 fish bearing streams in the region including some in the Martin River, Johnson River, Falls Creek, and Sheep Creek drainages. These major salmonid producers have spawning habitats present at some of the crossings (USFS CAC unpublished data reports 1998, 1999). The extent and intensity of fishing effort will undoubtedly increase on these systems. Current fishing effort on these streams is likely low, but no baseline data exists. Increased recreational use can indirectly affect stream habitat through stream bank erosion and destruction of riparian vegetation (Clark and Gibbons 1991).

Additionally, improved access may alter the remote wilderness setting experienced that currently exists across much of the analysis area. Some anglers may prefer to fish on uncrowded streams and in a remote, wild setting. The difficult stream access associated with most streams in the area currently ensures this wilderness type of experience for recreational users including anglers.

Oil Drilling - A private entity has subsurface rights to the oil and gas reserves in the Katalla area. Oil and gas production occurred in the Katalla area from 1902 – 1933 and from 1982 – 1988. Although the drilling occurred on private land, these operations had the potential to affect streams flowing into National Forest System lands. The environmental effects of earlier oil operations on the fisheries resources are unknown but appear to be minimal. A permit to explore for oil and gas reserves was issued by the Forest Service in 2003 (USDA Forest Service 2002e). If recoverable quantities are found during the exploration, full production could resume in this area. The Forest Service completed an Environmental Assessment of the proposed project in 2002 (USDA Forest Service 2002e). This document evaluates, in detail, the potential effects of the “Plan of Operations” for exploration on fisheries resources in the Katalla area.

Water pollution is generally the most serious affect that oil drilling could have on fish populations. Chemicals used to lubricate drills, seal the walls of the drill hole, and flush cuttings from the hole can pollute nearby waters and kill fish. Some of these chemicals such as paraformaldehyde and capryl alcohol can be toxic to trout at 100 mg / L (Nelson et al. 1991). Streams may also be contaminated by oil leakage or large spills. These and other potential effects of the proposed exploration were analyzed by the Forest Service in an Environmental Assessment (USDA Forest Service 2002e).

Coal Mining - Mining in the Bering Coal fields could occur in if the CAC road is constructed. Although development would occur on private land, these activities have the potential to impact downstream fisheries resources in the analysis area. Access routes to these developments would also cross National Forest System lands and have the potential to directly affect fisheries resources.

Coal mining can pollute water resources and negatively affect fish populations and habitat. Acidification of streams due to coal mining can be detrimental to salmonids (Nelson et al. 1991). Fish prefer neutral to slightly alkaline waters (pH 6.5 – 8.7) and mining produces a highly acidic effluent that can be discharged from underground mining operations, as surface runoff over tailings, and as leakage from settling ponds (Nelson et al. 1991).

Timber Harvest – No timber harvest is expected on National Forest System lands. The proposed CAC road would access 76,995 acres of Native Corporation land known as the Carbon Mountain Tract where plans include timber harvest and coal extraction (CAC 1999). Timber harvest could occur on these lands if market conditions improve. Depending on type and location of harvest and roads, these activities may potentially impact downstream fisheries resources in the analysis area. Stream hydrology and channel morphology can be altered by removal of riparian and watershed vegetation (Chamberlin et al. 1991). Erosion and landslides resulting from timber harvest can increase the transport of sediment to streams and thus reduced water quality (Chamberlin et al. 1991). Fine sediment can clog interstitial spaces in streambed gravels and reduce oxygen flow that is important for egg to fry survival (Chamberlin et al. 1991; Bjornn and Reiser 1991).

Little is known of the current fish habitat quantity and quality on National Forest System lands downstream of this potential resource development. The operations could affect fisheries resources throughout much of the Bering River watershed, including the important salmon spawning streams Shepard Creek, Stillwater River, Steele Creek, and the upper Bering River. The ADF&G collected data on fish presence and distribution and general habitat and water quality information from streams in the southern portion of the Carbon Mountain Tract (Wiedmer 1999).

Factors affecting vegetation

Tectonic influences on vegetation succession

As previously described, the earthquake in 1964 and subsequent uplift played a major role in shaping the vegetative characteristics of the Copper River Delta. Since 1964, vegetation succession on the delta has been rapid on the uplifted marsh (Crow 1968, Potyondy et al. 1975b, Scheierl and Meyer 1977, Boggs 2000). The uplift increased drainage of slough levees and the new marsh which created suitable hydrologic conditions for shrub and forest vegetation. Vegetation is changing from a system dominated primarily by graminoids and forbs to a mosaic of forb-graminoid wetlands with patches of woody vegetation. Mudflats that were subtidal prior to the earthquake are becoming tidal marsh and woody plants are becoming more dominant on the uplifted tidal marsh. It is likely that some plant communities mapped in the early 1980s are no longer represented today. This succession has had a dramatic effect on wildlife habitat (Crow 1972, Campbell 1990).

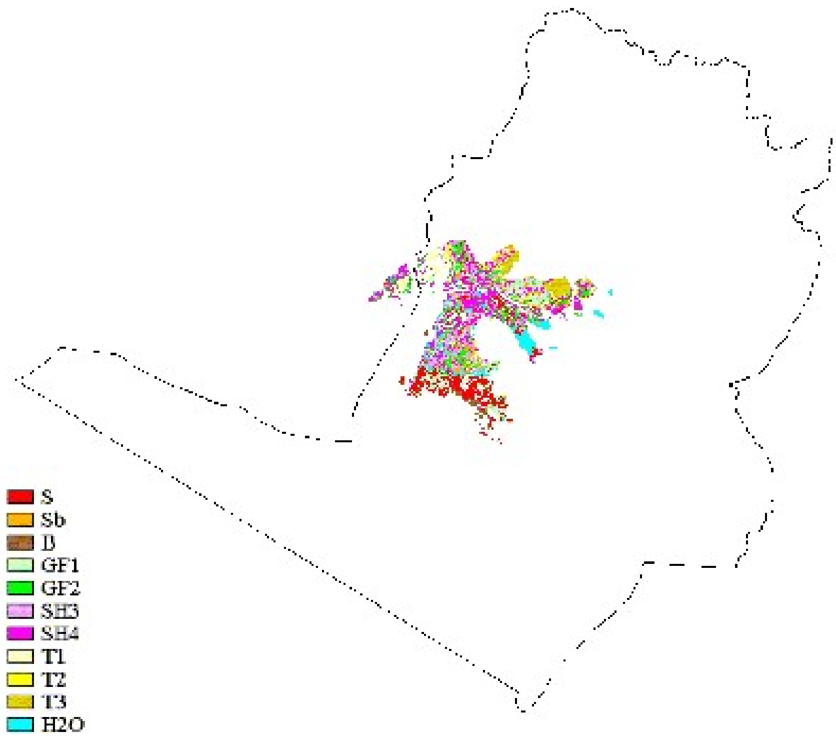


Figure 4.14 - The distribution of landcover classes for the year 1974 as used in the DeVelice et al. (2001) successional model for the East Copper River Delta.

Only a small portion of the landscape analysis area is included because the area modeled was to the extent of the map of Scheierl (1974) that was used as a base. The landscape types are: S = sedge; Sb = sedge-bog transition (i.e., peatland); B = bare ground/mud; GF1 = grass-forb (<10% shrubs); GF2 = grass-forb (10-40% shrubs); SH3 = shrubs (41-70%); SH4 = shrubs (71-100%); T1 = 10-40% tree canopy closure; T2 = 41-70% tree canopy closure; T3 = 71-100% tree canopy closure; H2O = water.

Understanding vegetation succession, spatially and temporally, on the Copper River Delta has a direct influence on management strategies for many species of wildlife. Detailed information about the role of succession on the Delta is available in DeVelice et al. (2001) and Boggs (2000). A computer model was developed (DeVelice et al. 2001) to quantitatively predict vegetation succession on the wetlands of the Copper River Delta and provide baseline information for modeling the influence of these changes on wildlife populations. The work involved spatially documenting vegetation change since the 1964 uplift and developing a spatial succession model to map vegetation in 10-year time steps over a 100-year period (Fig 4.14). The model is available on CD-ROM and displays the predicted transitions for outwash plain, uplifted marsh and new marsh landscapes.

a.

b.

c.

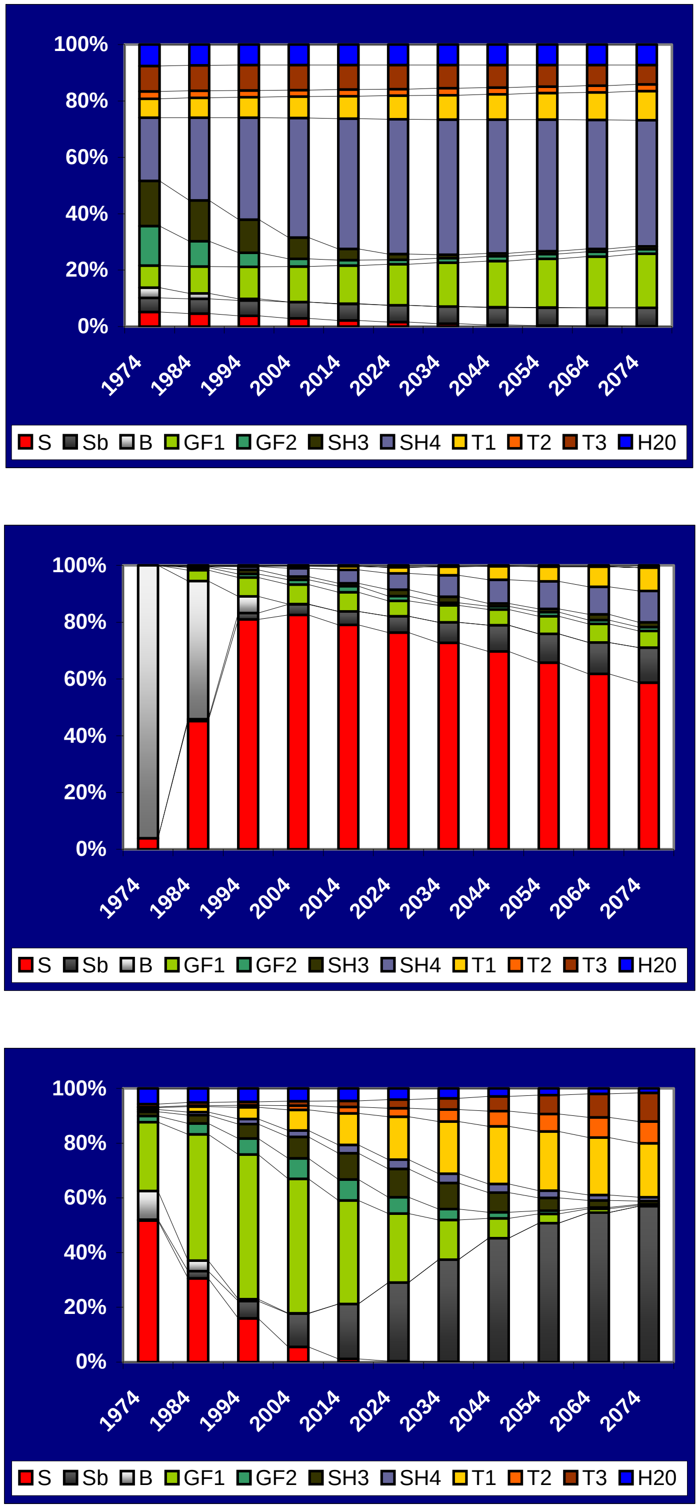


Figure 4.15 - East Copper River Delta projected landcover transitions over the 1974-2074 simulation period on the a) outwash plain, b) new marsh, and c) uplifted marsh (DeVelice et al. 2001). Units are % of total area of landscape type (as defined in Fig 4.14).

The model predicts that the greatest change in vegetation composition would occur on the new marsh followed by the uplifted marsh (DeVelice et al. 2001). In contrast, composition on the outwash plain was predicted to be relatively stable at the landscape scale (Fig. 4.15a).

Landcover on the new marsh was projected to convert from about 100% bare ground in 1974 to a mosaic of eight landcover classes by 2074 and total area of tall woody vegetation increased from 0% to about 21% from 1974 to 2074 (Fig. 4.15b; DeVelice et al. 2001).

On the uplifted marsh, peatland (i.e., sedge-bog transition) area is projected to increase from near zero to over 55% while tall sedge landcover drops from about 50% to almost zero (Fig 4.15c). Total area of woody vegetation is modeled to increase from about 4.5% to 41% from 1974 to 2074 (DeVelice, et al. 2001).

Boggs (2000) fully describes the successional patterns for all landscapes that occur on the delta in *Classification of Community Types, Successional Sequences, and Landscapes of the Copper River Delta, Alaska*. He includes idealized cross sections illustrating vegetation succession and tables listing late, mid, and seral stage species associated with each site. Thirteen successional sequences were described for the outwash plain and floodplain. Fourteen successional sequences were identified on the uplifted marsh landscape. Eight sequences were identified for linear dune landscape. Nine successional sequences were identified for the tidal marsh. Three sequences were identified on the barrier island-spit-coastal dune landscape.

Following are sample cross sectional figures from Boggs (2000) depicting successional sequences for the Delta. One can compare sequences that would occur on the Copper River Subsection and the Copper River Delta subsection with Figures 4.16 and 4.17. Figures 4.18 and 4.19 illustrate sequences on the uplifted marsh and tidal marshes respectively.

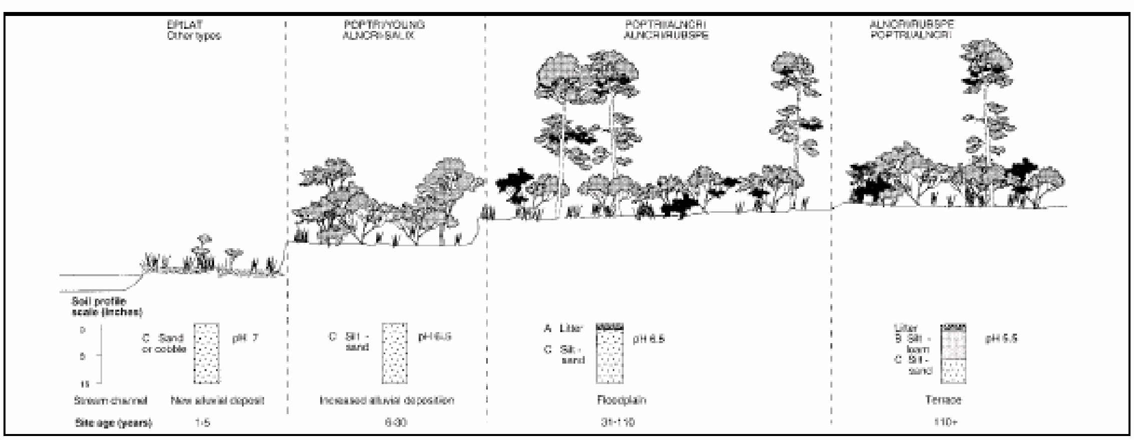


Figure 4.16 -Idealized cross-section of vegetation succession and soil and landform development on well-drained terraces of the Copper River outwash plain, within the Copper River Subsection (ECOMAP1993) (Boggs 2000: Fig 10).

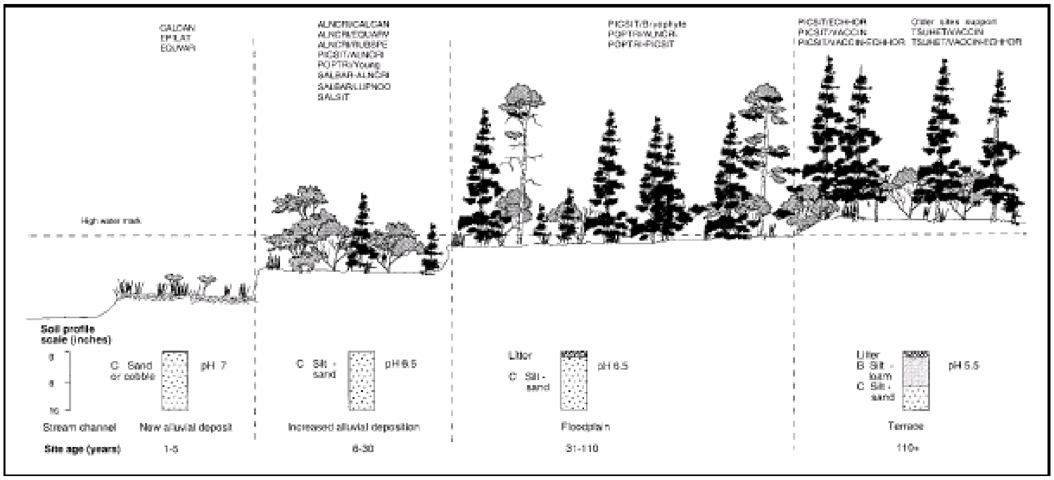


Figure 4.17-Idealized cross-section of vegetation succession and soil and landform development on well-drained terraces of outwash plains and floodplains within the Copper River Delta subsection (ECOMAP 1993) (Boggs 2000: Fig 11).

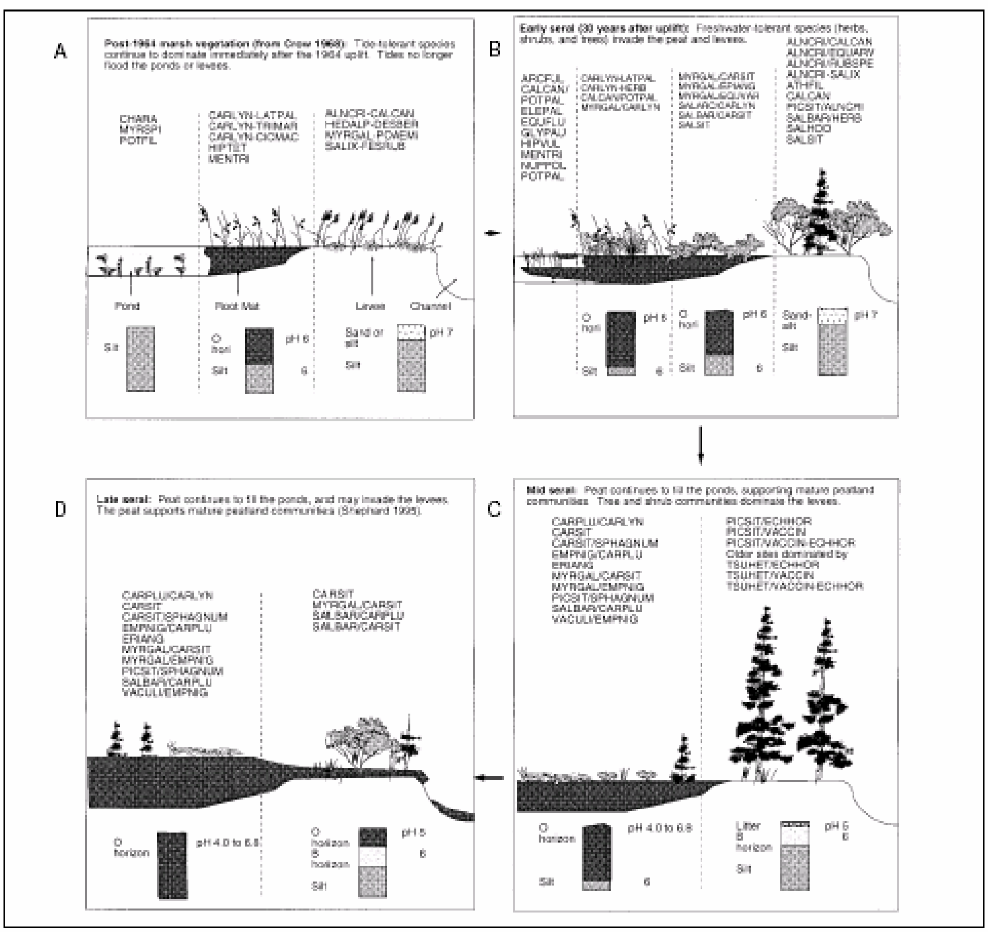


Figure 4.18-Idealized cross-section of vegetation succession and soil and landform development on uplifted marshes (Boggs 2000: Fig 13).

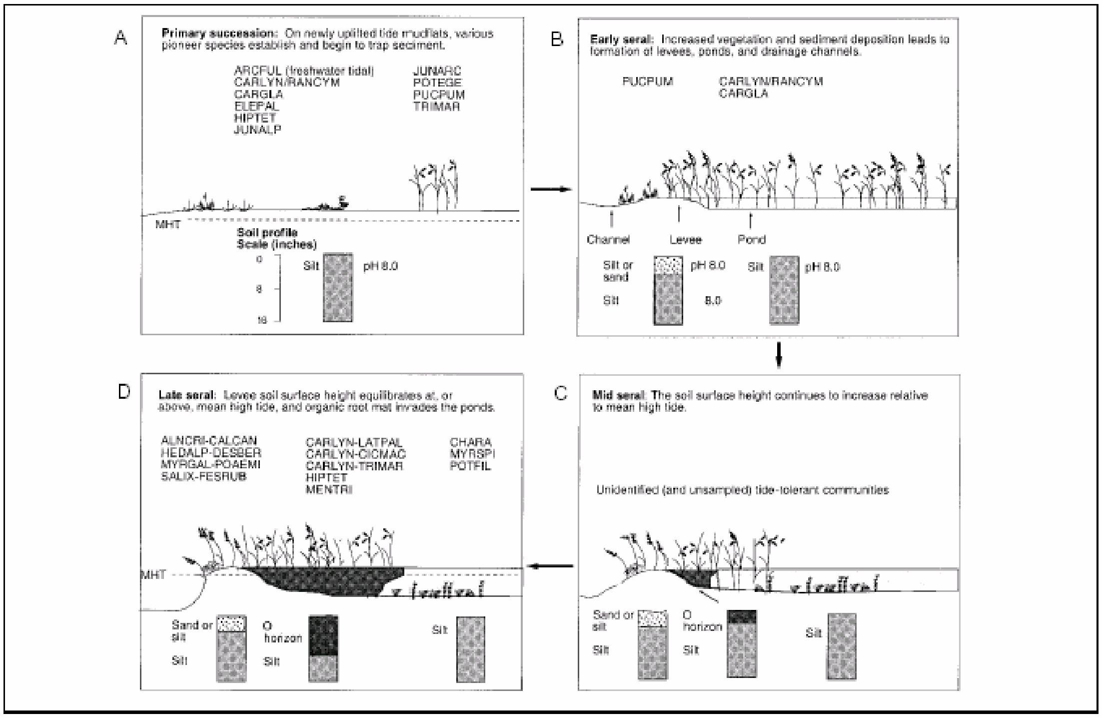


Figure 4.19-Idealized cross-section of vegetation succession and soil and landform development on tidal marshes (Boggs 2000: Fig 14).

Soil influences on vegetation development

Continuous changes in the outwash floodplain river channels limit the time available for vegetation to progress into forested communities and erode established vegetation. High water or floods cover the vegetation with sediment. This results in large areas of water tolerant herbaceous and shrub dominated communities.

In other areas the slow infiltration rate of the soil keeps water ponded on the surface for long periods of time. The water tolerant vegetation stays in an herbaceous or shrubby stage and is composed of species more tolerant of wet soils. The infiltration and permeability of the soil greatly influence vegetation succession on the Delta. The ability of the soil to drain water determines the composition of the plant community and how fast succession occurs since the area receives high precipitation. Coarse textured soils or soils on slopes drain water readily, provide greater aeration and normally aerobic conditions, and are more suitable for larger woody plant species. They also appear to support a faster progression from the initial meadow plant type communities to the larger tree dominated communities. An excellent example can be seen on the slough levees where the vegetation has progressed from mostly grass and herbaceous species in the mid 1960s to tall, dense shrub, spruce and cottonwood in the late 1980s and 90s.

Fine textured soils on level sites that have slow infiltration and permeability cannot readily remove the water. These soils provide poor aeration and normally anaerobic conditions and support hydrophytic plant species. Plant succession on these sites appears to be much slower. In order for the vegetation to progress to more advance community, better aeration of the root zone must be established. To increase aeration of the roots, some shrubs develop a platform above the critical water level that allows for less hydrophytic plant species to invade. The same process also occurs where thin sand layers overlay surface deposits of impermeable silts.

Wind Influences

Wind influences forest structure and composition to varying degrees depending on the extent and severity of the disturbance. Some storm events can result in many acres being blown down or tree tops being snapped. Other wind events may only affect single trees or small group of trees altering the forest structure and composition on a much smaller scale. Often the wind generated from snow avalanches can blow trees over in front of the snow avalanche. Scattered windthrow commonly occurs along forest edges due to the high winds that frequent the area. Prior to 1999, high winds blew down an estimated 10 to 20 acres of trees in the Martin River drainage. The area is accessible only by air and has not been surveyed.

Insect and Diseases

Insect and diseases are two other disturbance regimes that can shape forest composition, structure and development. In the analysis area, these agents most commonly affect forest ecosystems on an individual or group of trees basis, not on a landscape scale. Small outbreaks of western black-headed budworm (*Acleris gloverana* Walsingham) and spruce bark beetle (*Dendroctonus rufipennis* Kirby) were recorded in the area during 2001 surveys (Wittwer 2002). No outbreaks were noted in the area during 2002 and 2003 surveys (Wittwer 2003; 2004). These outbreaks are cyclical in nature, characterized by a rapid increase in numbers followed by rapid declines 1 to 5 years later. While bark beetles cause tree mortality, tree defoliators can weaken trees making then predisposed to secondary mortality agents. Black-headed budworm can influence stand composition and structure favoring small mammals and deer (Wittwer 2004). During 2003 insect and disease aerial surveys, 11,227 acres of hardwood defoliation including cottonwood was mapped along the lower Copper River. To date, a causative agent has not been identified. Further surveys will be conducted in 2004 (Wittwer 2004).

Moose

Moose may have a role in increasing plant productivity even though they consume large quantities of vegetation. They prefer species such as willow and avoid alder and sweet gale, which are nitrogen fixers. The result is an increase in nitrogen-supported plant productivity. This increased nitrogen production could help fertilize willow, stimulate their growth and in turn produce more food for moose. If this is so, then management practices that remove competitors of willow may be counter productive if they also remove nitrogen fixing plants (Christensen and Mastrantonio 1999). Moose browsing willow may accelerate the rate of succession and create a competitive advantage for spruce (Witten 1995).

Timber Harvest

There's been scattered harvest of trees on the Delta since people first settled in the area. Harvest records indicate that none has been harvested in the analysis area since the 1950s. However, timber was harvested in the early 1900s around the Katalla area and was used for fuel, mining timbers, and building material for houses, boats, railroads, fish wheels, canneries, and other structures.

The revised Forest Plan does not identify commercial timber harvest, either chargeable or nonchargeable, as an appropriate activity for the analysis area, however personal use timber and special forest products are appropriate. There is a demand for firewood, houselogs, and sawtimber from accessible National Forest System lands near Cordova and it is expected to increase as the material left on the harvested areas on Eyak Native Corporation lands deteriorates and the wood cut and decked from around the airport in 1998-99 is depleted. It is expected that this decked wood may last a couple more years. If CAC builds the road to access the Carbon Mountain area, there may be potential to allow gathering of forest products in the analysis area. Currently the timber is not accessible.

Non-Native Plant Species

In 1997, a basic inventory for non-native plant species (including invasive species) was conducted in the Copper River Delta area (Duffy 2003). The surveys were limited to the "front-country," with an emphasis on areas of human disturbance such as roads, trailheads, and recreation sites and included a few samples along the Copper River Highway in the East Delta analysis area. A few areas of natural disturbance such as gravel bars and sand dunes were surveyed for comparison, as well as undisturbed habitats such as forests, meadows, and bogs adjacent to visitor facilities. The study did not encompass "back-country" public use cabins, long trails, or areas that could only be reached by air, boat, or extensive hiking. Table 4.3 shows the twenty-five taxa of non-native plants found (Duffy 2003).

Table 4.3 - Non-native plant taxa observed during the 1997 surveys in the Copper River Delta area (Duffy 2003).

Scientific Name	Common Name
Achillea millefolium var. *millefolium*	common yarrow
Achillea ptarmica	sneezeweed
Agrostis gigantea	redtop
Cerastium fontanum	larger mouse-eared chickweed
Deschampsia elongata	slender hairgrass
Hordeum jubatum	squirreltail grass
Leontodon autumnalis	fall dandelion
Leucanthemum vulgare[10]	ox-eye daisy
Lolium perenne ssp. *perenne*[11]	perennial ryegrass
Matricaria discoidea[12]	pineapple weed
Papaver nudicaule ssp. *nudicaule*	Iceland poppy
Phleum pratense	Timothy
Plantago major var. *major*	common plantain

[10] synonym = *Chrysanthemum leucanthemum*
[11] synonym = *Lolium perenne*
[12] synonym = *Matricaria matricarioides*

Plantago major var. *pilgeri*	Pilger's common plantain
Poa annua	annual bluegrass
Poa pratensis	Kentucky bluegrass
Poa trivialis	rough bluegrass
Ranunculus repens	creeping buttercup
Rumex acetosella	sheep sorrel
Rumex crispus	curled dock
Stellaria media	common chickweed
Taraxacum officinale	common dandelion
Trifolium pratense	red clover
Trifolium repens	white clover
Veronica serpyllifolia var. *serpyllifolia*	thyme-leaved speedwell

The number and abundance of non-native plant species was observed to decline as distance from Cordova increased (Duffy 2003). Along the highway within the analysis area only one non-native plant species was found (*Poa pratensis*, Kentucky bluegrass) compared to 11 species along the highway west of the Copper River. At the Childs Glacier recreation site, *P. annua* (annual bluegrass) and Kentucky bluegrass were found. Near an old railroad bed in the near Mile 41 of the Copper River Highway three non-native plant species were found: *Matricaria discoidea* (pineapple weed), *Plantago major* var. *major* (common plantain), and annual bluegrass. In addition to the distance from town (source area for non-native plant propagules), competition from native species in the harsh climatic conditions (strong winds, cold temperatures) along the highway corridor in the analysis area may impede establishment of non-native plant species.

Of the 25 taxa shown on Table 4.3, none are listed as prohibited noxious weeds under the Alaska Administrative Code (11 AAC 34.020), but three (*Plantago major* L. var. *major*, *Plantago major* L. var. *pilgeri*, and *Poa annua*) are listed as restricted noxious weeds. The taxa regarded as invasive in the United States (http://plants.usda.gov) are shaded in Table 4.3. As defined in Executive Order 13112[13], an invasive species is a species not native to the ecosystem in question and whose introduction does or is likely to cause economic or environmental harm or harm to human health. Seventeen of the 25 taxa are regarded as invasive based on the "Invasive Plants of the U.S." list posted on the PLANTS national database website[14].

Duffy (2003) summarizes his survey of the area with the following statements:

a) The amount of non-native flora of the Cordova/Copper River Delta area is very small compared to the Kenai Peninsula (25 versus 59 species).
b) Non-native plants were, by and large, confined to areas of great human modification and use, and nearly disappeared beyond the road corridors.
c) The number and abundance of non-native species declined as distance from Cordova increased.
d) A low number of both non-native and native species is present in the biophysically harsh Copper River Ecological Subsection.

[13] http://www.invasivespecies.gov/laws/execorder.shtml
[14] http://plants.usda.gov/

e) Areas of human activity and places where heavy machinery is used, such as boat ramps, had more non-native species and greater cover. Boats ramps appeared to be likely places for propagules to be dislodged during loading and unloading.
f) Areas of dense shade, such as the hiking trails in forests, had no non-native plants.

Threatened, Endangered and Sensitive Plant Species

The only federally listed plant in Alaska is *Polystichum aleuticum*, which is listed as endangered. It is only known from Adak Island and is not expected to occur in the Copper River Delta area. The Regional Forester designated 19 vascular plants as sensitive in the Alaska Region. Of these, the following 12 species are known or suspected to occur on the Cordova Ranger District of the Chugach National Forest:

Eschscholtz's little nightmare (*Aphragmus eschscholtzianus*)	known
Norberg arnica (*Arnica lessingii* ssp. *norbergi*i)	known
moonwort fern (*Botrychium tunux*)	suspected
moonwort fern (*Botrychium yaaxudakeit*)	suspected
goose-grass sedge (*Carex lenticularis* var. *dolia*)	known
truncate quillwort (*Isoetes truncata*)	known
Calder lovage (*Ligusticum calderi*)	suspected
pale poppy (*Papaver alboroseum*)	suspected
smooth alkali grass (*Puccinellia glabra*)	suspected
Kamchatka alkali grass (*Puccinellia kamtschatica*)	suspected
Unalaska mist-maid (*Romanzoffia unalaschcensis*)	known
circumpolar starwort (*Stellaria ruscifolia* ssp. *aleutica*)	suspected

There is one previously documented (but unverified) sighting of the sensitive plant, *Romanzoffia unalaschensis* in the East Delta landscape analysis area on a beach terrace northwest of Cape St. Elias on Kayak Island. This is currently the only sensitive plant record for the area. Based on comparison of a matrix of general habitats for the each of the species listed above (Stensvold 2002) and known habitats within the analysis area, all 12 species potentially occur in the area in the following habitats:

Aphragmus eschscholtzianus - heath, alpine and subalpine habitats
Arnica lessingii ssp norbergii - tall shrubland, open forests, meadows, alpine and subalpine habitats
Botrychium tunux and *B. yaaxudakeit* - maritime beaches, upper beach meadows, well drained open areas
Carex lenticularis var. dolia and *Stellaria ruscifolia* ssp. *aleutica* - lake margins, marshy areas, alpine and subalpine habitats
Isoetes truncata - shallow freshwater
Ligusticum calderi - forest edges, wet meadows, alpine and subalpine habitats
Papaver alboroseum - well drained open areas, dry meadows, alpine & subalpine habitats
Puccinellia glabra and P. kamtschatica - maritime beaches, upper beach meadows
Romanzoffia unalaschcensis - forest edges, streamsides/riverbanks, rock outcrops

Wildlife

As previously discussed, the vegetation on the Copper River Delta is dynamic and unstable because of tectonic uplift and geomorphic processes such as erosion and deposition of sediments on tidal flats and glacial river channels. The change in vegetation characteristics resulting from the uplift of the 1964 earthquake has affected many wildlife species. Before 1964, the seaward portion of the delta was covered by tidal marshes dominated by sedges and mixed grass/forb communities. The earthquake lifted these marshes above tidal influence, initiating massive changes in vegetation composition and structure. Some tidal communities that were once common are now rare, while some upland communities have become more widespread (Boggs 2000).

Trumpeter Swans

In the 1930's, the trumpeter swan populations were severely depleted, with only 69 individuals known to exist and unrecorded flocks existing in Alaska and Canada. The majority of the world's population of trumpeter swans breed in Alaska. Over 700 nesting pairs of swans inhabit the Copper River Delta and surrounding wetlands representing the largest breeding population of trumpeter swans in North America (Groves et al. 1998) (Fig 4.20).

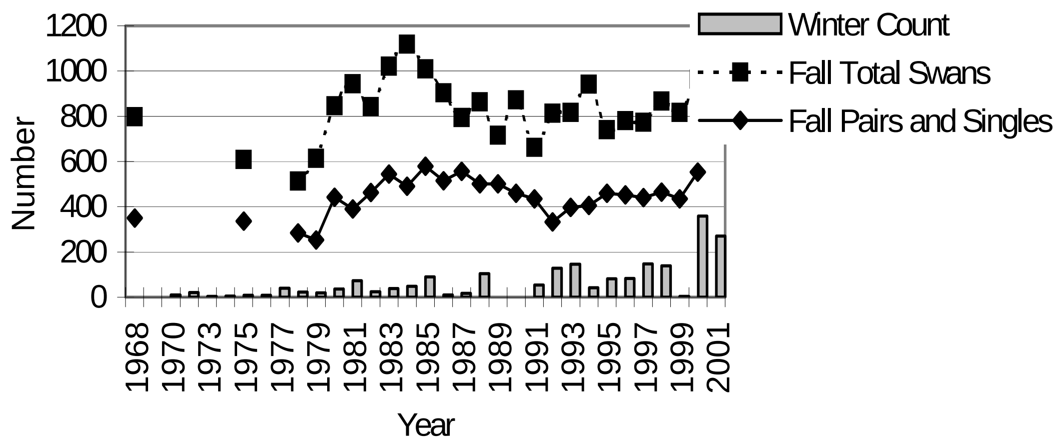


Figure 4.20 -Winter and fall counts of trumpeter swans on the Copper River Delta

Dusky Canada Goose

The Pacific Flyway Council (1997) recognized the dusky Canada goose as a unique subspecies with a nesting range limited to the Copper River Delta and Middleton Island in Prince William Sound Alaska. Midwinter population indices during the last 40 years have fluctuated from less than 10,000 in 1953 to greater than 28,000 in 1960, then declined to 9,700 in 1995 (Fig 4.21). The most recent population estimates distinguishes the subspecies as one of the numerically smallest populations of Canada geese in North America.

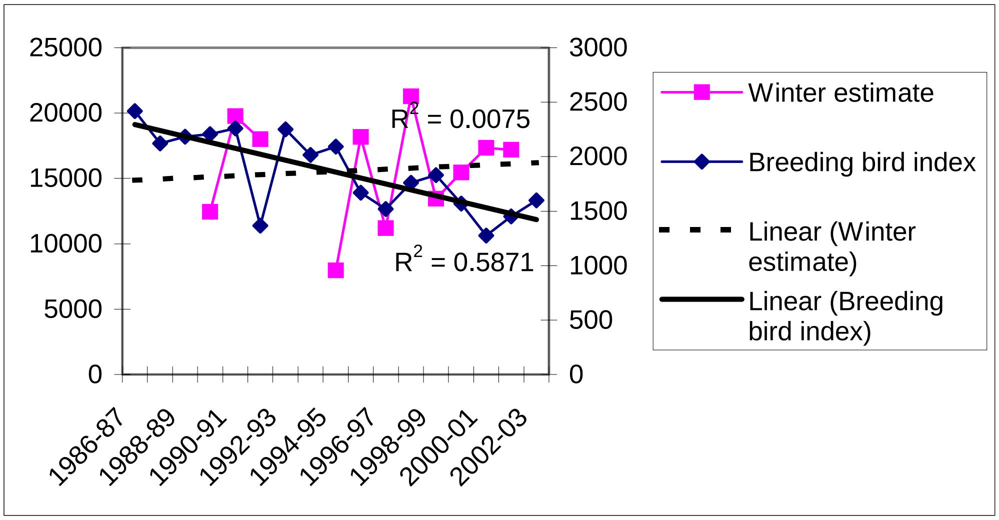


Figure 4.21-Population trend of dusky Canada geese, as measured by winter population estimates and a breeding bird index.

Ecological changes occurring on the Delta since the March 1964 earthquake, have contributed to the declining productivity of the dusky goose population (Crow 1972, Bromley 1976, Campbell 1990, Pacific Flyway Council 1997). Prior to 1964, primary nesting areas were tidally influenced, geese selected mixed forb/low shrub nest sites on the slightly elevated slough levees (Trainer 1959). Periodic tidal flooding maintained broad expanses of sedge and salt-tolerant forb habitats dissected by an extensive network of drainage channels and sloughs. Avian nest predation was low, mammalian predators rarely frequented the lower Copper River Delta and flooding was the major cause of nest loss. Nest success averaged greater than 80%, which is above the reported rate for self-sustaining Canada goose populations (Trainer 1959, Bromley 1976, Campbell et al.1988, Bromley and Rothe 1999).

After the uplift from the 1964 earthquake, the absence of periodic flooding decreased nest loss due to storm tides, but the drier condition on the slough levees allowed the invasion of shrubs, particularly willow and Sitka alder. Nest losses from brown bear, coyote, and red fox increased as shrub cover and height increased (Shepherd 1966, Bromley 1976, Campbell and Rothe 1985, Campbell et al. 1988, Campbell 1990). Average nest success dropped from 82% during 1959-1974, to 47% during 1975-1982, and has remained low at 28% during 1983-1995 (Pacific Flyway Council 1992, Bromley and Rothe 1999).

The precipitous decline in the early 1980s led to restricted hunting (Pacific Flyway Council 1997). Prior to this, dusky Canada geese were relatively heavily harvested, with greater than 25% of the population taken annually. By 1985, a harvest quota of not more that 300 birds (< 3% of the population) was set for Oregon and Washington. However, the primary cause of the decline was attributed to low recruitment due to high predation on the breeding grounds. In 1983, the Forest Service and ADF&G started an artificial nest island program to provide nest sites safe from mammalian predation. Several authors demonstrated Canada geese nesting on a variety of artificial structures suffered less mammalian predation than geese nesting on natural sites (Hammond and Mann 1956, Hilden 1965, Vermeer 1970, Ewaschuk and Boag 1972, Atkins 1979, Giroux 1981).

Currently, no projects to increase Dusky Canada goose nest success exist on the east Copper River Delta., however since 1984, more than 850 artificial nest islands have been installed west of the Copper River to enhance nest success of dusky Canada geese. Continued maintenance of these nest islands has resulted in continued high nest success rates. Nest success on artificial islands has averaged 64% from 1984-2002, double that found at natural sites (32%).

Moose

The moose population in GMU 6B has shown a decrease since 1997/1998 (Fig. 4.22). Both the bull harvest and percent calves in the population have fluctuated at the same time, however, both have increased recently.

Construction of Carbon Mountain road could affect management of the moose harvest in GMU 6B. Currently, this hunt is open to all Alaskan residents that obtain a registration permit. The harvest is regulated by quota, with some of the harvest taking place during a 5 day non-motorized season, and the rest being taken after opening the season to motorized access. Improving access to the unit could necessitate a change in harvest, resulting in decreased hunter opportunity (Dave Crowley, pers. comm.). Six outfitters currently have Forest Service permits for moose hunting camps in the analysis area.

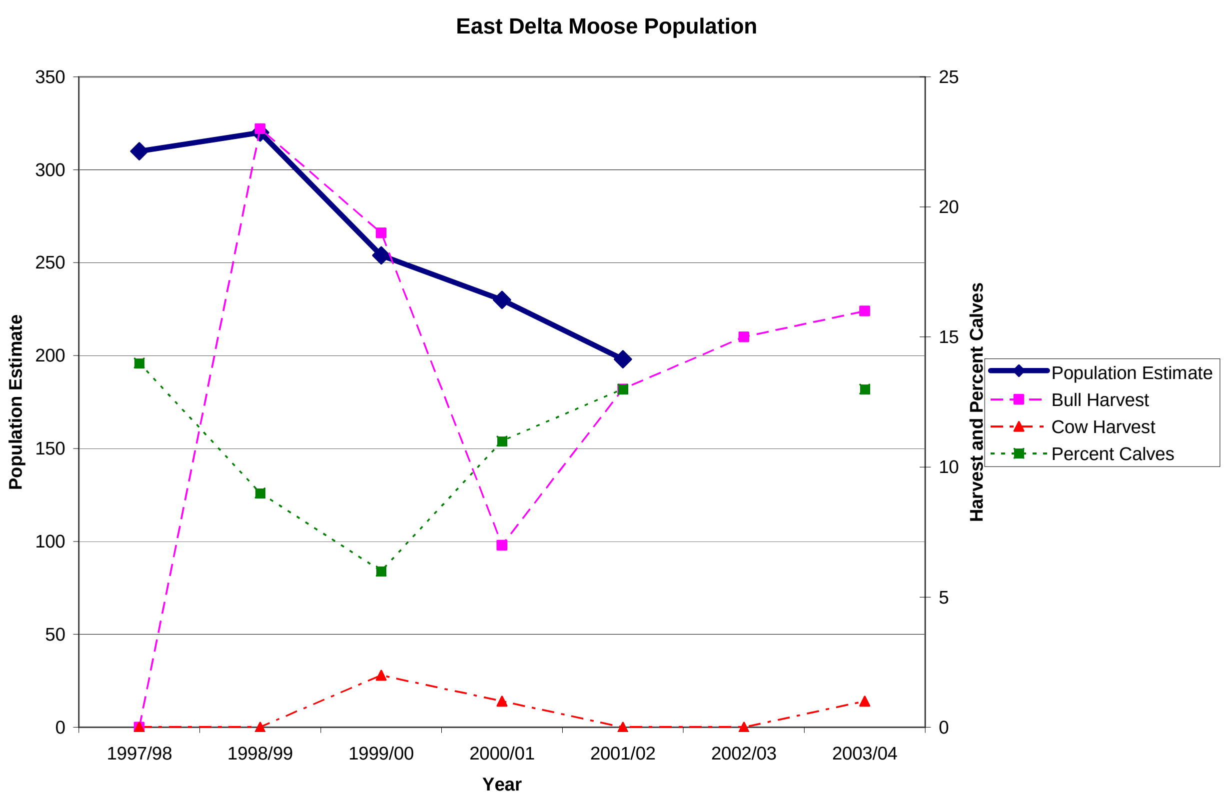


Figure 4.22 - Moose population in Unit 6(B) and associated population parameters.

McCracken et al. (1997) suggested that predators, especially brown bears were an important calf mortality factor. Predation on calves by brown and black bears has been shown to limit or regulate moose population (Franzmann et al. 1980, Van Ballenberghe 1987, Ballard et al. 1991, Ballard 1992, Van Ballenberghe and Ballard 1994).

Mountain Goats

Mountain goats are harvested in Unit 6B, which includes most of the East Copper River Delta analysis area. The area east of the Copper River, south of Miles Glacier, and northwest of Pleasant Valley and Pleasant Glacier is closed to goat hunting. Mountain goat populations appear to be relatively stable in most portions of the analysis area, although some of the populations, namely those within the smaller isolated mountain ranges with limited escape habitat, are small (Fig. 4.23). Mountain goats are hunted in most of the unit by state registration hunt and no federal subsistence harvest of goats occurs in the analysis area. Five outfitters currently have Forest Service permits for mountain goat hunting camps in the analysis area. No hunt currently takes place in the Suckling Hills or the Kushtaka areas.

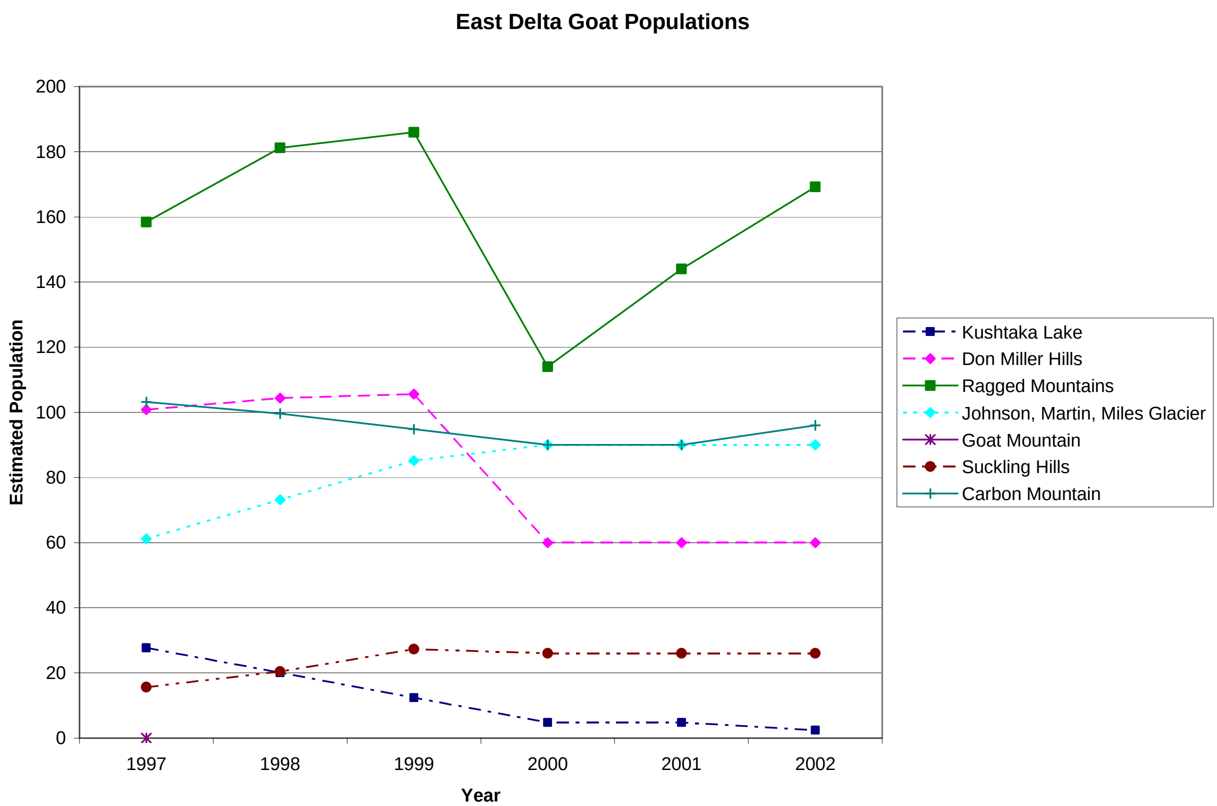


Figure 4.23 - Population parameters for mountain goats within the analysis area.

Condition and trends of heritage resources

Prior to the influx of miners and the establishment of canneries, oil claims, and a refinery and the spread of introduced Western European diseases, historic properties consisted of Native Alaskan residences and camps primarily in areas near subsistence resources with defensible qualities related to pre-European technology. With the advent of prospectors and miners in the late1800s, and oil drillers in the early 1900s, historic properties illustrating human use of the land began to be associated with mineral resource occurrences. The establishment of railroad construction, mining, and drilling camps in the early 1900s contributed to changes in settlement patterns from those in late prehistoric and early historic times.

Heritage resources have been increasingly protected over the past 50 years as non-renewable resources. The National Historic Preservation Act of 1966 requires the identification and preservation of significant historic and prehistoric sites on federal land, and the mitigation of both direct and indirect impacts of federal undertakings on sites that are eligible for the National Register of Historic Places.

Under the Programmatic Agreement between USDA Region 10, the State Historic Preservation Officer, and the Advisory Council on Historic Preservation, the high sensitivity zones for cultural resources are identified using a predictive model that describes areas where proposed development may have an impact on heritage resources. These areas include:

a) River valleys, lake and river systems providing passes or portages across larger land masses;
b) All areas between mean high water and 150 ft. in elevation above mean high water, regardless of slope angle;
c) Areas of former lode and placer mining activity;
d) Elevated/fossil marine, river, and lake terrace systems; Lake and stream systems containing or known to have contained, anadromous fish runs, including barrier falls locations;
e) Caves, rock shelters, and igneous rock formations known for caves and rock shelters;
f) Known sources of potential raw materials;
g) Other areas identified through literature or oral history research/sources.

Over 99% of the analysis area has not been inventoried for cultural resources. Of the 90 known cultural resources in the analysis area, 8 have been documented and evaluated for the National Register of Historic Places. The remaining 82 either need to be documented and evaluated or have determinations completed.

Although historic Native Alaskan cultural resources are among those known to be present in the analysis area, none of the documented sites have firmly identified prehistoric components. This is, for the most part, due to the limited nature of surveys, which have been done in support of Forest Service projects primarily along the road corridor, such as easements and Special Use Permits. A complete inventory would allow better interpretation of the significant historic resources related to Native Alaskans, early European exploration, attempts to develop railroads from the Katalla and Controller Bay area, the successful CRNW railroad, and early 20th century mining and oil drilling. It would also make compliance with NHPA section 106 easier, as the eligibility of resources for the National Register would already be known for specific projects.

The revised Forest Plan states that the desired future condition for cultural resources is that they remain in an undisturbed state with data recordation as the preferred method to mitigate their loss. The Forest Service also has laws and obligations it needs to comply with which are listed in the East Delta Heritage Resource Report (Yarborough 2004).

Increased recreation tourism and public use by Cordova residents and people from outside locations can result in direct, as well as cumulative and indirect, impacts to cultural resources. The Forest Service is required by the rules and regulations that implement the NHPA to consider indirect effects, as well as direct effects, of projects and management actions on historic properties. An example of indirect effects is the creation of a new recreation trail which passes by a historic cabin or an archaeological site. By increasing the ease of access, and routing the public into the vicinity of the cultural resource, the integrity of the resource is put at risk of either purposeful vandalism or accidental disturbance by the public, and must be addressed by the project. Individual sites in the area, such as the wreck of the *Portland*, the Bering Expedition Landing Site, and various other sites are somewhat known to the public, particularly those interested in Alaska history, or who are able to travel to the area and see the existing visible cultural resources.

Although minimal management is desired for the area, the NHPA nevertheless requires that properties in the area which “may be eligible for the National Register are managed and maintained in a way that considers the preservation of their historic, archaeological, architectural, and cultural values in compliance with section 106 of this Act and gives special consideration to the preservation of such values in the case of properties designated as having National significance” (16U.S.C. 470-2(a)(2)(B)). Historic properties in such a management area could not simply be neglected, because “Neglect of a property that causes deterioration, except where such neglect and deterioration are recognized qualities of a property of religious and cultural significance to an Indian tribe” is considered an adverse effect (CRF36 Part 800.5(2)(vi).

Conditions and trends of recreation resources

Introduction

Recreation use of the area by residents of Cordova has a long history, beginning in the early 20th century. When the Copper River and Northwestern Railroad was operating, an Interstate Commerce Commission Report noted: “during the summer months, special tourist trains have been operated between Cordova and Childs Glacier” (Pritchard 1939).

Cordova’s tourism industry is growing at an estimated rate of 3 to 7% annually (Christensen and Mastrantonio 1999). Within the past 5 years a 35 bed lodge has opened as well as several bed & breakfasts and two rental car companies. With the advent of the daily high speed ferry connecting Cordova to Whittier and Valdez, scheduled to come online in 2005, it is anticipated that there will be a 600% increase in visitors to Cordova. Most use will be concentrated along the road system, however there may be more demand for remote cabins, camping, river trips, picnic sites, and the like. Visitors currently enjoy activities such as fishing, hunting, hiking, camping, bird watching, mountaineering, river rafting and sightseeing, and guided hiking.

As shown in Chapter 1, Figure 1.4, outside of a narrow band of ANILCA 501(b)-3 that parallels the proposed Carbon Mountain road, the analysis area is divided into two major management prescriptions, ANILCA 501(b)-1 and ANILCA 501(b) -2. North of the road is 501 (b)-2 and south is 501 (b)-1. The area is managed to emphasize the conservation of fish and wildlife and their habitat and provide a variety of recreational opportunities for backcountry activities. The difference in the two categories is that 501 (b)1 was developed to address the "Management of Fish and Wildlife Habitat" and "Natural Quiet" Interests, while 501 (b) 2 addresses the "management of Fish and Wildlife Habitat" , "Motorized Access", "Nonmotorized Access" and "Recreation Opportunities" Interests. The amount and types of use has been on a steady rise for the past decade. Twenty years ago use in this area centered around commercial and sport big-game hunting (moose, goat and bear). Today, not only do we have an increase in big-game guiding we also have requests for special use permits for commercial sport fishing, heliskiing, helicopter sight seeing, lodges, The District is currently determining the carrying capacity based on the newly revised Forest Plan direction. Part of the analysis will determine the capacity for the guided publics based on the 50% allocation from the Forest Plan.

High speed ferry

Most of the east delta analysis area is fairly remote and access is limited. However, we are experiencing an increase in individuals developing plans to promote new guided or expand existing guided activities. Whether this increased used spills over into the non-guided visitors remains to be seen. Recreational activities in this area have been rising and are expected to continue to rise. The introduction of the fast ferry to Cordova and Prince William Sound will definitely contribute to that increase. A determination of the capacity of the analysis area and the community to absorb and service this additional use has not yet been developed.

Campgrounds/Day-use Facilities

Campgrounds and day-use facilities are considered consistent with the management intent of the 501 (b) 2 prescription (the northern half of the analysis area). Campgrounds and Day-use facilities are not consistent with the management intent of the 501 (b) 1 prescription (the southern half of the analysis area). Currently, there are no plans to provide either of these types of facilities in this analysis area. If the Carbon Mountain road were to be constructed, these types of facilities may be considered at that time for 501 (b) 2 and 3 prescription areas only.

Trails

Of the 24.2 miles of trail within the analysis area, all have been constructed during the last 10 years. Users have a variety of hiking preferences, from well-established, highly maintained trails to simple access routes that allow freelance hiking through alpine areas. Hikers can choose a number of short hikes ranging from the Class IV accessible Copper River Trail to the Class III Childs Glacier Trail to Class I easements such as Goat Mountain and Goodwin Trails. To meet future demand, the Forest Service will need to address the deferred maintenance backlog for trails and bring them up to standard (Copper River & Childs Glacier Trails) and identify easements that offer new access and/or new opportunities and upgrade them from Class I trails to Class III trails. Because of the emphasis on new construction, the deferred maintenance backlog has increased.

Motorized and non-motorized opportunities

The Forest Plan identifies areas available to winter and summer motorized use. Winter and summer motorized recreation access maps are displayed in Figure 1.5**,** Chapter 1. The majority of the area is closed to summer motorized use except for subsistence. The barrier islands are open to motorized use on non-vegetated areas. During winter, the portion of the analysis area north of the Martin River drainage is open to all motorized use, while the south half has various restrictions concerning motorized use.

Motorized activities in the east delta are increasing. The public demand for both motorized and non-motorized areas is high and the trend is expected to continue. Different forms of transportation as well as expanded travel ranges through technological advances, changing river channels and low water levels have changed how and where our visitors use this area. In the past, motorized activities occurred primarily in the winter month by snow machiners. Today, motor bike and OHV's operators travel from the Round Island downriver nearly to the Gulf and upriver to the higher dunes east of the Copper River Hwy. at Mile 40. Increased human presence in these areas will undoubtedly affect fish and wildlife population.

Another major mode of off –road travel is airboats. In the past, the number of airboats and the areas they were used in were less, as was their impact. In recent years, the increase in number of airboats and the expanded area of operation for a variety of activities (State and Federal fish & wildlife research, sightseeing, hunting, fishing, etc.) has elevated the concern about this activity and its effects on streambanks, other visitors, vegetation fish and wildlife.

Wildlife Viewing

This type of recreational activity has been occurring for years. For the most part viewing wildlife was a past-time of locals and visiting friends and relatives. As commercial development grew (Outfitters, Guides, and Bed & Breakfasts), watching wildlife became a secondary benefit to many primary activities. Only recently has it been deemed viable as a commercial venture.

Outfitters and Guides

This analysis area generally falls just outside the home range boundaries. The home range concept identifies areas close to a community where commercial activities such as fish and game guiding and heli-skiing are in direct conflict with resident activities. Therefore, these commercial activities are allowed in the analysis area and could be significant.

Demand for outfitting and guiding services in this analysis area are rising causing capacity concerns and user conflict issues. Commercial special use permit requests for sport fishing on the East Delta is increasing. The focus is on coho salmon but sockeye salmon and trout are also targeted. Concerns with the area's capacity for guided and unguided forest users are becoming an issue. The Cordova District is currently revising the recreation carrying capacity analysis to reflect current Forest Plan direction and analyzing whether additional permits for big game hunting should be approved for the East Delta. Besides capacity, the interaction between guided and un-guided users will have to be addressed soon.

Mineral resources development

Where oil, gas, or coal are known to be present, there may be interest in staking claims or submitting lease applications to develop those resource. The Katalla Area, for example, is a known area of interest for oil and gas. Coal occurs in the Bering River area, mainly under Native-owned lands. There has been little interest in developing mineral resources in areas covered with ice fields and glaciers or in areas where no valuable minerals are known to be present. In order to properly manage an area, it is important to have an understanding of whether mining is likely to occur because it may conflict with other uses. Mining may render the land unsuitable for certain uses, at least for a period of time.

Mineral Entry

All public domain lands are open to mineral entry under the 1872 Mining Law unless specifically closed. Bona fide mineral development cannot be prohibited where lands are open to mineral entry. The statutes also provide for a mining claimant's rights to reasonable access for prospecting, locating mining claims, and developing the mineral resource. Such activities must conform to the rules and regulations of the Forest Service; however those rules and regulations may not be applied so as to prevent lawful mineral activities or cause undue hardship on bona fide prospectors and miners (FSM 2810).

The ANILCA Copper River Addition, located in the northern part of the analysis area, is closed to mineral entry (Figure 1.3). On lands closed to mineral entry, leasing or sales of mineral materials may still occur, but these sales are discretionary. The Forest Service may limit or prohibit such activities.

The Forest Service manages the surface estate of the Katalla Area under the terms of the CNI Agreement. The government also owns the mineral estate with the exception of CAC's term interest in oil and gas. Figure 1.3 displayed where CAC owns the subsurface estate while the surface estate is National Forest System land. These lands are called "split estate" lands where the Forest Service must allow CAC to develop the mineral resources of their subsurface. CAC's mineral rights in both cases described above include title to the mineral and the necessary authority to enter upon and use as much of the surface overlying the mineral estate as is reasonably necessary to explore for, develop, extract, and process the minerals.

Locatable Minerals

Although about half of the land is open to mineral entry, there are no approved (or proposed) plans of operations or mining claims in the analysis area. This fact does not preclude some entity from locating a mining claim in the future, but it does indicate a general lack of interest for prospecting and development of mineral resources. In the past, mining claims were staked for oil and gas and coal. These resources are no longer “locatable” minerals but instead are “leasable”. This is an important distinction because leasable actions are discretionary while locatable actions are not.

There are two known occurrences of gold and one of copper and are considered to have low or unknown mineral development potential. A large portion of the southern half of the analysis area consists of Quaternary deposits of sand and gravel however these deposits not locatable. Trace amounts of placer gold occur in the beach sands. The Orca Group hosts one small copper occurrence and the Valdez Group does not host any known occurrences.

Leasable Minerals

Oil and Gas - Within the Katalla Area (Fig 1.3), Chugach Alaska Corporation has certain oil and gas rights as defined in the 1982 CNI Settlement Agreement and the Forest Service must allow CAC to develop their oil and gas resources. In order to retain these rights, CAC must drill a paying well by December 31, 2004. If they fail to drill such a well their rights revert back to the government. If they drill a paying well, their rights continue until production ceases.

One active Special Use Permit for exploration drilling in the old Katalla Oil Field is in place related to the exercise of CAC oil and gas rights under the 1982 CNI Settlement Agreement. The permit holder has proposed drilling 9000 feet deep into the Tokun Formation that underlies the Katalla Formation. The Tokun Formation is considered a weak source horizon for petroleum and has never produced oil or gas. Any well drilled into the Tokun Formation will most likely result in a dry hole. A productive oil or gas field requires a petroleum source, a porous reservoir rock, and an impermeable cap rock. These conditions are not met in the geology of the area. The overlying Katalla formation is a petroleum source but lack of a reservoir and cap rock has prevented formation of a “pool” and has allowed migration of the oil to the surface. As of March 18, 2004, no activity has occurred on the site and no notice to begin activities has been given to the Forest Service. The permit requires a 30-day notification prior to commencing activities.

Coal - There is no known activity occurring in the Bering River coal field. The Korean Corporation who owns most of the known coal has negotiated with the Forest Service in 1999 to sell their subsurface rights. At present, there are no negotiations occurring.

The Bering River coal field is unlikely to be developed primarily because coal seams are locally thin, lack continuity, and are structurally complex. Lack of infrastructure and the remote nature of the field are additional obstacles to development.

Hardrock minerals - The CRA tract is almost entirely overlain by ice so even if metallic mineral deposits (such as gold, silver, and copper) exist they are unlikely to be discovered and developed. No lease application for metallic minerals in the CRA has been submitted to BLM or the Forest Service. There is a complete lack of mining history and industry interest in searching for mineral deposits in this area.

Salable Minerals

The geology is highly favorable for deposits of sand, gravel and stone. Local development and construction activities will dictate the need for this material. If the Carbon Mountain Road is built, National Forest mineral materials would be used. A special use permit issued to CAC by the Forest Service allows the use of National Forest mineral materials. In other areas, since materials sales are discretionary, the Forest may either sell or decline to sell the material if it is deemed appropriate to do so.

Along the road corridor, the revised Forest Plan allows for the development of small mineral materials sites to support trail, facilities, and road construction, consistent with conservation of fish and wildlife and their habitats. All sites will be completely rehabilitated on completion of the project.

Chapter 5 –Inventory, monitoring, and project recommendations

Most of the East Copper River Delta analysis area is in its natural condition because it receives relatively little use. Receding glaciers and dynamic river channels affect almost every aspect of the deltaic plain, including water quality, streamflows, lakes, wetlands, ecology, fish and wildlife habitat, and human uses. Inventory and monitoring projects can be useful to quantify dynamic natural changes as well as human caused changes that affect valuable resources in order to determine appropriate management strategies. Projects were identified to provide interpretation and visitor facilities, update resource databases, and as solutions to manage physical processes in areas that receive concentrated use.

Inventory and monitoring proposals

Hydrologic Resources

1. **Channel type verification**: Streams in the East Delta analysis area were classified based on basic variables using aerial photography, but channel type verification was conducted on very few of these channels. This information is used for fish habitat management and to predict how streams will behave over time. Initial reconnaissance suggests that many stream reaches in the analysis area are currently mis-classified by process group, based on the R10 stream classification system (USDA Forest Service, Alaska Region, 1992). Channel type verification can be conducted systematically to cover the East Delta over a period of many years.

2. **Katalla water quality testing**: Cassandra Energy Corporation plans to begin drilling operations in the Katalla Oil Field. A water quality testing plan should be developed and implemented during and after this activity to assess any effects of oil drilling on water quality in Katalla Slough. New water quality data can be compared to baseline data collected between 2000 and 2003.

3. **Martin, Little Martin, and Bering Lake bathymetry**: Martin, Little Martin, and Bering Lakes lie in shallow basins created by the damming effects of glacial outwash from the Martin River and Bering Glaciers. These shallow lakes are slowly shrinking as a result of sedimentation and as their outlet channels are incising into the outwash plains. In conjunction with fish surveys to determine fisheries values, bathymetric measurements should be conducted in these lakes to assess the rate at which they are decreasing in size. Such baseline data could be useful to determine sedimentation rates of future flood events. Although these lakes are undergoing a natural succession, they are important for human uses and fisheries. If deemed necessary and feasible, grade control structures could be constructed at the outlets to increase lake depths and maintain constant water surface elevations. In the 1980s, a proposal to construct grade control structures

at the outlets to maintain constant water surface elevations was proposed; this ideas was rejected as being unfeasible after additional investigations.

Fish

1. Identify spawning, rearing, and overwintering habitat in the watershed regions. Streams and regions could be classified in order of importance based on relative fish distribution and adult escapement documented in this analysis.

2. Establish a monitoring plan for fish habitat and populations in streams that will be affected if the CAC road is constructed.
    a. Collect baseline fish distribution and population data.
    b. Monitor stream habitat upstream and downstream of road crossings.
    c. Collect baseline data on timing of fry emergence, smolt out migration, and spawn timing for the key species. This information will be important to determine the best “window of operation” for road construction so that impacts to fish populations are minimized.

3. Collect baseline data on recreational use along the CAC road corridor. Estimate current angler use on streams crossed by the road corridor.

4. Monitor water quality of streams that may be impacted by exploration and drilling in the Katalla area.

5. Collect baseline habitat, water quality, and fish population and distribution data on streams that might be affected by resource developments in the Carbon Mountain Tract.

6. Collect baseline morphology and water quality data on Bering and Martin Lakes to monitor changes over time. Collect baseline data on seasonal presence and patterns of use by juvenile sockeye salmon in Bering Lake. Use this data and water quality data to determine if conditions in the lake are limiting production.

7. Establish an accurate, updated stream layer for the corporate GIS database.
8. Inventory streams on islands to document fish species presence and distribution.

9. Survey streams for Atlantic salmon and collect suspected specimens for genetic analysis.

10. Conduct chinook and steelhead escapement surveys in the Katalla River to determine run timing, important spawning areas, and relative abundance of spawners. This information could help protect habitat and populations if the private lodges expand operations throughout the entire year.

11. Conduct coho salmon escapement surveys at Softuk Lagoon to establish timing and magnitude of the run for cabin users.

Vegetation Resources

1. Update timber and vegetation databases to include northern portion of the analysis area, private land, and new vegetation information. Existing database uses 1976 information and does not reflect current conditions. With rapid succession on Delta, vegetation types have changed.

2. Documenting the spatial and temporal patterns of change in vegetation composition and structure to assess the extent of ecosystem change, the influence of management on these changes, and how do the changes compare to the expected range (Revised Forest Plan, Chapter 5).

3. Document sensitive plant population sizes and trends to determine their abundance and distribution and the effect of management on the species (Revised Forest Plan, Chapter 5).

4. Conduct surveys to determine abundance and distribution of exotic plants, particularly in areas affected by management activities. Monitor selected sites to measure changes in exotic plant populations. (Revised Forest Plan, page 5-8)

Wildlife

1. Identify key habitats for breeding, feeding, shelter, and resting, for all species known to exist in the analysis area, with priority places on Threatened and endangered species, species of special management concerns, and game species.

2. Establish a monitoring plan for wildlife habitat and populations that will be affected if the CAC road is constructed. Collect baseline wildlife distribution and population data.

3. Collect baseline data on recreational use along the CAC road corridor. Estimate current hunter use of lands crossed by the road corridor.

4. Collect baseline data on timing of use by migratory species, such as shorebirds, and species that use the area or specific habitats seasonally, such as sea lions at haulouts.

5. Document timing and use of brown bears at berry feeding sites on barrier islands and beaches.

Heritage Resources

1. Cultural resources in project areas proposed by the Forest Service are inventoried under section 106 of the NHPA. Other inventories of cultural resources on National Forest System lands outside identified project areas fall under Section 110 of the NHPA. This could also involve partnerships. The State of Alaska’s Office of History and Archaeology staff has partnered with the Forest in the past on historic research and is a likely future partner, as are the University of Alaska

Departments of Anthropology and History. Depending on funding, two options to inventory the cultural resources of the area and develop a database are:

- ***Option 1 (High funding)*** Showcase Forest Service management of historic sites, complete the inventory and evaluation of cultural resources of the analysis area over a period of 25 years and refine the predictive model after completing archaeological survey of 25% of the analysis area. Assuming 15,000 acres per year could be surveyed and excluding lakes, glaciers, and permanent icefields, it would take an estimated 11 years to complete the sample.

- ***Option 2 (Moderate funding)*** Complete the inventory and evaluation of cultural resources of the analysis area over a period of 40 years and build a predictive model after 25% of the analysis area was surveyed. Assuming 8,700 acres per year, it would take 20 years to complete the sample.

2. Partner with interested entities for documentation, preservation, and interpretation of prehistoric and historic sites, cultural landscapes, and rehabilitation of historic buildings.

3. Develop collaborative stewardship relationships for protection and interpretation of cultural resources; partner with university programs for research work to provide background information for management and interpretation.

Mining

1. The area should continue to be monitored for any new mining claims locations. This can be done through a township and range search of BLM mining claim records. The Forest geologist currently routinely conducts such a search. Where claims are staked, the area should be monitored for activity.

Recreation and Special Uses

1. Determine recreation carrying capacity based on revised Forest Plan to assist in issuing special use permits for outfitting and guiding. There is concern about some permits being too broad and intrusive to other users.

2. Survey recreational users in the Katalla area to determine impact of drilling operations on recreational quality.

3. Determine OHV and airboat use for baseline information before the high speed ferry arrives and identify specific areas of concern.

4. Determine what use is occurring on east of the Copper River and carrying capacity. Is it being reached for guided and unguided publics?

Potential projects for East Copper River Delta analysis area

Appendix C of the revised Forest Plan lists potential projects for the Copper River Delta on pages C12-13. Table 5.1 displays those projects that include activity in this analysis area. Each would be further analyzed through the NEPA process and additional public involvement before a decision was made to implement or not. The Forest Plan did not identify any fish or wildlife habitat enhancement or trail construction or reconstruction projects.

Table 5.1-Potential projects for analysis area listed in revised Forest Plan

Projects by category	Year planned	Est. cost (M$)	Description
Cabin construction and reconstruction, recreation site construction			
New cabin on the Copper River Delta	2010	$110.0	Provide 1 more cabin (may or may not be on East Copper River Delta)
Campground Construction			
Childs Glacier Day Use and Campground	2003	$1,500.0	Build new campground and rehabilitate existing day use site in partnership with AK DOT&PF (ongoing)

The IDT and public identified projects for the analysis area to meet the desired future condition as described in the revised Forest Plan. Letters and emails were sent in December 2003 to adjacent landowners and various organizations, private individuals, Native Corporations, Federal, State, and City land managers requesting information on future plans on their lands and any ideas, issues and concerns for the area. These potential projects would be further analyzed through the NEPA process with additional public involvement before a decision is made.

1. The myriad of waterways on the Copper River Delta has the potential to transport forest visitors to more areas then any other form of transportation. Some routes have been identified, marked on the ground, and made available to the public only to be withdrawn due to safety concerns (Saddlebag/McKinley Lake/upper Alaganik Slough west of the Copper River). Paddle trails could increase the range of recreation opportunities and disperse visitors but to date remains untapped.

2. Consider constructing angler access trail from Martin Lake cabin along Martin River to reduce bank trampling and disperse anglers. Establish permitted backcountry tent camping platforms away from the cabin.

3. Consider establishing permitted backcountry tent camping sites at another remote lake to disperse angler pressures (Tokun?, Kushtaka?).

4. Determine where to construct another public use cabin. Consider Bering Lake, Kanak Island, upper end of Tokun Lake, and Kayak Island (one on west side near Wingham Island and one on outside by landing strip). Some publics do not see the need for another cabin on the east side.

5. Place interpretive signs at the Martin River cabin that discuss catch and release angling, carcass disposal, lake formation, and fish populations.

6. Place interpretive signs at places that receive recreational, hunting or fishing sites such as Martin Lake cabins, Cape Saint Elias, Softuk, or Katalla. Signs could educate

visitors about avoiding disturbance to wildlife, importance of habitats, or the history of local wildlife populations.

7. Identify locations and consider constructing developed boat access/launch sites along the Copper River Highway between Mile 32 – 42.

8. Remove culvert and rehabilitate channel at crossing number 6 of the old Katalla access road.

9. Enhance juvenile winter habitat by placing structures in Martin Lake and associated ponds.

10. The rate of plant succession has increased so much that many herbaceous plant communities have progressed to forested shrub communities. It is likely that some plant communities mapped in the early 1980's are no longer represented today. This may be significant enough, relative to the prediction of various wildlife habitats, to consider a new vegetation mapping effort on the delta.

11. Develop research studies to examine potential factors influencing salmonid production, identify limiting factors, and build predictive production models. For example, a project that examines fish species composition, diet, and growth in relation to channel type and riparian vegetation could be used to predict changes in fish populations after natural disturbances such as earthquakes or changes in the dominant riparian vegetation type from shrub to conifer.

12. Develop research studies to examine effects of human disturbance (viewing on foot, landings by helicopter, passes by airplanes, etc.) at Cape Saint Elias on sea lions and nesting seabirds.

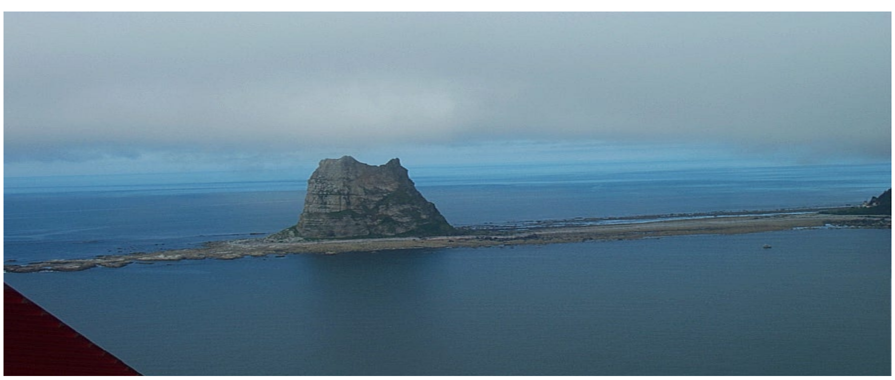


Figure 5.1-Cape St. Elias, Pinnacle Rock (Aug 2003)

13. The history of the analysis area is quite rich, with active human settlement and use of area resources by Eyak and Sugpiaq peoples by the 19th century, and Euro-American settlement and development of mineral resources of the area continuing in the first four decade of the 20th century. Because of this, there are many potential partners for a variety of cultural resource related projects including CAC, Native Village of Eyak, UAA, NPS, Alaska Mining Association (AMA), SHPO, Cordova and Alaska

Historical Societies, outfitter guides, and others. Recommendations for off-site interpretation include in brochures available in the Cordova District and Supervisor's Offices and interpretive panels at the Softuk and Martin Lake Cabins.

14. The project to bring the Bering River Train to Cordova is one which has been approved by the SHPO and is of interest to many in the City of Cordova.

Figure 5.1-Steam Engine in Bering River Valley (Feb 2004)

15. The State Archaeologist is interested in documenting and interpreting shipwrecks such as the *Portland* and the *Afognak* in partnership with Department of Interior's Minerals Management Service, interested publics, and the Chugach National Forest. A site visit was made in the Spring of 2004.

Project Implementation Recommendations

Wetlands and Soils

Wetlands perform the very important hydrologic functions of water storage and regulation of water flow. Some wetlands include the greatest diversity of plant species of any other ecosystem. The revised Forest Plan standards and guidelines also specify that wetlands will be avoided by all soil disturbing activities unless there is absolutely no other alternative. It is important to consider the type and location of wetlands present when designing any soil disturbing projects.

The standards and guidelines in the revised Forest Plan state "an analysis will be done for all major soil-disturbing activities greater than one-half acre in size, proposed on slopes from 56 to 72%, and $1/10^{th}$ acre in size on slopes greater that 72%." There may be a high potential for landslides on slopes greater than 56% when there is a restricting layer in the soil profile such as compact glacial till. Although, soils with a water restriction layer are not extensive enough to be mapped, they are known to occur as inclusions. Thus, when soil-disturbing projects are proposed in areas where slopes exceed 56%, the sites should be investigated for the potential of landslides prior to the design and implementation.

Hydrology and Copper River Highway reconstruction

The State of Alaska Department of Transportation has plans to reconstruct the Copper River Highway in the next 10 years. The Copper River is eroding east near between milepost 40 and 44 of the Copper River Highway, and continued erosion may eventually damage the highway. A portion of the river is spilling into Clear Creek, and the drainage structures on the highway bed may not be able to pass the additional flow during high flow events. The Alaska Department of Transportation should consider the pros and cons of the following options: a) improving drainage under the highway by installing larger culverts or bridges, b) moving the highway to the east, or c) re-directing flows away from the highway using engineered structures.

Mineral resource development

Mineral development is often perceived to cause negative impacts to surface resources and conflict with other uses of the land. However, it can be managed to minimize such impacts. ANILCA and the Forest Plan provide additional protection of wildlife values in the analysis area. Mineral development should not be an issue in the analysis area because it is unlikely to occur in the foreseeable future given what is known of existing deposits. Significant development projects on National Forest system land, inholdings, or adjacent lands are unlikely given the current knowledge of mineral deposits, lack of interest, lack of activity, remote nature of the area, and lack of infrastructure.

Locatable mineral development can be managed under Forest Service regulations found at 36 CFR 228 Subpart A in order to minimize potential adverse impacts to surface resources. Salable minerals can be managed under regulations found at 36 CFR 228 Subpart C, Disposal of Mineral Materials. Mineral materials sales may be allowed, limited, or prohibited entirely. The BLM manages leasable activity but such activity must be consented to by the National Forest. Oil and gas resources are managed under regulations found at 36 CFR 228 Subpart E.

Any development that occurs under the Special Use Permit granted to CAC must be closely monitored to assure that the company abides by the various provisions of the permit that are designed to protect the surface resources of National Forest System lands. The 1982 CNI Settlement Agreement authorizes the Forest Service to modify or suspend operations when the conditions of the permit, or state or federal law are violated.

Only reasonably incidental activities should be allowed to occur under a mining plan of operations. It is recommended that the Forest Mineral Examiner be contacted when/if a plan of operations is submitted to the District. All proposals to mine leasable or salable minerals should be carefully weighted against the fish and wildlife values, and if allowed, mitigation measures must be developed to protect such values.

Non-native plant species

Owing to the relative rarity of non-native plants in the area, land managers of the Copper River Delta are in a unique position to prevent problems with non-native plant species. Prevention is generally much cheaper than control and identifying outbreaks early and responding to them quickly can reduce costs. Further, justification of an active program is non-native plant survey and control is specified by the Revised Forest Plan on pages 3-4, 3-25, and 4-10 (USDA Forest Service 2002b).

Threatened, Endangered and Sensitive Plant Species

Because this analysis area is within the known or suspected range of sensitive plant species and contains potential habitat for sensitive plant species, plant biological evaluations to analyze the possible effects on these plants must be conducted for land disturbing activities on National Forest System lands (FSM 2670.31 and 2670.32).

It is recommended that if any previously undiscovered sensitive plants are encountered prior to or during implementation of a project, the population should be protected and disturbing the area containing the population should be avoided (and similar habitats in that vicinity). The district or forest botanist/ecologist should be notified immediately to evaluate the population and recommend avoidance or mitigation measures.

Heritage Resources

Acts of Congress and Executive Orders mandate inventories of cultural resources and preservation and interpretation of all types of cultural resources for the benefit of the public. The National Historic Preservation Act (NHPA) requires consultation with Native tribes. In this area, that includes the Native Village of Eyak. In areas Chugach Alaska Corporation selected for conveyance, they will also be consulted. Other local interested parties may include groups such as the Cordova Historical Society.

Indirect as well as direct effects must be considered for each project. An example of a potential indirect effect is the creation of a new recreation trail that passes by a historic cabin or an archaeological site. By making access easier and routing the public into the vicinity of a cultural resource, the integrity of the resource is put at risk of either purposeful vandalism or accidental disturbance by the public.

Manage and interpret cultural resources in conjunction with other projects. Human use of the area has been generally due to the presence of various biological, botanical, geological and hydrological resources. Interpreting past use of the resources and the cultural resources that remain for the public will provide a holistic view of the area.

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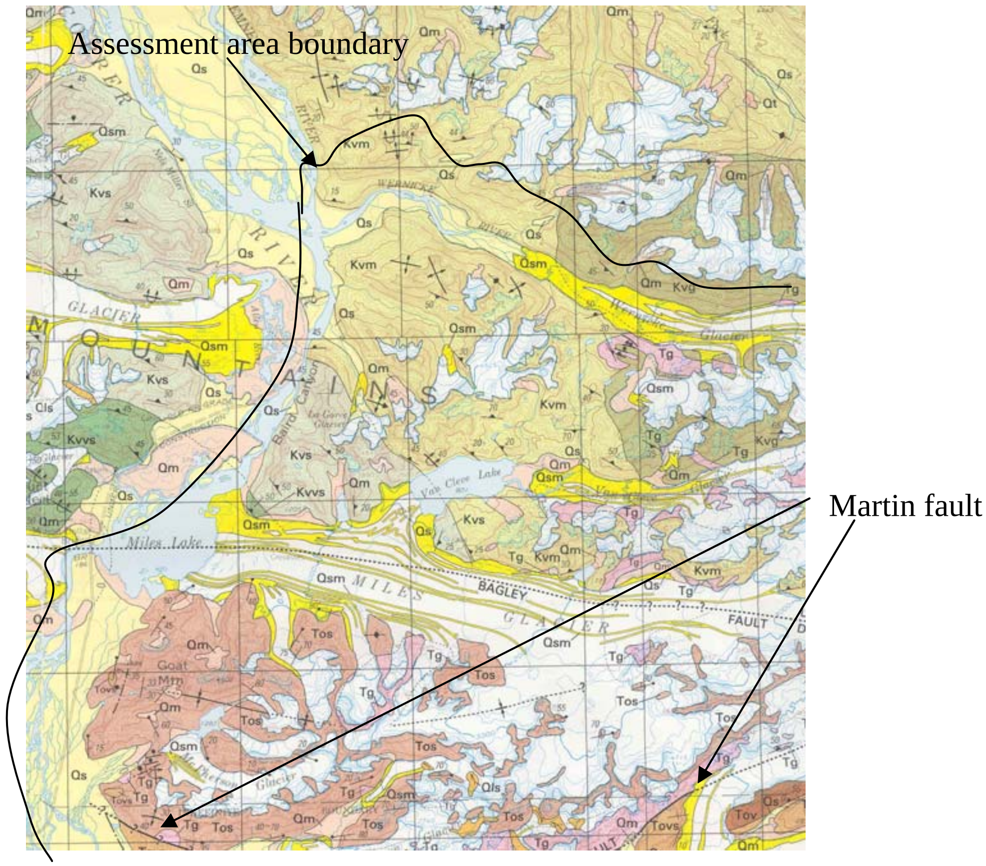
Appendix A – Maps, Tables, and Graphs

Geology

Figure A.1-Geology of the northern portion of analysis area. From Winkler and Plafker, 1993.



Vegetation

Table A.1 includes the scientific and common names of plant species mentioned in the text. The common names are those considered to be in most widespread use by workers in the study area.

Table A.1 – Plant list for East Delta analysis area with scientific name

Scientific Name	Common Name
TREES	
Picea sitchensis	Sitka spruce
Populus balsamifera ssp. *trichocarpa*	black cottonwood
Tsuga heterophylla	western hemlock
SHRUBS	

Scientific Name	Common Name
Alnus crispa ssp. *sinuata*	Sitka alder
Echinopanax horridum	devil's club
Myrica gale	sweetgale
Rubus spectabilis	salmonberry
Salix barclayi	Barclay willow
Salix sitchensis	Sitka willow
Vaccinium alaskense	Alaska blueberry
Vaccinium ovalifolium	early blueberry
FORBS	
Epilobium angustifolium	tall fireweed
Equisetum fluviatile	swamp horsetail
Lupinus nootkatensis	Nootka lupine
Lysichiton americanus	skunk cabbage
Menyanthes trifoliata	buckbean
Nuphar polysepala	yellow pondlily
Potentilla egedii	Pacific silverweed
Potentilla palustris	marsh fivefinger
Sparganium sp.	burreed
GRAMINOIDS	
Carex lyngbyei	Lyngby's sedge
Carex sitchensis	Sitka sedge
Deschampsia cespitosa	tufted hairgrass
Elymus arenarius	beach rye
Puccinellia sp.	alkaligrass

Figures A.2 and A.3 and Table A.2 display the amount of each vegetation type from the Forest corporate database. This information is based on 1976 timber type data and aerial photo interpretation. For the most part the vegetation type for private land will show up as acres with "no data" since the information is not in the database.

Table A.2-Vegetation characteristics of East Delta analysis area

Vegetation Type	Acres	Percent of Area (not water)
Alder	37,377	Tall Woody
Brush - other	39,414	165,390
Cottonwood	4,890	19.6%
Grass and Alpine	35,186	Low Woody
Hemlock	36,491	96,736
Hemlock-Spruce	56,812	11.5%
Mixed Hardwood-Softwood	1,911	Herbaceous
Sitka Spruce	65,286	49,350
Muskeg	14,134	5.8%
Non stocked	30	Non-Vegetated
Rock	14,031	26,549
Snow and Ice	12,518	3.1%
Other nonforest (in low woody)	19,945	
Water	(44,969)	n/a
No Data	516,847	61.2%
Salt water	(750,000)	n/a
Total Area	843,652	

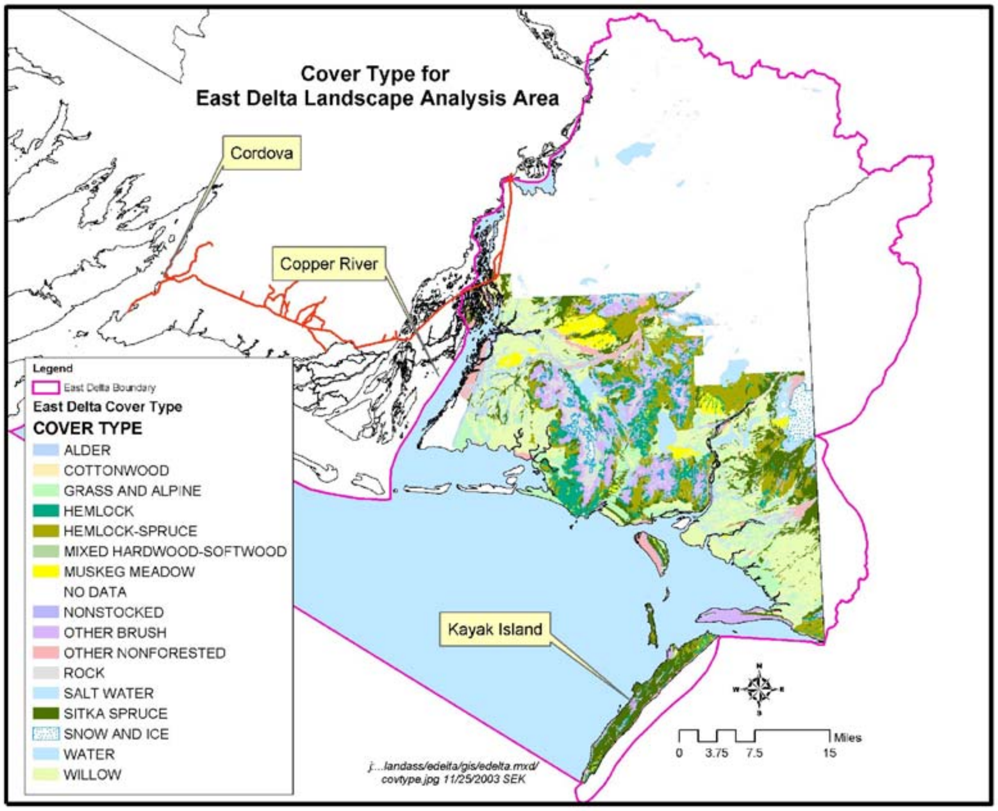


Figure A.2 – Vegetation cover from timber type maps for analysis area.

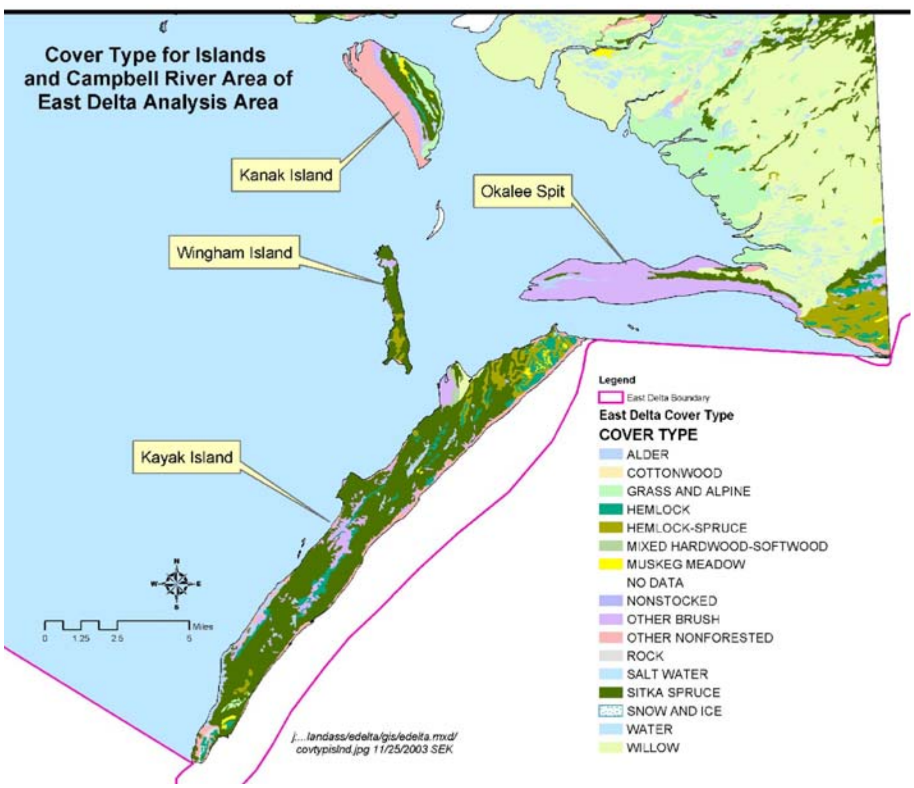


Figure A.3 – Cover types for islands portion of analysis area from GIS corporate database (2003)

Wildlife

Information on species detected on two breeding bird surveys are shown in Table A.3

Table A.3 – Species detected on 2 breeding bird surveys on Copper River Delta 1993 - 1995

Horned Grebe	*Podiceps auritus*	Tree Swallow	*Tachycineta bicolor*
Red-throated Loon	*Gavia stellata*	Violet-green Swallow	*Tachycineta thalassina*
Common Loon	*Gavia immer*	Bank Swallow	*Riparia riparia*
Great Blue Heron	*Ardea herodias*	Cliff Swallow	*Hirundo pyrrhonota*
Canada Goose	*Branta canadensis*	Barn Swallow	*Hirundo rustica*
Trumpeter Swan	*Olor buccinator*	Black-capped Chickadee	*Poecile atricapillus*
Gadwall	*Anas strepera*	Chestnut-backed Chickadee	*Poecile rufescens*
American Wigeon	*Anas americana*	Boreal Chickadee	*Parus hudsonica*
Mallard	*Anas platyrhynchos*	Red-breasted Nuthatch	*Sitta canadensis*
Northern Pintail	*Anas acuta*	Brown Creeper	*Certhia americana*
Blue-winged Teal	*Anas discors*	Winter Wren	*Troglodytes troglodytes*
Green-winged Teal	*Anas crecca*	American Dipper	*Cinclus mexicanus*
Ring-necked Duck	*Aythya collaris*	Golden-crowned Kinglet	*Regulus satrapa*
Lesser Scaup	*Aythya affinis*	Ruby-crowned Kinglet	*Regulus calendula*
Common Goldeneye	*Bucephala clangula*	Arctic Warbler	*Phylloscopus borealis*
Common Merganser	*Mergus merganser*	Townsend's Solitaire	*Myadestes townsendi*
Red-breasted Merganser	*Mergus serrator*	Gray-cheeked Thrush	*Catharus minimus*
Bald Eagle	*Haliaeetus leucocephalus*	Swainson's Thrush	*Catharus ustulatus*
Red-tailed Hawk	*Buteo jamaicensis*	Hermit Thrush	*Catharus guttatus*
Northern Harrier	*Circus cyaneus*	American Robin	*Turdus migratorius*
Greater Yellowlegs	*Tringa melanoleuca*	Varied Thrush	*Ixoreus naevius*
Lesser Yellowlegs	*Tringa flavipes*	Orange-crowned Warbler	*Vermivora celata*
Spotted Sandpiper	*Actitis macularia*	Yellow Warbler	*Dendroica petechia*
Least Sandpiper	*Calidris minutilla*	Myrtle Warbler	*Dendroica coronata*
Short-billed Dowitcher	*Limnodromus griseus*	Townsend's Warbler	*Dendroica townsendi*
Common Snipe	*Gallinago gallinago*	Blackpoll Warbler	*Dendroica striata*
Red-necked Phalarope	*Phalaropus lobatus*	Northern Waterthrush	*Seiurus noveboracensis*
Mew Gull	*Larus canus*	Wilson's Warbler	*Wilsonia pusilla*
Glaucous-winged Gull	*Larus glaucescens*	Chipping Sparrow??????	*Spizella passerina*
Arctic Tern	*Sterna paradisaea*	Savannah Sparrow	*Passerculus sandwichensis*
Rufous Hummingbird	*Selasphorus rufus*	Fox Sparrow	*Passerella iliaca*
Great Horned Owl	*Bubo virginianus*	Song Sparrow	*Melospiza melodia*
Belted Kingfisher	*Ceryle alcyon*	Lincoln's Sparrow	*Melospiza lincolnii*
Hairy Woodpecker	*Picoides villosus*	White-crowned Sparrow	*Zonotrichia leucophrys*
Downy Woodpecker	*Picoides pubescens*	Golden-crowned Sparrow	*Zonotrichia atricapilla*
Red-shafted Flicker	*Colaptes cafer*	Slate-colored Junco	*Junco hyemalis hyemalis*

Table A.3 – Species detected on 2 breeding bird surveys on Copper River Delta 1993 - 1995			
Olive-sided Flycatcher	*Contopus borealis*	Oregon Junco	*Junco hyemalis oregonus*
Western Wood-Pewee	*Contopus sordidulus*	Red-winged Blackbird	*Agelaius phoeniceus*
Alder Flycatcher	*Empidonax alnorium*	Rusty Blackbird	*Euphagus carolinus*
Say's Phoebe	*Sayornis saya*	Pine Grosbeak	*Pinicola enucleator*
Steller's Jay	*Cyanocitta stelleri*	Red Crossbill	*Loxia curvirostra*
Black-billed Magpie	*Cyanocitta stelleri*	White-winged Crossbill	*Loxia leucoptera*
Northwestern Crow	*Corvus caurinus*	Common Redpoll	*Carduelis flammea*
Common Raven	*Corvus corax*		

Appendix B – List of available resource reports and GIS products.

All reports and GIS products are electronically filed at Cordova District in J:/fsfiles/office/1900_planning/land_ass/edelta/

Resource Reports (/edelta/resource_rpts)

Fisheries Report – Dirk Lang
Lands Resource Report – Bruce Campbell
East Copper River Delta Hydrology Report – Bill MacFarlane
East Delta Wildlife Assessment report – Milo Burcham
Vegetation Ecology Resource Report – Rob DeVelice
Heritage Resources Report - Linda Yarborough
East Delta Soils and Wetlands Report – Ricardo Velarde
East Delta Minerals and Geology Report – Carol Huber
Subsistence Fisheries Report – Tim Joyce

GIS products (/edelta/gis)
Several ArcMap projects are located in the gis folder for "edelta". Main project is edelta.mxd which has the landstatus, Forest Plan, ROS cover types, roads, trails easements, streams and watershed boundaries. All maps and figures are located in the "map and figure" folder. Wildlife has a separate .mxd files.

Shapefiles and layers that have been clipped to the boundary are available in the gis folder and "shpfls" folder. These are based on August 2002 GIS information. Any updates to the corporate database are not reflected in these clipped layers.

Appendix C – 1982 CNI Settlement Agreement

From 1982 CNI Settlement Agreement, Katalla Exchange Preference Rights, pp 39-45

7. KATALLA EXCHANGE PREFERENCE RIGHTS

A. The lands adjacent to the Katalla Area consisting of 55,375 acres, more or less, and hereinafter referred to as the "Katalla Exchange Preference Area", shall be subject to the exchange preference described in this paragraph. The Katalla Exchange Preference Area is described as follows:

Township 17 South, Range 6 East, Copper River Meridian
Sections 26-27: All
Sections 34-35: All

Township 18 South, Range 5 East, Copper River Meridian
Sections 1-3: All
Sections 10-12: All
Sections 13-15: All
Sections 22-27: All
Sections 34-36: All

(-39-)

Township 18 South Range 6 East, Copper River Meridian
Section 2: All, including lots 1-4
Sections 3-10: All
Section 11: All, including Lots 1-3
and,U.S. Coal Survey 314
Sections 16-21: All
Sections 28-35: All

Township 19 South Range 4 East, Copper River Meridian
Sections 1-2: All including the unpatented portion of M.S. 1447
Section 3: All, fractional, including Unpatented portion of M.S. 1447
Section 4: All, fractional
Section 10: All, fractional
Sections 11-12: All, fractional, including the unpatented portion of M.S. 1447

Section 13: All
Sections 14-15: All, fractional
Sections 23-26:All, fractional
Section 36: All, fractional, including M.S. 881

Township 19 South Range 5 East, Copper River Meridian
Sections 1-9: All
Section 12: All
Section 13: N½NE1/4, SW1/4NE1/4,W½
Section 14: All
Sections 16-20: All
Sections 22-23: All
Section 26: All
Section 27: All,fractional
Section 29: N½,N½S½
Section 30: All
Section 31: All, fractional,including M.S. 881
Section 34: NE1/4
Section 35: All, fractional
Section 36: All, including the unpatented portion of M.S. 599

Township 19 South Range 6 East, Copper River Meridian
Sections 1-4: All
Section 6: All
Section 32: All, fractional

(-40-)

Township 20 South Range 5 East, Copper River Meridian
Sections 1-2: All, fractional

Township 20 South Range 6 East, Copper River Meridian
Section 4: W½
Section 5: N½
Section 6: All, fractional

B. The United States, through the Secretary of Agriculture, may make available to CNI for a period of twenty-five years from the date of this Agreement, the Katalla Exchange Preference Area for oil and gas exploration, development and production. In the event that the Secretary or his representative makes a management decision that all or any part of the Katalla Exchange Preference Area should be made available for oil and gas exploration, development, and production through the issuance of federal oil and gas leases, or similar federal action authorizing such activities, then CNI shall have the first opportunity to acquire, by exchange, rights to explore, develop and produce oil and gas in the Katalla Exchange Preference Area subject to the conditions of this paragraph and any subsequent exchange agreement. An exchange proposal may include interests in land greater than the oil and gas estate, including fee title. The United States shall not be obligated to make a management decision on opening all or part of the Katalla Exchange Preference Area.

C. At such time as a management decision, as set forth in sub- paragraph B of this paragraph, is made by the Secretary of Agriculture or his representative, the Secretary or his

(-41-)

representative shall so inform CNI in writing of such decision. In the written notice to CNI, the Secretary shall state the following:

(1) The area or areas within the Katal1a Exchange Preference Area being proposed for exploration, development, and production.

(2) To the extent known, the terms and conditions which will or may apply to any exploration, development, and production of the area or areas to be opened. It is recognized that the Secretary may impose more or less stringent requirements on operations within the Katalla Exchange Preference

Area than are imposed on operations within the Katalla Area.

(3) Any lands or interests in land owned by CNI that the Secretary would like CNI to consider for possible exchanges for the rights to explore, develop and produce oil and gas in the Katalla Exchange Preference Area.

D. CNI shall have up to two years from the date of receipt of the written notice to negotiate and execute an exchange agreement for lands or interests therein. The two year period for negotiation and execution of an exchange agreement shall not exceed the twenty-fifth anniversary of this Agreement.

(-42-)

E. Consistent with the provisions of this Agreement, all rights of CNI and the United States concerning the exploration, development and production of oil and gas in the Katalla Exchange Preference Area, and to lands or interests therein exchanged for such rights, shall be in accord with an exchange agreement negotiated between the parties at some future date. Such an agreement will provide, among other things, that any exploration, development, and production of oil and gas, and the utilization of other interests in land in the Katalla Exchange Preference Area shall be subject to such terms and conditions deemed appropriate, by the Secretary of Agriculture for the protection of fish and wildlife and the scenic, recreational, timber and other: 4t values of the lands of the united States.

F. Any exchange made pursuant to this paragraph shall be in accordance with section 22(f) of ANCSA, as amended or supplemented, or other authority existing at the time. All rights of exploration, development and production of oil and gas shall be subject to any laws in effect at the time such an exchange is to take effect.

G. The United States shall not be obligated to CNI in any way or liable for any damages in the event oil and gas exploration, development or production in the Katalla Exchange Preference Area is restricted or prohibited by:

(1) action of Congress; or

(-43-)

(2) administrative withdrawal; or

(3) state selection; or

(4) disposition of interests in lands other than oil and gas, and the right of access to such oil and gas.

H. If an exchange is offered to CNI for some or all of the lands within the Katalla Exchange Preference Area and an exchange agreement is not consummated in accordance with this paragraph, then, for a period of five years following expiration of CNI's negotiation period as provided in subparagraph I, the Secretary may lease, exchange or otherwise dispose to any other party any or all of the oil and gas rights and any other interests in those tt lands which had been offered to CNI, or allocate those lands or resources for any other purpose. The exchange preference right of CNI shall not inhibit, encumber or otherwise limit such subsequent allocation, lease, exchange or disposition of oil and gas or other interests in those lands. Following expiration of the five year period specified above, the Secretary shall again offer the lands to CNI pursuant to this paragraph if he makes a new management decision as set forth in subparagraph B of this paragraph.

I. If no management decision as set forth in subparagraph B of this paragraph is made within twenty-five years from the date of this Agreement or as provided in this subparagraph, whichever

(-44-)

comes first, then the exchange preference of CNI terminates. Additionally, except as provided in subparagraph H, the exchange preference of CNI will expire for any given area if no exchange agreement is forthcoming from exchange negotiations between CNI and the Secretary of Agriculture two years after the date of the notice provided CNI, in accordance with subparagraph D of this paragraph, or before the end of the two years if CNI states in writing its intent not to enter into an, exchange agreement. Any expiration shall not preclude any exchange or other disposition of lands by the Secretary to CNI or any other party in accordance with applicable law.

J. The State may select under Section 6(a) of the Alaska Statehood Act no more than 680 acres of land in the Katalla

Exchange Preference Area prior to July 1, 1983, and may make additional selections during subsequent rounds of selection. Selections made by the State prior to July 1, 1983, shall have priority over any exchange preference granted CNI under paragraph 7 of this Agreement. Any selections filed by the Stat~ after July 1, 1983, within the Katalla Exchange Preference Area shall be subject to this Agreement.

Appendix D – Public Involvement

Letters and emails were sent or phone calls were made to 75 individuals, organizations, landowners, and Native, State, Federal or City agencies soliciting input on the East Copper River landscape analysis in the winter of 2003. Six responses were received and those were used to develop key questions, issues, and potential projects. A summary of the comments follows the contact list. The Cordova District analysis file has the scoping letter that was sent out and the response letters that were received.

<u>Name</u>
Native Village of Eyak
City of Cordova - Mayor
State of Alaska Dept of Natural Resources – Parks
Cascadia Wildlands Project
National Park Service – Wrangell-St. Elias & Regional Office
Alaska Association for Historic Preservation
Ducks Unlimited
National Wildlife Federation
George Covel
Cordova ORV Group
City & Borough of Yakutat
Lonesome Dove Outfitters
Native Sun Charters and Copper River Cruises
Alaska River Rafters
Alaska Mountain Adventures
Clare Doig, Forest & Land Mgmt Inc.
Points North
State Historic Preservation Office
Toni and John Bocci – St. Elias Lighthouse Group

<u>Name</u>
Eyak Native Corporation
Cordova Historical Society
State of Alaska - Dept of Transportation
Tatitlek Native Corporation
Bureau of Land Mgmt – Glenallen office
Alaska Center for the Environment
Wilderness Society – Alaska
Dick Groff
Joan and Mike Jackson
Cordova Air
Osprey Expeditions
Alaska Trophy Hunts
Ellis Big Game Guides and Outfitters
Copper Oar
Vision Quest Adventures
Susan Ogle and Kelley Weaverling
Cordova Museum
The Nature Conservancy
Ecotrust

<u>Name</u>
Chugach Alaska Corp.
Audubon Society
Alaska Dept of Fish and Game – Cordova office
Cordova Chamber of Commerce
Cordova Fish and Game Advisory Board
Prince William Sound Science Center
Copper River Watershed Project
Dick Shellhorn
Sierra Club – Alaska
Fishing and Flying
North American Outfitters
Acord Guide Service
Bill Stevens, Cassandra Corporation
Alaska Hunting Adventures
Fejes Guide Service
Cordova District Fisherman United
Sundog Expeditions
Invasive Plant Group - UAF

Table D.1 East Delta December 2003 scoping summary sheet

#	issue - type	issue/service/ project description	concern	level to address	how to address
1	cabin	not wanting one on east delta	Hope that Forest Plan does not obligate us to build one.	ID in LA & project scoping	Find out specific concern
1	Outfitter /guides	impact of Ranney permit	permit is far to broad and intrusive on other users	Permit followup & NEPA	Call to see if mitigation in permit addresses his concern.
2	Outfitter /guides	be able to guide hunters	continue to guide mid to late Sept.	Permit followup & NEPA	permit

#	issue - type	issue/service/ project description	concern	level to address	how to address
3	cabin	would like cabin on edelta	"lists places for cabin. A) Kanak Island - beach combing, clams, b) Kayak Island - 2 sites, 1 near west side opposite wingham Island by Stellers landing site, near Ranney's strip on outside Kayak, c) Tokun Lake at upper end? Fishing, goat & bear"	ID in LA & project scoping	Alternatives, pros & cons of site suggestions
4	Coordinated resource mgmt	Multiple agencies and landowners in Copper River watershed - need to address threats and issues on a whole system approach	Ecotrust can work with all stakeholders for an integrated approach	LA	use integrated approach for this LA & project level NEPA. plans of adjacent landowners etc
5	future plans	Carbon Mountain Road	will be built as soon as economically feasible. No hard date	LA	n/a
6	Monitoring	"Katalla area for wildlife, bird, fish"	important if drilling	LA/ Katalla EA	check in Katalla EA
6	studies needed	"presence, extent and impact of natural oil and gas seeps in Katalla area"	water quality	LA	
6	inventory	historic sites in Katalla area	several sites listed, need archeologist on team	LA	an archeologist is on team, discuss areas in existing resource"
6	oil potential in Katalla Area	"Projections of future oil development and what it would look like, ways it would be developed"	oil/gas development will change things	LA/ EA	
6	analysis extent	analyze Katalla Area and Katalla exchange as tho they were NF since they are	What will FS do once oil threat is gone	Forest Plan	
6	cabin	things fine way they are	"maintenance is difficult, more visitors than area can support and be wild"	LA/EA	ROS class & PAOTS
6	mapping	need updated GIS layers for east Delta	"nesting, salmon habitat, forest type layers"	LA	future work/projects
6	monitoring	hydrology of Bering /Martin/Copper R	how evolved over time - critical to long term mgmt	LA	future work/projects
6	monitoring	recreation & Tourism use	who/what/why/where/what they think etc	LA /Forest Plan monitoring	future work /projects, also point to national work being done
6	current projects	Tourism loop - up delta. Eyak Corp dev lands, Princess lodge on Klutina, cruise ships, logging near Cape Yakataga - cumulative effects, University timber rights at Cape Suckling	dev should be given a close look - pvt lands, princess, logging moving westward	LA/Forest Plan monitoring	Cape Yakataga harvest is on other side of Bering Glacier. Not in analysis area or NF lands